Evaluating Commercial off the shelf (COTS) solutions for Flight Data Monitoring

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Outline

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Introduction

- Business/Corporate aviation sector highly diverse
- Corporate/Executive aviation (2 person professional crew) accident rates comparable with commercial airlines
- Air taxi and business aviation (single pilot) accident rates are higher > opportunity for improvement
- FDM routinely used by commercial airlines (more complete & balanced view of flight ops, risks & mitigating actions)
- FDM uptake in Business/Corporate aviation limited due to:-
  1. Size & diversity of fleets
  2. Lack of digital data-bus (legacy aircraft)
  3. Cost
  4. Lack of legislation
- If points 1-3 can be addressed then uptake of FDM may be increased??

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Diversity of the Business Aviation Fleet

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Accident Rates by Sector for USA, 1990 to 2013 (NBAA)

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Project Objectives

- To determine if:-
  - COTS technologies may support FDM for Business/Corporate
  - flight parameters can be measured and at what frequency and precision.
  - flight parameters can be related to significant (CAA Sig-7) events or pre-cursors.
- To compare the quality of the trend information against that received from a QAR
- To determine installation reqs. & considerations
- To disseminate the research findings as agreed by the participating stakeholders.

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FDM Integration

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Desktop Study:
Safety events vs device type

	CFIT	LOC	MAC	MAINT	REX	PHASES (S) OF FLT	EVENT CATEGORY	Event No.	Event Group RED - essential - directly unsafe	Description	Calibrated Airspeed, CAS (kts)	Ground Speed (GSPC), V_G (kts)	Pressure Altitude, FALT (ft)	Altitude above Mean Sea Level (AAL) (ft)	Distance to AAL & AALT & Distance	Radio Altitude, FALT (ft) AGL
2		X				ALL IN FLIGHT	SOP/FLT MAN	1	Flight Manual Speed Limits	Vmo exceedance	X		X			
3		X				ALL IN FLIGHT	SOP/FLT MAN	2	Flight Manual Speed Limits	Mmo exceedance	X		X			
4		X				ALL IN FLIGHT	SOP/FLT MAN	3	Flight Manual Speed Limits	Flap placard speed exceedance	X					
5		X				ALL IN FLIGHT	SOP/FLT MAN	4	Flight Manual Speed Limits	Gear down speed exceedance	X					
6		X				ALL IN FLIGHT	SOP/FLT MAN	5	Flight Manual Speed Limits	-	X					
7		X				ALL IN FLIGHT	SOP/FLT MAN	6	Flight Manual Altitude Limits	Exceedance of flap/slat altitude			X			
8		X				ALL IN FLIGHT	SOP/FLT MAN	7	Flight Manual Altitude Limits	Exceedance of maximum operating altitude			X			
9	X				X	DES-APP-LDG	SOP	8	High Approach Speeds	Approach speed high within 30 sec of touchdown	X					
10	X				X	APP-LDG	SOP	9	High Approach Speeds	Approach speed high below 500 ft AAL	X		X	X		
11	X				X	APP-LDG	SOP	10	High Approach Speeds	Approach speed high below 50 ft AGL	X				X	
12	X				X	APP-LDG	SOP	11	Low Approach Speed	Approach speed low within 2 minutes of touchdown	X					
13	X					TO-CLB	SOP	12	High Climb-out Speeds	Climb out speed high below 400 ft AAL	X		X	X		
14	X					INITCLB-CLB	SOP	13	High Climb-out Speeds	Climb out speed high 400 ft AAL to 1000 ft AAL	X		X	X		
15		X				TO-INITCLB	SOP	14	Low Climb-out Speeds	Climb out speed low 35 ft AGL to 400 ft AAL	X		X	X	X	
16		X				INITCLB-CLB	SOP	15	Low Climb-out Speeds	Climb out speed low 400 ft AAL to 1500 ft AAL	X		X	X		

	Type 1	Type 2	Type 3
Events	QAR	iFDR	EFIS
No. of Available Parameters	86	16	49
Baseline Events (59)	59	9	30
%age of QAR Baseline Events	100%	15.3%	50.9%
Extended Events (22)	22	11	17
%age of QAR Extended Events	100%	50%	77.2%
ALL Events (81)	81	20	47
%age of ALL Events	100%	24.7%	58%
Rank	1	3	2

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Simulated FDM

Full Flight Simulator → **Simulator Data Log** → **Simulated Device Types**

Type 1:
QAR
(FDR/SSFDR)

Type 2:
iFDR

Type 3:
EFIS with
data
collector

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Simulator Sessions

Simulator Session No.	Aircraft	Pilot	LPC/OPC	Duration (hrs)	No. Files	File Size (Mb)	Usable?
~~1~~	~~G550~~	~~1~~	~~??~~	~~1~~	~~88~~	~~9.23~~	~~No~~
2	G550	2	Yes	2	88	18.25	Yes
3	G550	3	Yes	4	88	34.60	Yes
4	G550	4	Yes	4	88	34.00	Yes
5	G550	5	Yes	4	88	37.00	Yes
Total		4		14	352	123.85	

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FDM Analysis using Flight Simulation

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Results

Phase of Flight	LFL_1 (QAR)	LFL_2 (iFDR)	LFL_3 (EFIS)
Air	5		4
	(100%)	(0%)	(80%)
Ground	2		1
	(100%)	(0%)	(50%)
Landing & Approach	64	9	33
	(100%)	(14%)	(52%)
Take Off & Climb	25	13	18
	(100%)	(52%)	(72%)
Grand Total	96	22	56
Using QAR as a 'baseline'	(100%)	(23%)	(58%)

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Conclusions

Within the limitations of the study it has been shown that:-

- QAR is effective in detecting safety events in all phases of flight
- Simulated EFIS data collector detected more than 58% of ALL safety events in ALL phases of flight (52% of App & Ldgs)
- This could improved by the addition of warnings & configuration data
- Simulated (stand-alone) iFDR detected only 23% of ALL safety events in ALL phases of flight (14% of App & Ldgs) due to lack of air data, WX, warnings and configuration data
- However, a detection rate of 23% is better than 0%!
- Extension of the basic iFDR parameter set using sensed or derived parameters will increase effectiveness

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Conclusions…cont'd

- Flight simulation method offers an effective means to:-
  - Rapidly evaluate new technology
  - Rapidly develop LFLs for new devices/aircraft more quickly than manual/desktop approach (identify false +VEs/-Ves)
  - Compare devices/LFLs

- Commercial operators may extend FDM scope by:-
  - Use of iFDR technologies for legacy aircraft with no QAR capability;
  - Use of EFIS systems with data collectors for aircraft < 27 tonnes where no QAR is fitted

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Further Reading

Bromfield, M.A., Walton, T., Wright, D. & Rusby, M., (2016) ' Commercial off The Shelf (COTS) Flight Data Monitoring (FDM) Solution For Business Aviation' CAP 1394, Civil Aviation Publications, United Kingdom Civil Aviation Authority, Gatwick, UK.

www.caa.co.uk/CAP1394

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QUESTIONS?

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