Example Application
of
Cockpit Emulator for Flight Analysis
(CEFA)

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Preface

This example application has been prepared by CEFA Aviation in conjunction with the Global Aviation Information Network (GAIN) Working Group B (Analytical Methods and Tools) (WGB) as one of a number of such examples of the use of analytical methods and tools described in the "*Guide to Methods & Tools for Airline Flight Safety Analysis*". The intent of these example applications is to illustrate how various tools can be applied within an airline flight safety department, and provide additional information on the use and features of the tool and the value of such analysis. GAIN WG B hopes that these example applications will help increase the awareness of available methods and tools and assist the airlines as they consider which tools to incorporate into their flight safety analysis activities.

Each example application of an analytical method or tool is posted on the GAIN website (*www.GAINweb.org*). Readers are encouraged to check the website periodically for a current list of example applications, as further examples will be added as they become available.

CEFA - Cockpit Emulator for Flight Analysis

1 Introduction

CEFA (Cockpit Emulator for Flight Analysis) is a powerful, comprehensive, and interactive tool for displaying information from any aircraft flight data recorders (DFDR, QAR, Wireless Telemetry). The software used is with event detection and any analysis ground station tool (FOQA), see figure 1. CEFA is aimed at airlines, aircraft manufacturers, and training organisations. It has been created to be used by pilots, analysts and maintenance technicians. CEFA reproduces the flight deck, instrumentation and the exterior view of the aircraft accurately, as a dynamic simulation on a personal computer, using one or more screens.

The software is divided into two distinct parts each with a specific role: **Analysis** and **Training**.

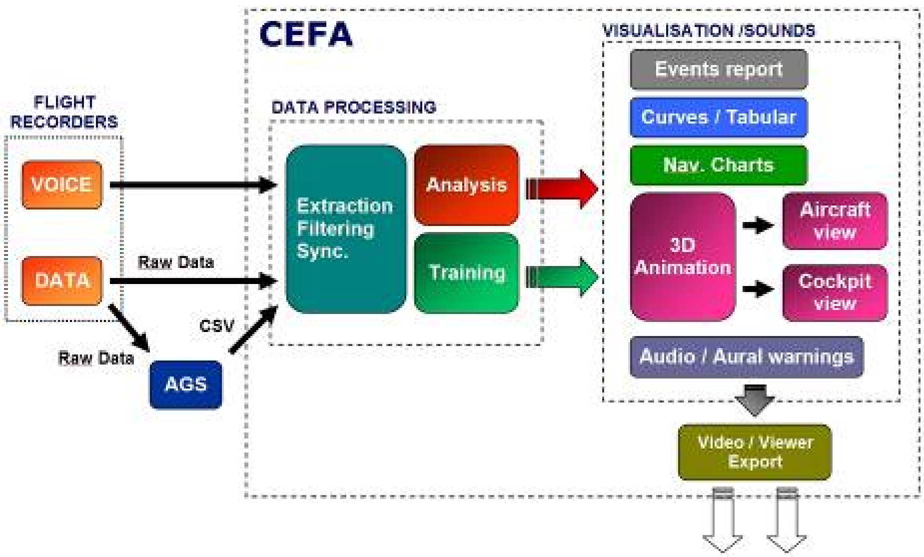

Figure 1 **The CEFA System**

1.1 OVERVIEW OF THE TOOL FUNCTIONALITY

a. "CEFA Analysis" has been developed for use in analysis in which only recorded parameters are used. They are displayed by a panoramic virtual cockpit with fully realistic instrumentation. The symbols and functional models are re-created in an identical fashion to the original cockpit to minimize the need for interpretation. Other classic tools are also provided such as a curve-tracing module, tabular data and a navigational chart with the aircraft trajectory superimposed.

   Besides the classic tools, the philosophical concept behind CEFA software leads us to understand the complex relationship between man and machine. It considers all the following requirements:

   - Reduce conceptual effort to a minimum. It goes without saying that forming a mental picture is subjective. Thus two people analyzing the same event may have distinct perceptions and therefore react differently.

- Restrict the interpretative effort required by using a familiar environmental context that is a specific cockpit for each aircraft type.
- Enlarge the field of vision to include the full control panel so the information is displayed in context. A view restricted to part of the panel only, showing indistinct instruments, makes a full analysis impossible. Essential data presented on a single instrument does not have the same effect as the information displayed in a full panoramic cockpit. With the information hidden somewhere in the mass of instruments, the viewer develops realistic situational awareness.
- Integrate all parameters for a perfect analysis.

b. "CEFA Training" is based on the need to communicate an effective, high-quality message, adapted for training purposes. The realistic representation of a cockpit acts at an emotional level, helping the memorisation process.

