Ukraine International Airlines UIA

USING DATA

for Preventive Maintenance of Embraer 190/195

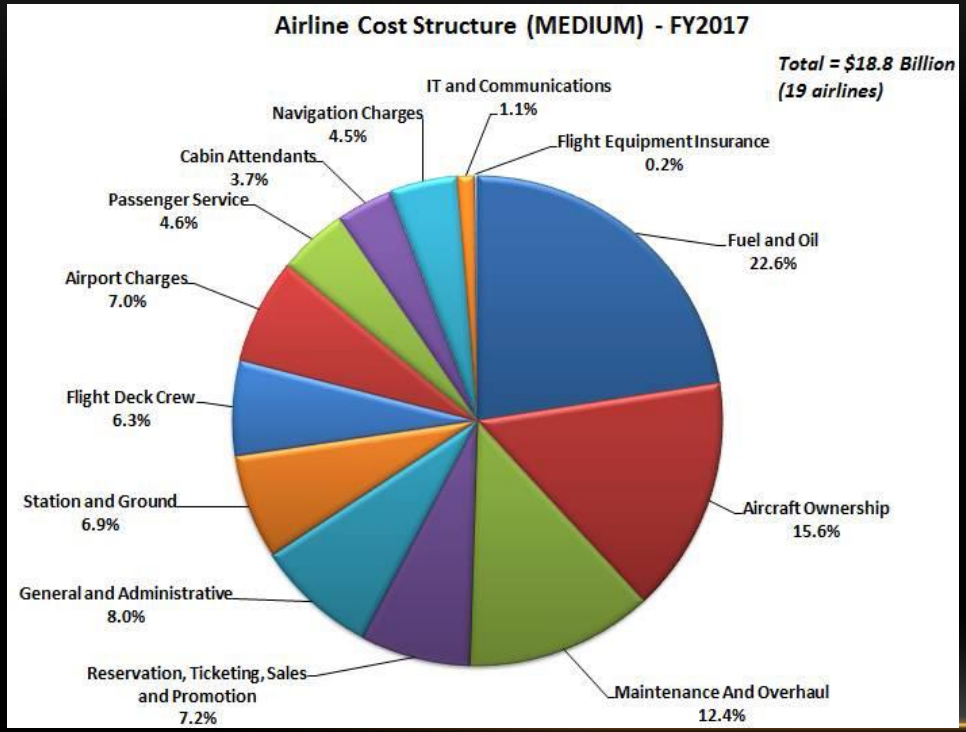
Vadym - Chief Engineer,
Avionics Systems

Andrey - Captain,
E190 Technical pilot

HISTORY

UR-EMA	LH HPSOV closed	AFT PAX door LKD snsr adj recomn	MAU 2 GIO2A FAULT	FLAP LO RATE
12.07.2017	OK	OK	45452139CMC	OK
13.07.2017	OK	OK	45452139CMC	27530001ACE
14.07.2017	OK	OK	45452139CMC	OK
15.07.2017	OK	OK	45452139CMC	OK
16.07.2017	OK	OK	OK	OK
17.07.2017	OK	OK	OK	OK
18.07.2017	36111103AM1	OK	45452139CMC	OK
19.07.2017	OK	OK	OK	OK
20.07.2017	OK	OK	OK	OK
21.07.2017	OK	OK	OK	OK
22.07.2017	OK	OK	45452139CMC	OK
23.07.2017	OK	OK	45452139CMC	OK
24.07.2017	OK	52122111PSS (CRUISE)	OK	OK
25.07.2017	OK	52122111PSS (Cruise)	OK	OK
26.07.2017	OK	OK	OK	OK
27.07.2017	OK	OK	OK	OK
28.07.2017	OK	OK	45452139CMC	OK
29.07.2017	OK	OK	45452139CMC	OK
30.07.2017	OK	52122111PSS (Cruise)	OK	OK
31.07.2017	OK	OK	45452139CMC	OK
01.08.2017	OK	OK	OK	OK
02.08.2017	OK	OK	OK	OK
03.08.2017	OK	52122111PSS (Cruise) need	45452139CMC	27530001ACE (APPROACH)
04.08.2017	OK	OK	45452139CMC	OK
05.08.2017	OK	OK	OK	OK
06.08.2017	OK	OK	OK	OK
07.08.2017	OK	OK	OK	OK
08.08.2017	OK	OK	45452139CMC + EICAS AVNX MAU 2A FAULT	OK
09.08.2017	OK	OK	Generic I/O was replaced iaw WO 889283	OK
10.08.2017	OK	52122111PSS (Cruise)	OK	OK
11.08.2017	OK	OK	OK	OK
12.08.2017	OK	52122111PSS (Cruise)	OK	OK
13.08.2017	OK	52122111PSS (Cruise)	OK	OK
14.08.2017	OK	OK	52139CMC (may be caused by transitory condition) + EICAS AVNX MAU 2A FAULT if msg will appear one more time than continue trou	OK
15.08.2017	OK	OK	OK	OK

