ISASI

2016 MILITARY AIR SAFETY WORKSHOP

Using engineering advanced simulators to support accidents/major incidents investigations

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Objectives

1. To highlight the role that an Advanced Engineering Simulator, fitted with real Aircraft Re-hosted Software and Visual Systems, can play as a key Accident/Major Incidents investigation tool.

2. To introduce a Methodology which can help Official Investigation Boards to perform qualitative assessments of accident scenarios using Advanced Engineering Simulators.

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Scope

- ✓ Simulator description + Accident case
- ✓ Accident case analysis provided exclusively under the role of Technical Advisor to the SP MoD Official Investigation Board: *Aircraft behaved as designed*?
- ✓ Only technical facts and findings: No pilot actions interpretation

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A bit of background: Airbus DS role

On-site

✓ **Airbus DS acts as Technical Advisor to Investigator In Charge.**

References:

- STANAG 3531.
- ICAO Annex 13.

✓ **Full cooperation with Investigation Boards:**

- Support always offered.
- On-site once Investigation Board in charge has provided authorization.
- Full confidentiality, acting as previously agreed.
- Detail findings in real time.
- Facts provided and on-site report review with Investigation Team.

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A bit of background: Airbus DS role

Post-accident support to Official Investigation

- ✓ **Airbus DS Lead Investigator : Focal point be C and Airbus DS specialists.**
- ✓ **Resources available:**
  - ➢ Engineering expertise and man
  - ➢ FDR data analysis tool
  - ➢ Flight Simulator
  - ➢ **Engin aboratories: ARBS and Mission Systems**
  - ➢ 10, C295-S1 and A400M.
- ✓ **U eports issuance:**
  - ➢ s description
  - ➢ Rig/Ground/Test results and detailed analysis.

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Eurofighter Engineering Simulator: Aircraft

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EF2000 Typhoon

Highly agile Air Superiority and Air-to-Surface, multirole weapon system.

DIMENSIONS / MASS	
Wingspan	10.95 m (35 ft 11 in)
Length overall	15.96 m (52 ft 4 in)
Height	5.28 m (17 ft 4 in)
Wing Area	51.2 m² (551.1 ft²)
Basic Mass Empty	11,000 kg (24,250 lb)
Maximum Take-off	> 23,500 kg (51,809 lb)
Maximum external load	> 7,500 kg (16,535 lb)

DESIGN CHARACTERISTICS	
Single seat twin-engine, with a two-seat variant	
Weapon Carriage	13 Hardpoints
G' limits	+9/-3 'g'
Engines - Two Eurojet EJ200 reheated turbofans	
max dry thrust class	60 kN (13,500 lb)
max reheat thrust class	90 kN (20,000 lb)

GENERAL PERFORMANCE CHARACTERISTICS	
with a full Air-to-Air Missile Fit	
Ceiling	> 55,000 ft
Brakes off to 35,000 ft / M1.5	< 2.5 minutes
Brakes off to lift off	< 8 seconds
At low level, 200 Kts to Mach 1.0 in 30 seconds	
Maximum Speed	Mach 2.0
Operational Runway Length	< 700 m (2,297 ft)

Eurofighter Engineering Simulator: Description 2 / 6

Eurofighter Tactic Development Simulator (SDT):

- ✓ **Advanced Engineering Simulator**
- ✓ **Initially designed for Eurofighter Flight Control Laws clearances**
- ✓ **Continuous updating to support SAF requests for Aircraft Handling and Procedures Training.**
- ✓ **Final evolution has led to a full production aircraft representative simulator based on:**
  - ➢ Related systems software re-hosting.
  - ➢ Control room fitted with analysis and systems failures injection tools in real time.
  - ➢ Real cockpit fitted in a 3D visual environment

