September 2017

PRESCRIPTIVE ANALYTICS FOR MAINTENANCE EFFECTIVENESS

IATA MCC 2017

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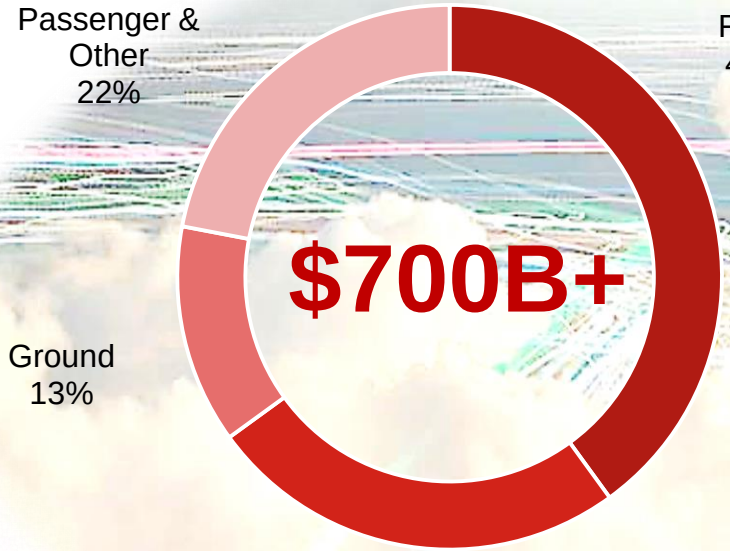
Air transportation is an expensive business

Industry Costs



Inventory per Aircraft

$600K-$1M

*Source: IATA, Honeywell research

Operational disruptions are costly…

- Delays can cost $10K per hour or more
- Cancellations can be in the $100s K
- On-time Performance is a major driver of customer satisfaction
- Parts don't last forever and will fail at some point but the operational disruptions can be avoided
- IATA estimated in 2015* that Predictive Maintenance can increase aircraft availability by up to 35%

*Source: IATA Airline Maintenance Cost Executive Commentary, December 2015

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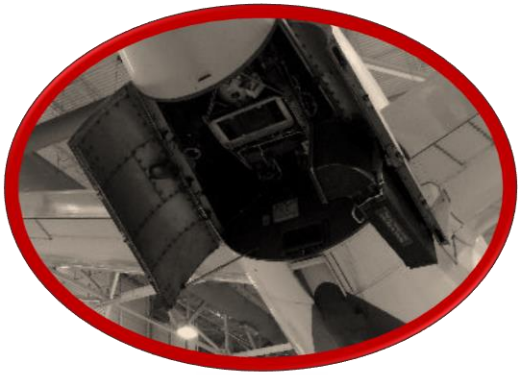
Customer case study, “in three easy steps”

Customer problem statement – Hot Cabins

- Inoperative Auxiliary Power Units in summer months cause passenger discomfort and operational disruptions



Objective – reduce operational disruptions

- Improve Airline’s operations and passenger experience by detecting imminent component failures and addressing them before they cause a disruption

Step 1 – understand the context

- Determined what is really going on
- Identified data needed to solve the problem

61
aircraft in fleet

16
months operations

90,000
flight sectors

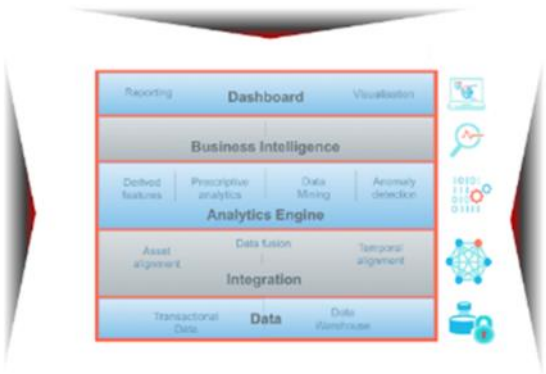
1.6 Million
flight data records

327,000
maintenance tech log entries

13,000
APU performance reports

570
APU auto-shutdown reports

485
Days airport temp records



44,000
fault messages (ATA 21, 36, 49)