COST STRUCTURE



Source: IATA ACMG 2017 Annual Report

STRATEGIC KPIs

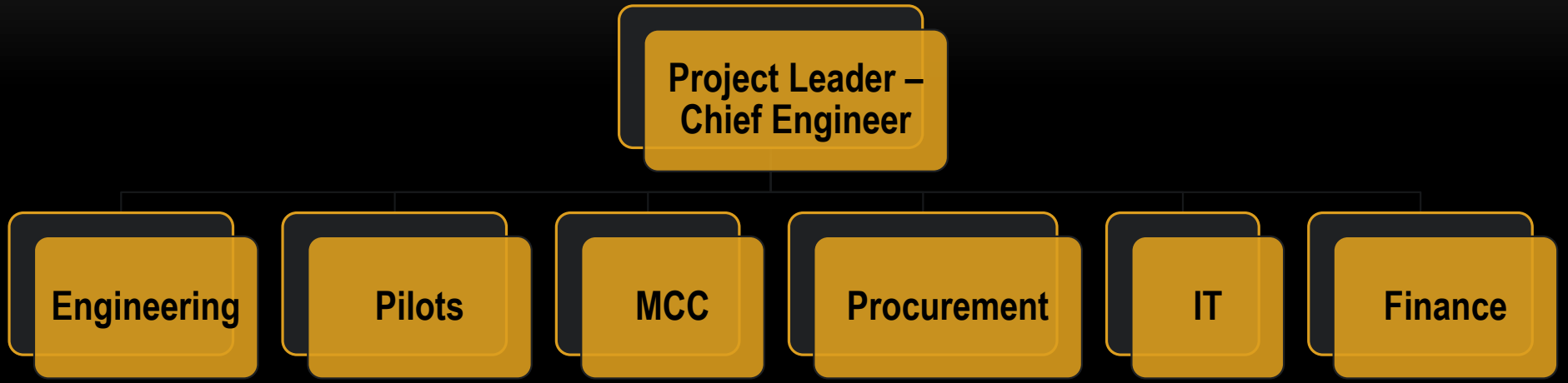
Cost Structure	FY2017 ACMG Airlines			UIA 2017
	US Cents/ASK	000$/FH	$/Pax	
Fuel and Oil	1.69	2.40	48.10	
Aircraft Ownership	0.91	1.29	25.80	
Maintenance and Overhaul	0.77	1.09	21.90	
Reservation, Ticketing, Sales and Promotion	0.52	0.74	14.90	
General and Administrative	0.53	0.76	15.20	
Station and Ground	0.48	0.69	13.80	
Flight Deck Crew	0.47	0.67	13.30	
Airport Charges	0.43	0.61	12.10	
Passenger Service	0.36	0.51	10.20	
Cabin Attendants	0.35	0.50	10.10	
Air Navigation Charges	0.30	0.43	8.50	
IT and Communications	0.08	0.11	2.20	
Flight Equipment Insurance	0.01	0.15	0.30	
Total	**6.90**	**9.92**	**196.40**	

Source: IATA ACMG 2017 Annual Report

PRIORITIZING

- Fuel Efficiency Program
- Preventive Maintenance /AHM
- Irregular Operations
- Air Navigation Charges
- …

TEAM


Project Leader – Chief Engineer
Engineering
Pilots
MCC
Procurement
IT
Finance

THE ROADMAP

Increasing value

Descriptive Analytics*

A **preliminary stage** of data processing that creates a **summary of historical data**

Diagnostic Analytics

A form of advanced analytics which **examines data or content to answer the question "What happened" or "What is the problem"**

Condition Monitoring

The process of monitoring a parameter of condition in order **to identify a significant change which is indicative of developing a fault.** A major component of predictive maintenance

Predictive Analytics

Encompasses a variety of statistical techniques **that analyze current and historical facts to make predictions** for future or otherwise unknown events

Prescriptive analytics

Encompasses a variety of statistical techniques that analyze current and historical facts and **informs the user on what specific action to take prior to an event occurring** to avoid a specific outcome

1st phase (Oct 2016 – Oct 2018)

Today we are here

2nd phase

* definitions from Honeywell presentation

1ST PHASE - RESULTS

- ✓ **XX** critical impacts on flight safety
- ✓ **XX** AOG
- ✓ **XX** MEL items (flight delays)

were avoided on E190 with only Descriptive/Diagnostic Analytics & Condition Monitoring within 1,5 years

Assumed cost of delay** = 1996,8 USD and cost of AOG = 10 920 USD

**based on average length of delay (company data) and average cost of delay per seat (based on industry data)

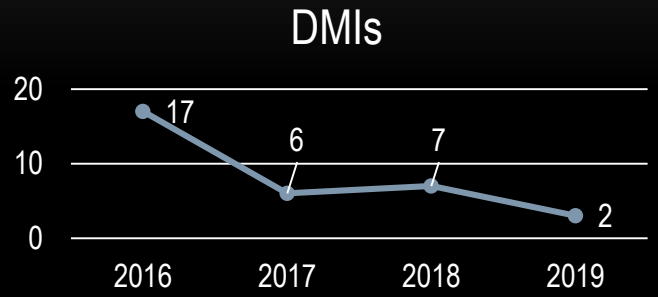
NEXT STEPS

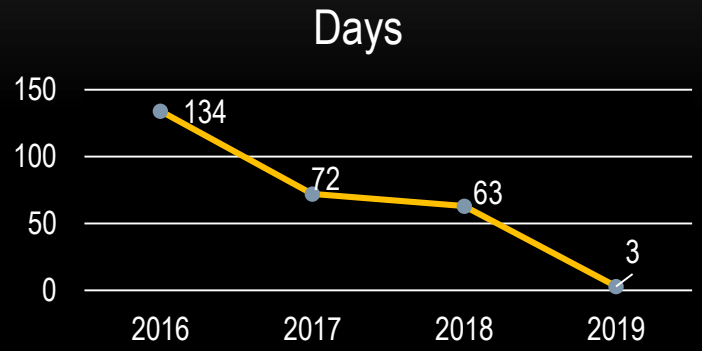
- Setup the business case
- Get connectivity for online
- Upgrade Aircraft software
- Setup analytical software
- Update internal processes