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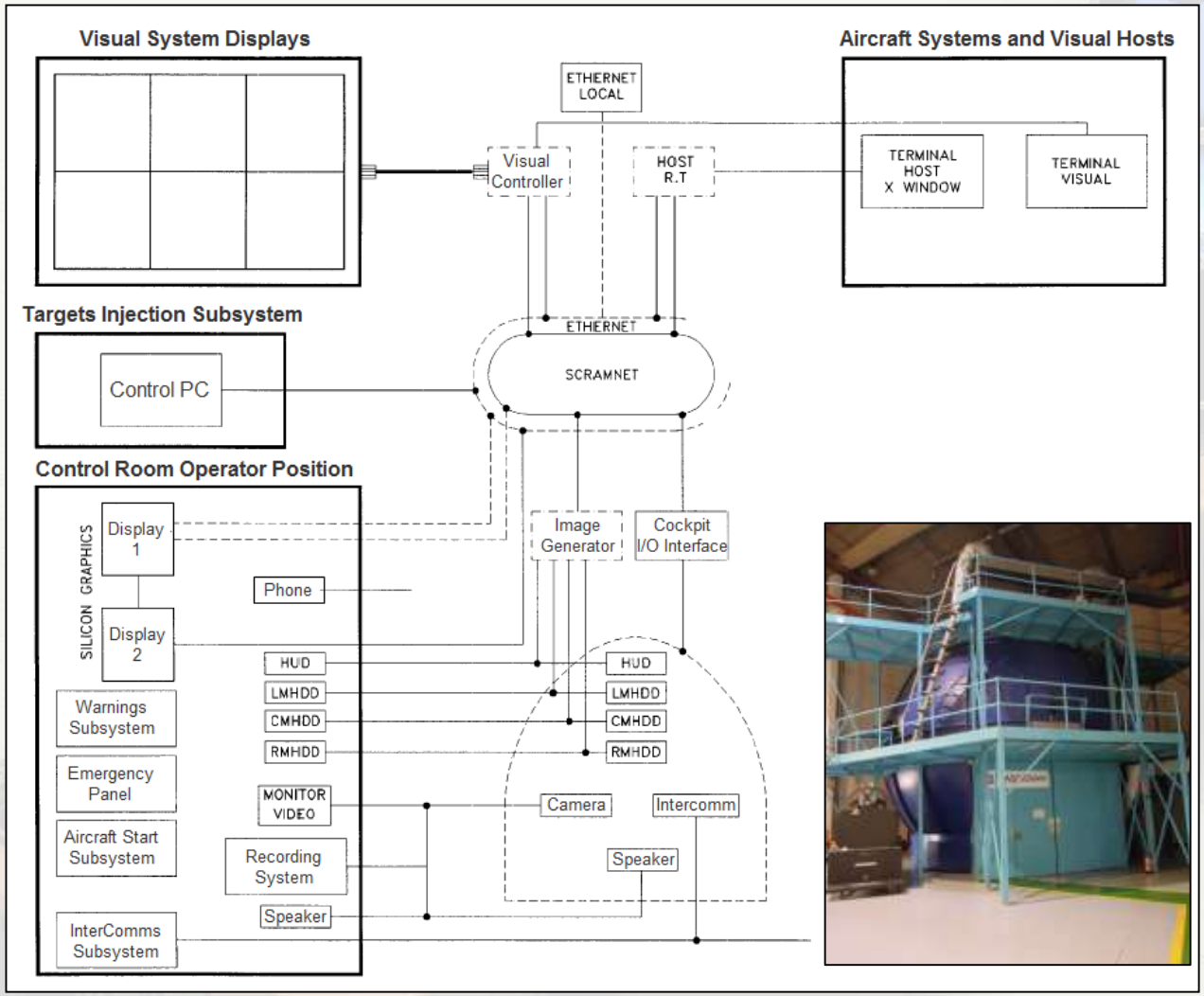
Eurofighter Engineering Simulator: Description 3 / 6

Eurofighter SDT: Architecture overview



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Eurofighter Engineering Simulator: Description 4 / 6

Eurofighter SDT: Re-hosted systems

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Eurofighter Engineering Simulator: Description 5 / 6

Eurofighter SDT: Control Room

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Eurofighter Engineering Simulator: Description 6 / 6

Eurofighter SDT: Real cockpit in 3D visual environment

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Accident case: SAF EF2000 C16-34

Accident background

- ✓ SAF EF2000 Single Seater. Routine training mission.
- ✓ Crash occurred in June 9th 2014, at 14:00 LT at Moron AFB following runway fly-over. Pilot fatally killed.
- ✓Airbus DS support on-site immediately (Go Team) offered.