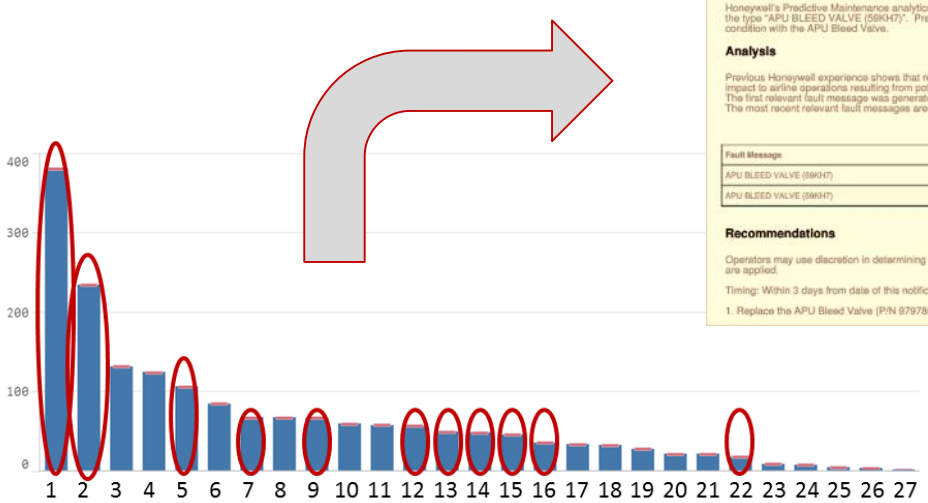
3000
ATA 49 – Mx events

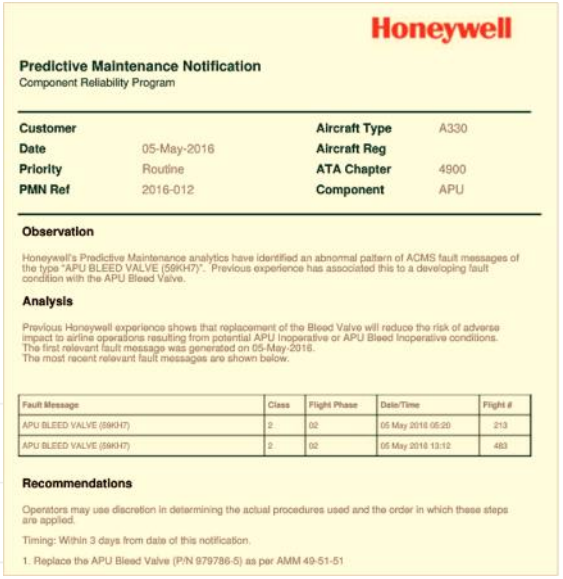
151
Honeywell shop removal records

88
route geo-locations

Step 2 – apply advanced analytics empowered by domain expertise

- Developed 11 prognostic models to detect developing issues
- Solution live for over a year
- Serving needs of Maintenance Control and Engineering





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Predictive Maintenance Notification
Component Reliability Program

Customer		**Aircraft Type**	A330
Date	05-May-2016	**Aircraft Reg**	
Priority	Routine	**ATA Chapter**	4900
PMN Ref	2016-012	**Component**	APU

Observation

Honeywell's Predictive Maintenance analytics have identified an abnormal pattern of ACMS fault messages of the type "APU BLEED VALVE (59KH7)". Previous experience has associated this to a developing fault condition with the APU Bleed Valve.

Analysis

Previous Honeywell experience shows that replacement of the Bleed Valve will reduce the risk of adverse impact to airline operations resulting from potential APU Inoperative or APU Bleed Inoperative conditions.
The first relevant fault message was generated on 05-May-2016.
The most recent relevant fault messages are shown below.

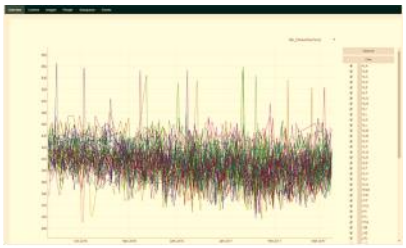
Fault Message	Class	Flight Phase	Date/Time	Flight #
APU BLEED VALVE (59KH7)	2	02	05 May 2016 05:20	213
APU BLEED VALVE (59KH7)	2	02	05 May 2016 13:12	483

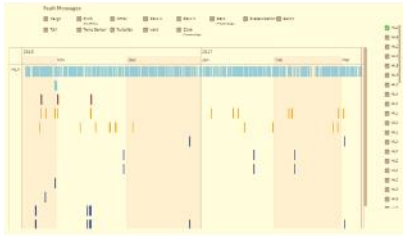
Recommendations

Operators may use discretion in determining the actual procedures used and the order in which these steps are applied.

Timing: Within 3 days from date of this notification.

1. Replace the APU Bleed Valve (P/N 979786-5) as per AMM 49-51-51





Step 3 – outcome

Customer problem statement – Hot Cabins

- 180,000 more happy customers

Objective – reduce operational disruptions

- Reduced by 35%
- 99% accuracy (No Fault Found)
- Dramatic improvement in first time fix effectiveness

Improvements today and in the future

- Connectivity and advanced analytics enable solutions today that were not possible before
  - Multiple customers live and in trials
  - Multiple platforms covered and more in development

A330 A320 B777 B737NG …

- More can be done once the aircraft is connected with other data sources to paint the complete picture

- New solutions that make aircraft data easier and less expensive to capture are coming to market