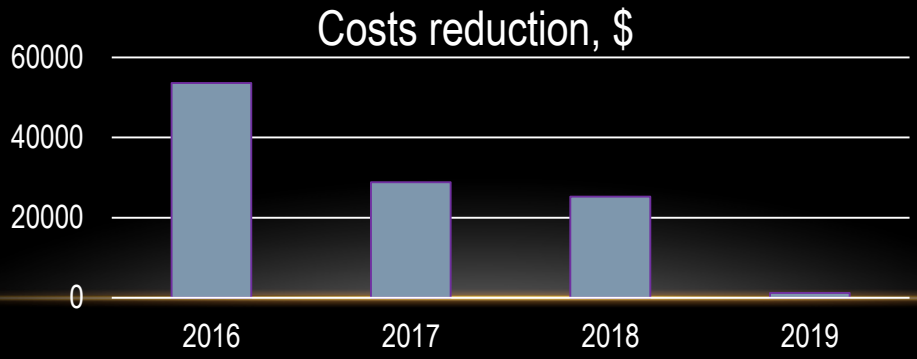
CLOSING THE LOOP

- Setup completed Oct 2018
- CAS/CMC Information
- Systems Trend Information

1.SINGLE-BLEED OPERATIONS







2. ENGINE FADEC

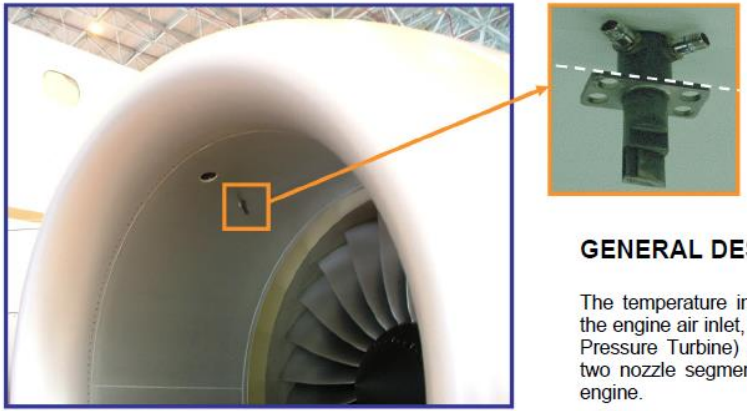
Full Authority Digital Electronic Control System controls the operation, performance and efficiency characteristics of the engine through full authority control over the entire engine fuel metering unit, variable stator vanes, operability bleed valve, T2 sensor heater, thrust reverser actuation, engine starting, ignition and also providing engine limit protection during ground starts.

2. ENGINE FADEC

- Engine FADEC 1 (no dispatch) <=> FADEC 2
- 7 days both worked properly
- A new fault message appeared (FIM executed → wire and sensor both ok, so only FADEC according to FIM)
- Solution – to replace FADEC?