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Accident case: SAF EF2000 C16-34

Stakeholders role:

✓**CITAAM**: *Sp MoD Military Aircraft Accidents Technical Investigation Committee*

- **Technical investigations conducted under RD 1099/1994**.
- **Direct reporting to the Chief of Logistic Support (Lt General)** and, through the Air Force Chief of Staff, to the Ministry of Defence.
- **Members**: President [Major General] + 7 Pilot Officers Armed Forces representatives + 1 Engineer Officer + 1 Medical Officer + 1 Legal Advisor
- **Convening an Accident Investigation Board**:
  - Nomination by order of the Chief of Logistic Support
  - Standard team:
    1xPilot Officer + 1xEngineer Officer + 1xNCO + 1xMedical Officer + Others, as required.
  - Committed to issue an Initial Report in less than 45 days. Final, 1 year.
  - Not public releasable. However, considerations for high interest mishaps.

✓**Airbus DS:**

- **Technical advisor if specifically requested by CITAAM**

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Accident case: SAF EF2000 C16-34

Support provided to Accident Investigation Board

✓**Technical support specifically requested by the Board:**

- Aircraft systems detailed information, beyond Operational Manuals already available in the Squadron.
- Recorded aircraft data analysis subject to confidentiality measures
  - 'No disclosure' pledge signed by all involved Airbus DS personnel.
  - Data files saved in secure server under controlled access.

✓ **Tool offered by Airbus DS: Eurofighter engineering simulator**

- To substantiate aircraft systems behaviour.
- To qualitative evaluate aircraft final maneuver.

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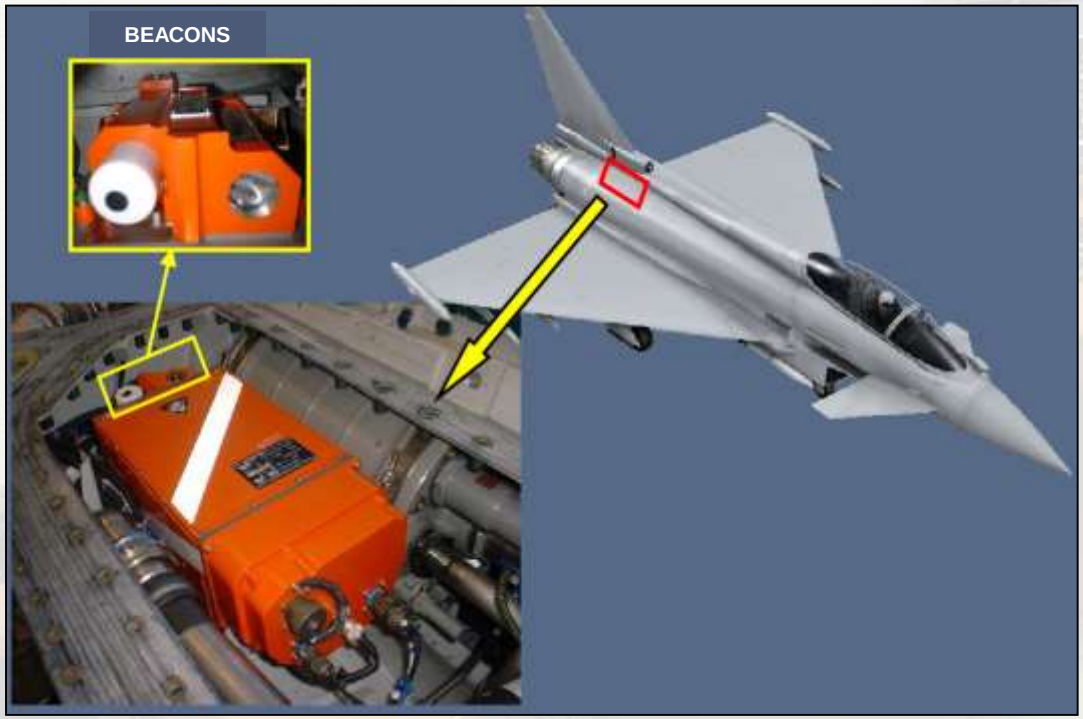
Accident case: SAF EF2000 C16-34

