

An MTU Aero Engines Company



Monitoring, understanding and managing engine data

Maintenance Cost Conference 2017, Panama Silvan Brandt, Director Marketing & Sales Americas





Worldwide network and customer base





An airline's operating costs





ECM benefits: Cost reduction



- Early detection of potential failures to avoid/reduce
 - secondary damage
 - early shop visits
- Enhanced fleet management



- Reduced maintenance cost (early detection or shop visit avoidance)
- Lower unscheduled downtime cost
- •Optimized on-wing time



- Better shop visit cost estimates
- Improved customized workscoping
- Increased knowledge about engine on-wing behavior
- Optimized shop capacity planning



The development of engine health monitoring



Offline

No health monitoring

- Standard shop visits based on EMM
- Removal on condition (EGT/LLP) or "fly to failure"
- Unscheduled
 engine removals

Diagnostics

Reactive system based on limited data collection

- Tailored solutions (workscoping) based on ETM results
- Limited unscheduled removals

Prognostics

Pro-active system based on predictive algorithms/ snapshots

- Earlier detection, better identification of upcoming problems
- Improved maintenance planning and workscoping

Business intelligence

Big Data analytics based on continuous data stream: all-encompassing engine data – and beyond

- Precise forecast for MRO cost, scrap rates and removal times
- Optimized engine/aircraft fleet management and operations
- ETM becomes a major fleet planning tool

September 2017



Diagnostics

Our system: All-in-one tool

Proprietary software based on full thermo-dynamic engine models

- **Continuous system enhancements**
- Advanced diagnosis, prognosis and analysis
- Substantial experience since 2006
- One platform for all engine types*



* other engine types can be supported on request

September 2017

IATA MCC conference 2017 - Monitoring, understanding and managing data



MTU^{Plus} ETM: Automatic diagnosis

Diagnostics

Business Intelligence

Automated root cause analysis



1. Pattern matching

Comparison of current trend pattern with historic failures stored in database

P	attem	Matching Re	esults Diagnosis MOF	Diagnosis MOPS Results			
Γ		Probability	Ass/Fail Type pro	b. Failure Type	Comment		
Γ	1	100,0%	VSV System				
	2		100,0%	schedule drift			

2. Simulation:

Thermodynamic model simulates failure to determine root cause on module basis

Pattern Matching Results Diagnosis MOPS Results									
Γ		Failure Indicator 💧	Probability 🔇	Descr	iption				
	1	PSUM8 OU	50,7%	HPC Flow Capacity					
	2	PSUM3 OU	14,5%	HPC Efficiency					
I	3	PSUM11OU	12,0%	HPC Bleed					
I	4	PSUM4 OU	5,6%	HPT Efficiency					
	5	PSUM7 OU	5,4%	Fan Flow Capacity					

September 2017



MTU^{Plus} ETM: Prognosis

- Forecast for each flight report
- •Remaining days (cycles) on-wing until a specific EGTM threshold is reached
- Smoothed deterioration gradient calculated on EGTM trend history
- Statistical smoothing excludes outliers
- •Results for each engine can be included in the periodical or fleet ranking reports

→ Improves fleet management of performance (EGT) critical fleets



Diagnostics

IATA MCC conference 2017 - Monitoring, understanding and managing data



MTU^{Plus} ETM: Modular Deterioration Diagnosis

Diagnostics

Prognostics

Business Intelligence

Next step: Modular deterioration diagnosis

EGT margin loss



- Diagnostics of module contribution to performance loss
- Prognostics of future modular behavior

→ Goal: **Optimize workscope planning** for the whole engine life

Engine flight hour

September 2017



MTU^{Plus} ETM: Fleet analysis

Workscope-specific deterioration



Deterioration matrix allows for historic data analysis:

Diagnostics

- fleet average and single engine deterioration rates
- shop visit effects (regained performance)
- performance information of mature engines*



Our vision: Integration of all available data sources





How will the data help improving operations?

Fleet management



- Engine fleet decision/growth Simulation of performance in current mission
- Mission change
 Simulation of fleet performance under
 changed operations
- Aircraft allocation
 Matching of performance and mission

MRO management



• MRO

Additional data further improves prognosis of MRO requirements

• **On-wing services** Visualization of services to extend on-wing times, if e.g. outphasing is changed...

September 2017



The future: Our challenges

- 1. Adapt our IT structure for growing amounts of maintenance data
- 2. Realize an efficient management of very large data sets in nearly real-time
- 3. Generate benefits and services for maintenance and engine operation from additional information w.r.t. future engine/aircraft data





Conclusion



Engine trend monitoring

- ... is a key instrument to improve engine operation and MRO
- ... faces enormous challenges with the **high amount of data** to be analyzed in future
- ... offers great opportunities for fleet management improvements



An MTU Aero Engines Company



Thank you for your attention!