2. ENGINE FADEC

T1.2 Sensor



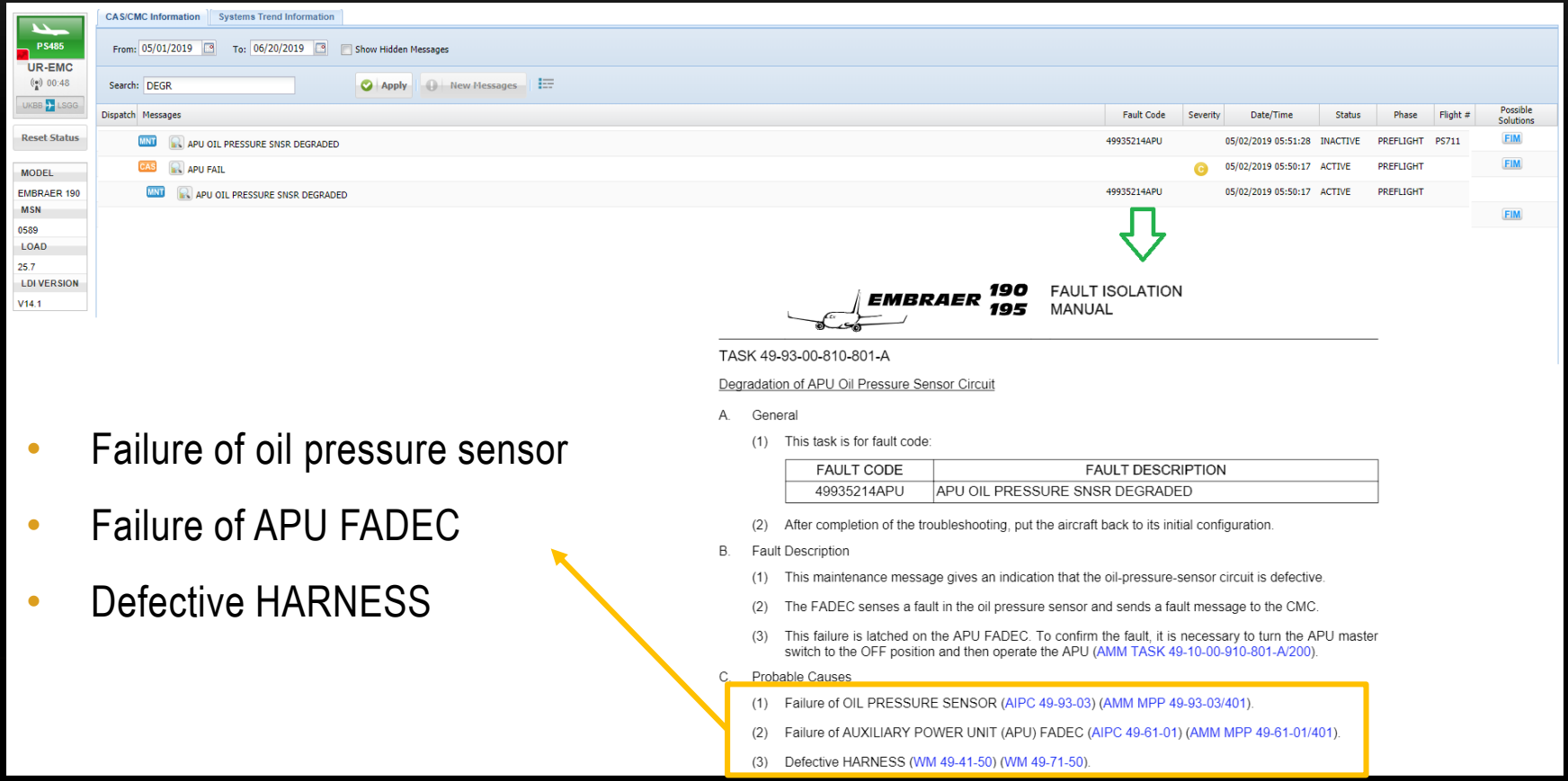
GENERAL DESCRIPTION

The temperature indicating system sensors provide temperature data of the engine air inlet, compressor air inlet, compressor discharge, HPT (High Pressure Turbine) case shroud, and LPT (Low Pressure Turbine) stage two nozzle segment. The FADEC uses these information to control the engine.

• The T 1.2 sensor is a dual-element RTD (Resistance Temperature Device) mounted in the flow stream, in front of the fan and above the engine centerline, with one element hardwired to each FADEC channel.

- Reviewed and decided to replace sensor
- ~2k $ vs ~ 50-60k $

3. APU FAIL

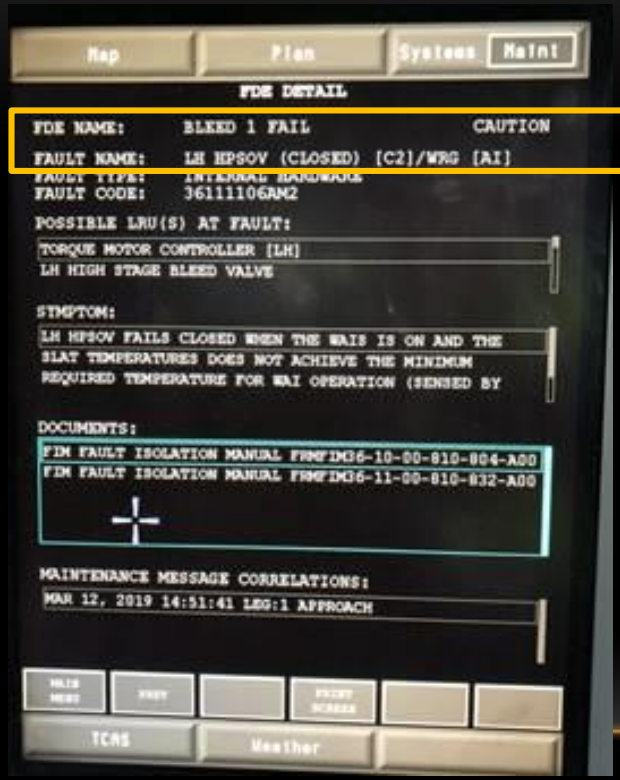


- Failure of oil pressure sensor
- Failure of APU FADEC
- Defective HARNESS

3. APU FAIL

- Sensor was switched EMC <=> EMB (problem occurred and sensor was replaced)
- APU FADEC was switched (100% not the problem)
- After this EMC 10 days was okay, then fault was reported again
- Decision was to replace APU Wire (at ~100k $)
- Additional troubleshooting was performed and decision to replace sensor (~12k $) first was made
- And it worked!

4. BLEED FAIL

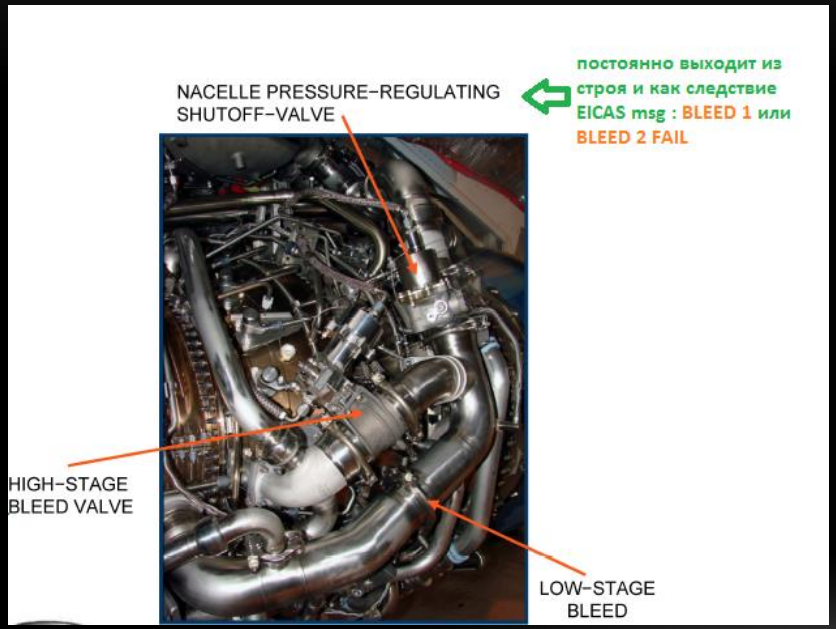


- “Bleed 1 fail” message
- HPSOV (High-stage pressure shut-off valve)
- Checked FHDB