Support provided to Accident Investigation Board

✓ **Recorded data analysis (1 / 2):**

- **Recorder**: CSMU [Crash Survivable Memory Unit]



- **Recorded parameters**:
  - ✓ **Discrete Take Off data**: From PowerOn upto 90 secs after WoW.
  - ✓ **Continuous data (510 parameters)**: Data from all aircraft sub-systems required to support accident investigation. From APU start upto PowerOff
  - ✓ **Audio data**: Intercomm, T/R audio, ground crew audio, tele-brief, warning tones
  - ✓ **Header data**: Flight number, date and UTC time.

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Accident case: SAF EF2000 C16-34

Support provided to Accident Investigation Board

- ✓ **Recorded data analysis (2 / 2):**

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Accident case: SAF EF2000 C16-34

Support provided to Accident Investigation Board

✓ **Eurofighter engineering simulator:**

- **Configured as per affected aircraft** [Sw + stores + fuel distribution]
  - ✓ Sw: PSP [*Production System Package*] 3.73.
  - ✓ External stores: 2xSFT (Supersonic Fuel Tanks) and 2xAIM-120 in stations 9 and 12.
  - ✓ In addition: 150 rounds, 160 Chaff and 60 flares.
  - ✓ Fuel distribution: Fuselage only
  - ✓ No malfunctions declared by aircraft ⇒ No systems failures injected.

- **Two (2) main tasks**:
  - ✓ Aircraft recorded inputs injected to the simulator. Data post-processing including output data comparison with aircraft recorded outputs.
  - ✓ Qualitative assessment involving Squadron and Airbus DS EF2000 pilots.

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Accident case: SAF EF2000 C16-34

Support provided to Accident Investigation Board

- ✓ **Eurofighter engineering simulator:**
  - Recorded inputs injected:
    - ✓ Initial conditions as per recorded data: Begin of turn for runway overpass
    - ✓ Stick and throttle inputs.
    - ✓ No systems failures. However, further trade-off done for verification purposes.
    - ✓Recorded sim outputs for comparison with CSMU data:
      - ➢ Aircraft attitude
      - ➢ Flight controls deflection
      - ➢ Cockpit indications
      - ➢ Warnings
    - ✓ Results:
      - ➢ 'Output CSMU data' *vs* 'Sim data' matching better than 2% in all parameters.
      - ➢ Aircraft behaviour as per designed.

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Accident case: SAF EF2000 C16-34

Support provided to Accident Investigation Board

- ✓ **Eurofighter engineering simulator:**
  - Qualitative assessment:
    - ✓ CITAAM: Human factors involved ?
    - ✓ Performed by Squadron an
      - A. First step: Bil
      - B. Se
      - C. Visual references: Disorientating?

Aircraft response in accordance with design

Human factors to be considered

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Conclusions

1. Modern aircraft are highly integrated machines fitted with complex systems driven by even more complex algorithms.
2. Classical recorded data analysis (i.e.: Time histories) can not be enough to fully understand the causes of an accident.
3. Engineering simulators fitted with re-hosted aircraft Sw, real cockpit and 3D visual environment allows to explore several aspects not reachable by classic analysis.

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