"CEFA Training" uses all the functionality of "CEFA Analysis" with adding restored parameters. Virtual hands can also be added to display the various operations of the control panel instruments. Of course, all these elements are only possible within the strict context of the training environment. If necessary, the display may be limited to one, or a selection of instruments, to focus attention on these.

1.2 INTRODUCTION TO THE EXAMPLE APPLICATION

The CEFA application demonstration is based on the flight of an Airbus A320, where its two main hydraulic systems have failed during take off, thus forcing the crew to do a U-turn and to request an emergency landing. The analysis allows us to understand the incident as it unfolds and the reactions of the crew faced an unexpected situation.

2 Input Data

CEFA accepts binary flight recorder data (raw data) or CSV (Comma Separated Value – ASCII) using an additional analysis tool, which produces this format. In this case, the CSV file generates specific formatting, defined in a supplied configuration file. For each type of aircraft, CEFA uses a flight parameter description file. This describes the details of each parameter recorded and the way in which it is to be handled by the system. Flight data loading and processing take around 20 sec /flight-hour which is fast considering that only portions of flight are usually analysed with such a tool.

3 Analytical Process and Tool Output

Following the detection of an event by a filtering tool (FOQA), the flight file is exported to CEFA and dynamically analyzed. CEFA loads the data and continues to corroborate all the parameters to remove faults related to specifying the recorded frame. *Note: The user always has access to the original data for comparison and verification purposes.*

When the data has finished loading, a preliminary event report is displayed on-screen, see figure 2. This report lists all the events chronologically (alarms, loss of synchronisation, etc.) as well as their respective duration.

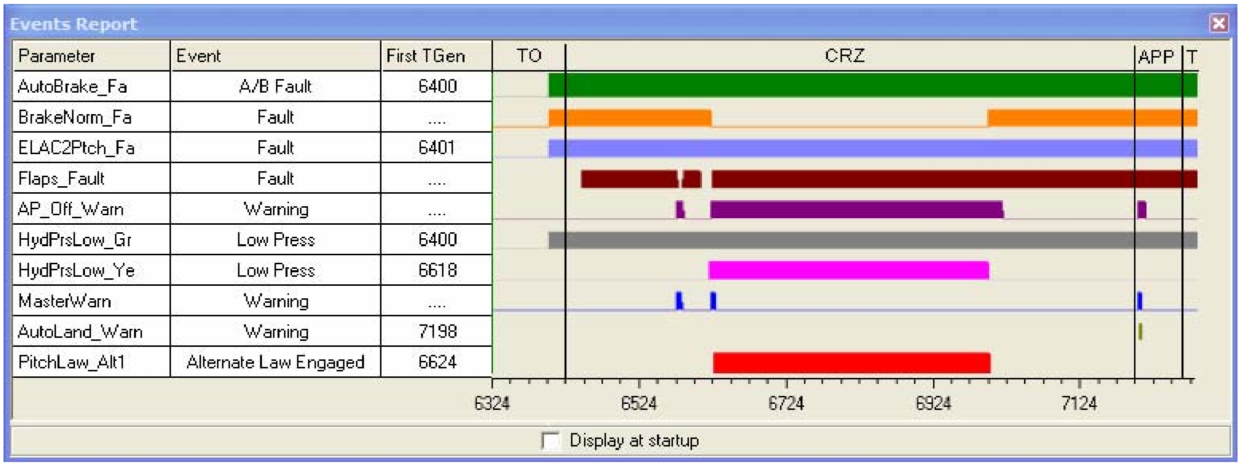

Figure 2 **Events Report**

Next, several windows can be resized are displayed in figure 3: A panoramic view of the virtual cockpit, matching that of the analyzed aircraft, appears on the first three screens, while a three-dimensional representation of the aircraft in flight appears on the fourth and final screen**.** As the pilot within the cockpit, the analyst can verify various aircraft systems status with the mean of additional pages displayed on dedicated instruments, see figure 4.

The display is complemented by a detailed curve-tracing module showing essential information about the change of parameters during the flight, and a navigational chart module, see figure 4. All these elements are fully synchronised and allow the user to become part of the analysis experience. A command bar with VCR-style buttons can then be used to view the flight.