4. BLEED FAIL

Main	A5536	1000,219,0,0,ACTIVE,03/11/2019 10:03:04,3,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,,,
Main	A5537	1000,219,344,2681,ACTIVE,03/11/2019 10:03:04,3,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,PRI HX IN TEMP SNSR (PK1)/WRG,21515061AM1,Internal Hardware
Main	A5751	1000,219,0,0,INACTIVE,03/11/2019 10:05:14,3,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,,,
Main	A6022	1000,219,0,0,ACTIVE,03/12/2019 14:51:41,4,7,APPROACH,BLEED 1 FAIL,CAUTION,,,
Main	A6023	1000,219,935,2523,ACTIVE,03/12/2019 14:51:41,4,7,APPROACH,BLEED 1 FAIL,CAUTION,LH HPSOV (CLOSED) [C2]/WRG FAULT,36111103AM2,Internal Hardwar
Main	A6024	1000,219,934,2868,ACTIVE,03/12/2019 14:51:41,4,7,APPROACH,BLEED 1 FAIL,CAUTION,LH HPSOV (CLOSED) [C2]/WRG [AI],36111106AM2,Internal Hardware
Main	A6027	1000,219,0,0,INACTIVE,03/12/2019 14:52:04,4,7,APPROACH,BLEED 1 FAIL,CAUTION,,,
Main	A6033	1000,219,0,0,INHIBITED,03/12/2019 14:56:34,4,8,ROLL OUT,BLEED 1 FAIL,CAUTION,,,
Main	A6034	1000,219,935,2523,INHIBITED,03/12/2019 14:56:34,4,8,ROLL OUT,BLEED 1 FAIL,CAUTION,LH HPSOV (CLOSED) [C2]/WRG FAULT,36111103AM2,Internal Hardw
Main	A6040	1000,219,0,0,ACTIVE,03/12/2019 14:56:47,4,8,ROLL OUT,BLEED 1 FAIL,CAUTION,,,
Main	A6041	1000,219,935,2523,ACTIVE,03/12/2019 14:56:47,4,8,ROLL OUT,BLEED 1 FAIL,CAUTION,LH HPSOV (CLOSED) [C2]/WRG FAULT,36111103AM2,Internal Hardware
Main	A6060	1000,219,0,0,INACTIVE,03/12/2019 15:51:31,4,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,,,
Main	A11866	1000,219,0,0,ACTIVE,03/18/2019 16:05:31,28,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,,,
Main	A11867	1000,219,344,2681,ACTIVE,03/18/2019 16:05:31,28,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,PRI HX IN TEMP SNSR (PK1)/WRG,21515061AM1,Internal Hardware
Main	A12278	1000,219,0,0,INACTIVE,03/18/2019 16:09:59,28,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,,,
Main	A16189	1000,219,0,0,ACTIVE,03/24/2019 16:14:36,58,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,,,
Main	A16206	1000,219,0,0,INACTIVE,03/24/2019 16:18:31,58,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,,,

4. BLEED FAIL

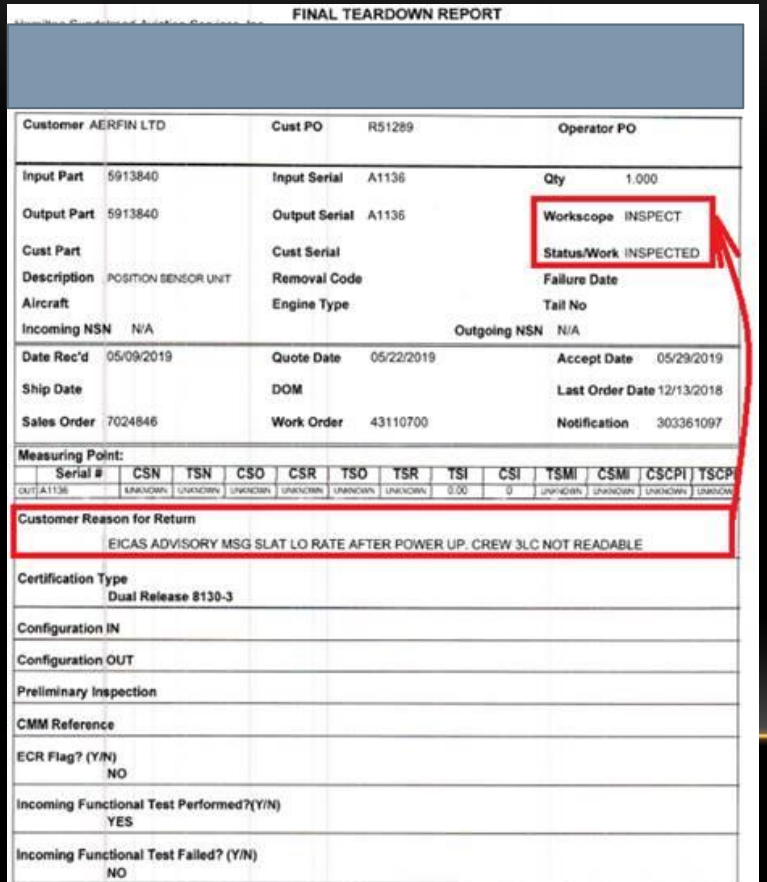


- Apparently there were multiple EICAS & maintenance messages, some resets (not during acceptance flight though)
- Situation was reported to lessor
- Valve at lessor's cost (~30k $)

IS THE LOOP REALLY CLOSED?

- Procurement, Logistics, Stock
- Analytics
- Ownership
- Promotion
- Value
- Scale

DISCOVERIES ON THE WAY



FINAL TEARDOWN REPORT

Customer	AERFIN LTD	Cust PO	R51289	Operator PO	
Input Part	5913840	Input Serial	A1136	Qty	1.000
Output Part	5913840	Output Serial	A1136	Workscope	INSPECT
Cust Part		Cust Serial		Status/Work	INSPECTED
Description	POSITION SENSOR UNIT	Removal Code		Failure Date	
Aircraft		Engine Type		Tail No	
Incoming NSN	N/A			Outgoing NSN	N/A
Date Rec'd	05/09/2019	Quote Date	05/22/2019	Accept Date	05/29/2019
Ship Date		DOM		Last Order Date	12/13/2018
Sales Order	7024846	Work Order	43110700	Notification	303361097

Measuring Point:

	Serial #	CSN	TSN	CSO	CSR	TSO	TSR	TSI	CSI	TSMI	CSMI	CSCPI	TSCPI
OUT	A1136	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	0.00	0	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN

Customer Reason for Return

EICAS ADVISORY MSG SLAT LO RATE AFTER POWER UP. CREW 3LC NOT READABLE

Certification Type
Dual Release 8130-3

Configuration IN

Configuration OUT

Preliminary Inspection

CMM Reference

ECR Flag? (Y/N)
NO

Incoming Functional Test Performed?(Y/N)
YES

Incoming Functional Test Failed? (Y/N)
NO

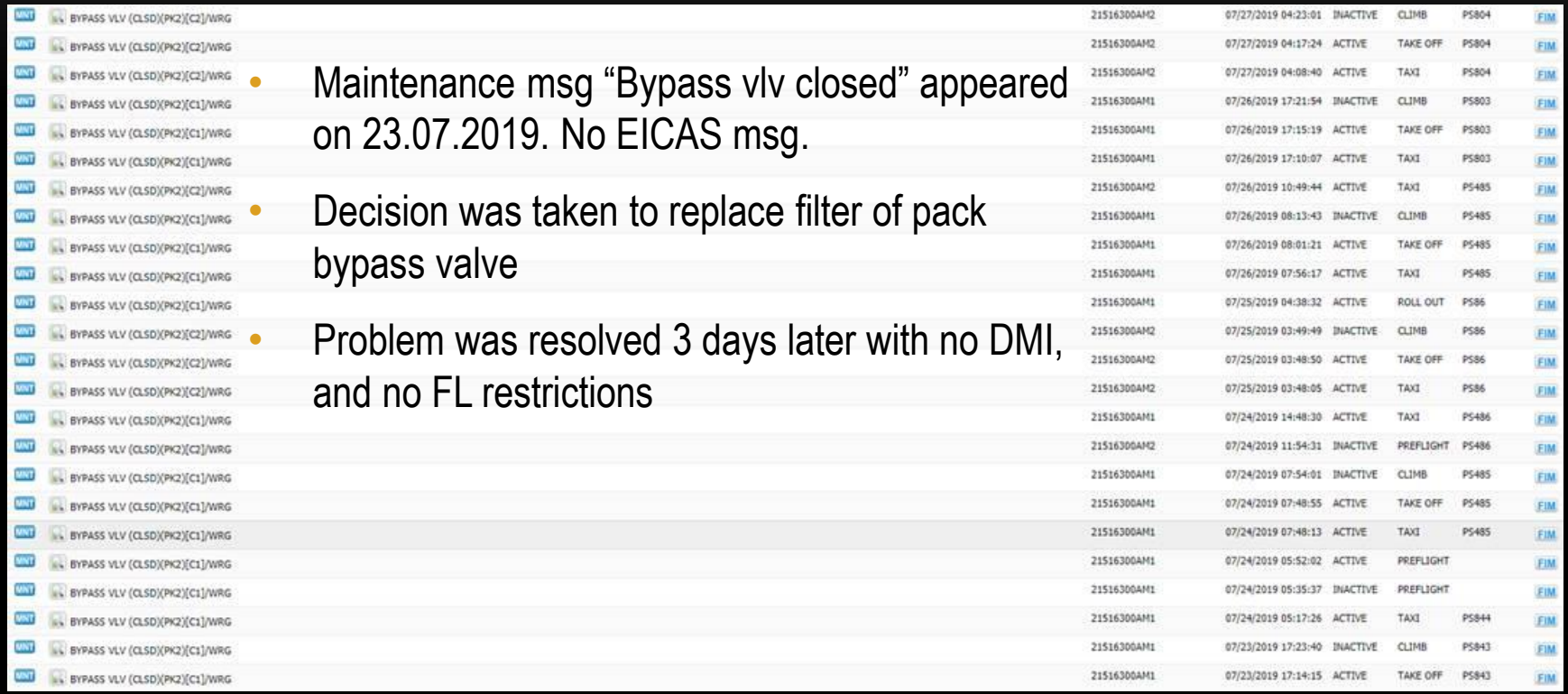
- "slat lo rate" EICAS message - Slat position sensor was removed and ordered
- New one was installed but problem remained
- After continuous t/s sensor was replaced once again – now successfully

DISCOVERIES ON THE WAY

Now we are paying more attention to:

- Certificates
- Warranties
- Stock levels

ARE WE REALLY PREVENTIVE?