Figure 3 **CEFA Single Screen Version**

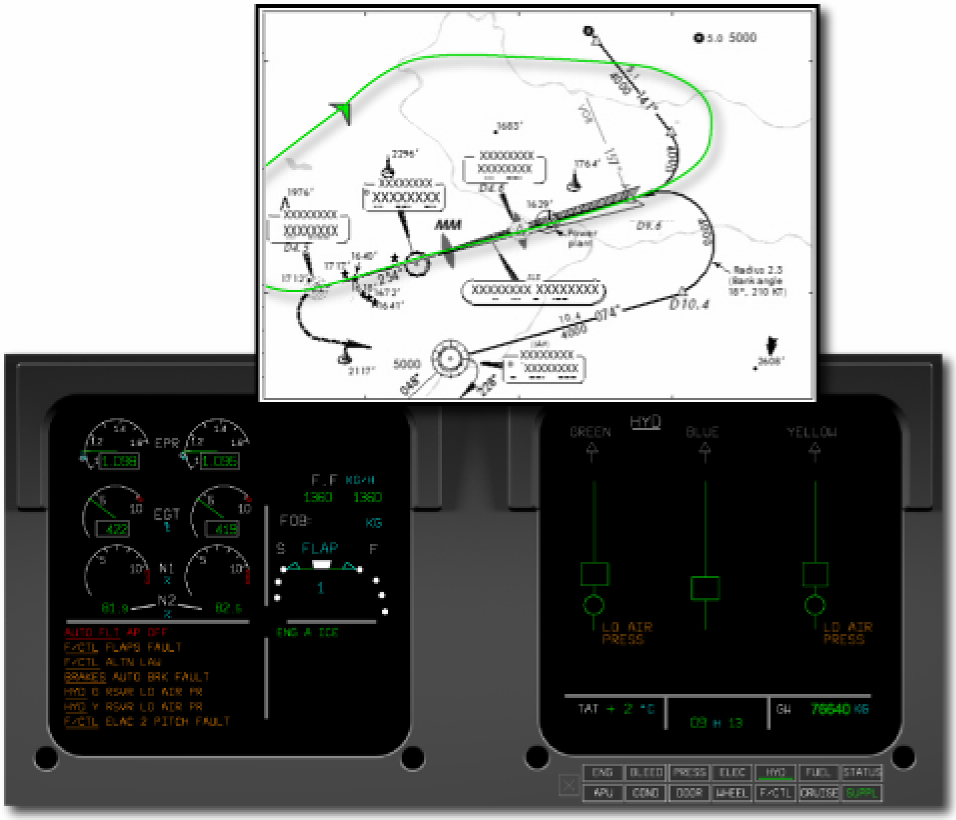

Figure 4 **Warning Messages, Aircraft Systems Pages & Navigational Chart Modules**

<u>One click on the "RUN" button replays the incident:</u>

Shortly after take off, with 1,700 ft indicated on the radio altimeter, the "Low-Pressure" alarm for the green hydraulic circuit (engine 1) illuminates. A series of alarms follow, indicating the downgrades of the braking system and malfunctioning flight controls (flaps and spoilers). The flaps remain jammed in position 1 (take off) despite the efforts of the crew to retract them. Twenty seconds later the flight captain decides to do a U-turn and contacts the control tower. The aircraft continues to climb to 10,000 feet, but experiences another alarm that indicating a drop in pressure in the yellow hydraulic circuit (engine 2), see figure 4.

The aircraft banks several times in succession and starts to descend. The ILS beam is intercepted, the autopilot activated and the Approach mode engaged. Three minutes before landing, the yellow hydraulic circuit returns to normal. At 8 NM, the crew carries out an emergency landing gear extension and then tries to extend the flaps to the approach configuration, but without success. Only the slats are correctly positioned. The aircraft is correctly aligned and the crew keep the autopilot engaged until 40 feet above the ground. The wheels touch the ground and the two thrust levers are placed in the "reverse" position. The "reverse" thrust application for engine n°1 does not work, causing unequal thrust. The crew compensate by using the brakes and the rudder pedals to keep the aircraft aligned with the runway. The aircraft stops without mishap.

4 Application of the Results of the Analysis

The analysis of this incident provides us with useful information about the behavior of a crew when faced with a critical situation. The high approach speed combined with severely restricted braking ability could have caused the aircraft to overrun the runway.

This incident is interesting from a training perspective. It allows participation in a real-life incident (rather than a mere simulation) that is brought to a successful conclusion by the application of correct procedures, but could have had dramatic consequences.

Users can switch to “CEFA Training” and fine tune the animation to add elements that improve understanding. The results can be exported in the form of a video (compressed.avi) or an encrypted flight file for use in a viewer without quality degradation (a cut-down version of CEFA).

The animation can then be projected in a classroom and the incident analyzed in detail during a CRM session. It would be interesting to determine what should or should not be done in these circumstances. A positive exchange of information between participants can then take place.