MNT	BYPASS VLV (CLSD)(PK2)[C2]/WRG	21516300AM2	07/27/2019 04:23:01	INACTIVE	CLIMB	PS804	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C2]/WRG	21516300AM2	07/27/2019 04:17:24	ACTIVE	TAKE OFF	PS804	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C2]/WRG	21516300AM2	07/27/2019 04:08:40	ACTIVE	TAXI	PS804	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/26/2019 17:21:54	INACTIVE	CLIMB	PS803	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/26/2019 17:15:19	ACTIVE	TAKE OFF	PS803	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/26/2019 17:10:07	ACTIVE	TAXI	PS803	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C2]/WRG	21516300AM2	07/26/2019 10:49:44	ACTIVE	TAXI	PS485	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/26/2019 08:13:43	INACTIVE	CLIMB	PS485	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/26/2019 08:01:21	ACTIVE	TAKE OFF	PS485	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/26/2019 07:56:17	ACTIVE	TAXI	PS485	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/25/2019 04:38:32	ACTIVE	ROLL OUT	PS86	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C2]/WRG	21516300AM2	07/25/2019 03:49:49	INACTIVE	CLIMB	PS86	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C2]/WRG	21516300AM2	07/25/2019 03:48:50	ACTIVE	TAKE OFF	PS86	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C2]/WRG	21516300AM2	07/25/2019 03:48:05	ACTIVE	TAXI	PS86	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/24/2019 14:48:30	ACTIVE	TAXI	PS486	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C2]/WRG	21516300AM2	07/24/2019 11:54:31	INACTIVE	PREFLIGHT	PS486	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/24/2019 07:54:01	INACTIVE	CLIMB	PS485	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/24/2019 07:48:55	ACTIVE	TAKE OFF	PS485	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/24/2019 07:48:13	ACTIVE	TAXI	PS485	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/24/2019 05:52:02	ACTIVE	PREFLIGHT		FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/24/2019 05:35:37	INACTIVE	PREFLIGHT		FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/24/2019 05:17:26	ACTIVE	TAXI	PS844	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/23/2019 17:23:40	INACTIVE	CLIMB	PS843	FIM
MNT	BYPASS VLV (CLSD)(PK2)[C1]/WRG	21516300AM1	07/23/2019 17:14:15	ACTIVE	TAKE OFF	PS843	FIM

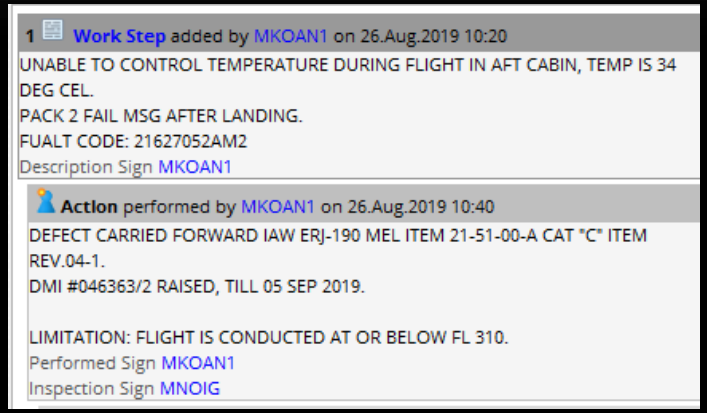
- Maintenance msg “Bypass vlv closed” appeared on 23.07.2019. No EICAS msg.
- Decision was taken to replace filter of pack bypass valve
- Problem was resolved 3 days later with no DMI, and no FL restrictions

ARE WE REALLY PREVENTIVE?

MNT	AFT TRIM BYP VLV (OPEN) [C2]/WRG	21627210AM2	08/29/2019 08:03:51	INACTIVE	CRUISE	PS151	FIM
MNT	AFT TRIM BYP VLV (OPEN) [C2]/WRG	21627210AM2	08/29/2019 08:00:33	ACTIVE	CRUISE	PS151	FIM
MNT	AFT TRIM BYP VLV (OPEN) [C1]/WRG	21627210AM1	08/27/2019 11:12:07	ACTIVE	TAXI	PS702	FIM
MNT	AFT TRIM BYP VLV (OPEN) [C1]/WRG	21627210AM1	08/26/2019 09:33:44	INACTIVE	CRUISE	PS802	FIM
MNT	AFT TRIM BYP VLV (OPEN) [C1]/WRG	21627210AM1	08/26/2019 09:19:44	ACTIVE	CLIMB	PS802	FIM
MNT	AFT TRIM BYP VLV (OPEN) [C1]/WRG	21627210AM1	08/15/2019 00:54:51	INACTIVE	CLIMB	PS7112	FIM
MNT	AFT TRIM BYP VLV (OPEN) [C1]/WRG	21627210AM1	08/15/2019 00:47:39	ACTIVE	CLIMB	PS7112	FIM

- 15.08.2019 maintenance msg “aft trim air vlv open position”, no EICAS msg or any complaints for air conditioning system
- According to FIM – the only solution is to replace valve, and it was ordered
- On 26.08.2019 second Maint msg noted, also high temperature in aft cabin was recorded

ARE WE REALLY PREVENTIVE?


1 **Work Step** added by MKOAN1 on 26.Aug.2019 10:20
UNABLE TO CONTROL TEMPERATURE DURING FLIGHT IN AFT CABIN, TEMP IS 34 DEG CEL.
PACK 2 FAIL MSG AFTER LANDING.
FUALT CODE: 21627052AM2
Description Sign MKOAN1

Action performed by MKOAN1 on 26.Aug.2019 10:40
DEFECT CARRIED FORWARD IAW ERJ-190 MEL ITEM 21-51-00-A CAT "C" ITEM REV.04-1.
DMI #046363/2 RAISED, TILL 05 SEP 2019.

LIMITATION: FLIGHT IS CONDUCTED AT OR BELOW FL 310.
Performed Sign MKOAN1
Inspection Sign MNOIG

- DMI was open
- The valve already arrived by then
- Due to aircraft availability (schedule) the valve was replaced on 29.08.2019 and problem was resolved

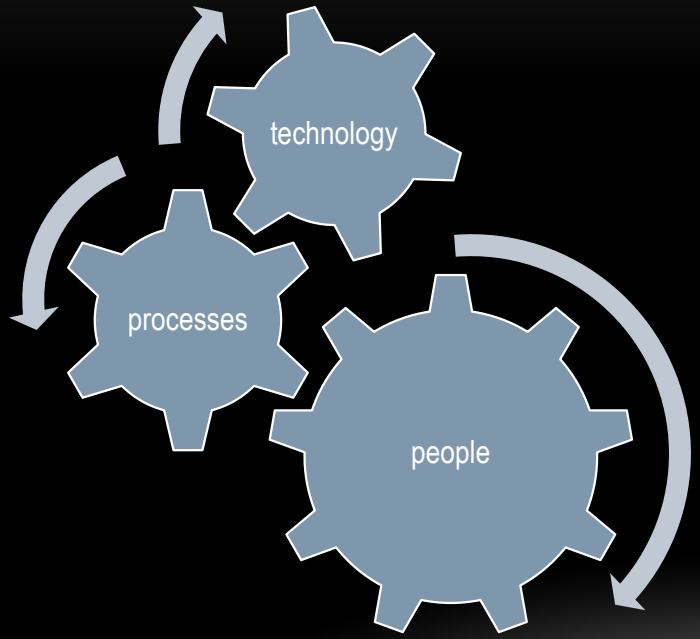
RESULTS

Our expert assumption for predictive accuracy is:

> 90%

- Reduced number of AOGs and delays, DMIs
- Improved troubleshooting (time & quality)
- Increased reliability and availability of the aircraft

SUMMARY



- Passion
- Hard work
- Constant challenge

UR-EMA	LH HPSOV closed	AFT PAX door LSO stair adj recomm	MAU 2 GIO2A FAULT	FLAP LO RATE
12.07.2017	OK	OK	45452139CMC	OK
13.07.2017	OK	OK	45452139CMC	27530001ACE
14.07.2017	OK	OK	45452139CMC	OK
15.07.2017	OK	OK	45452139CMC	OK
16.07.2017	OK	OK	OK	OK
17.07.2017	OK	OK	OK	OK
18.07.2017	36111103AM1	OK	45452139CMC	OK
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07.08.2017	OK	OK	OK	OK
08.08.2017	OK	OK	45452139CMC + EICAS AVNX MAU 2A FAULT	OK
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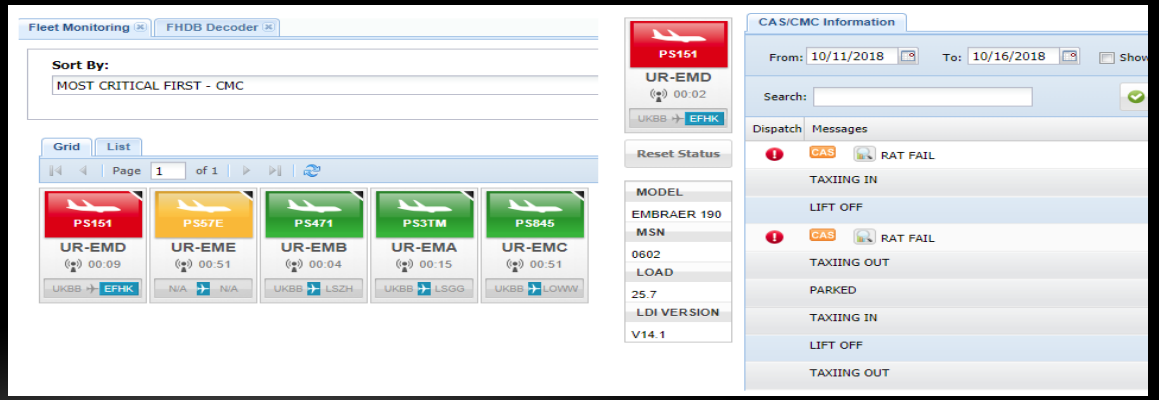
11.08.2017	OK	OK	OK	OK
12.08.2017	OK	52122111PSS (Cruise)	OK	OK
13.08.2017	OK	52122111PSS (Cruise)	OK	OK
14.08.2017	OK	OK	52139CMC (may be caused by transitory condition) + EICAS AVNX MAU 2A FAULT if msg will appear one more time than continue trip	OK
15.08.2017	OK	OK	OK	OK



JUST KEEP THEM GREEN!

PS486	PS472	PS172	PS702	PS152	PS036	PS845
UR-EMD	UR-EMA	UR-EME	UR-EMF	UR-EMC	UR-EMG	UR-EMB
00:05	00:05	00:08	00:16	00:37	01:07	03:29
LSGG → UKBB	LSZH → UKBB	ESSA → UKBB	LTBJ → UKBB	EFHK → UKBB	UKLL → UKBB	UKBB → LOWW

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