Enabling the journey toward Condition Based Maintenance for Airframe

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Agenda

Introduction

Structural Maintenance optimization & Operational Monitoring

Conclusion

Introduction - Structural Maintenance improvement through Aircraft Monitoring

High variability in aircraft usage across the fleet

Each aircraft are operated differently…

… but have to follow the same Structural Maintenance requirements

Benefits of operational monitoring

Optimize maintenance requirements

Increase aircraft availability and reduce operations costs

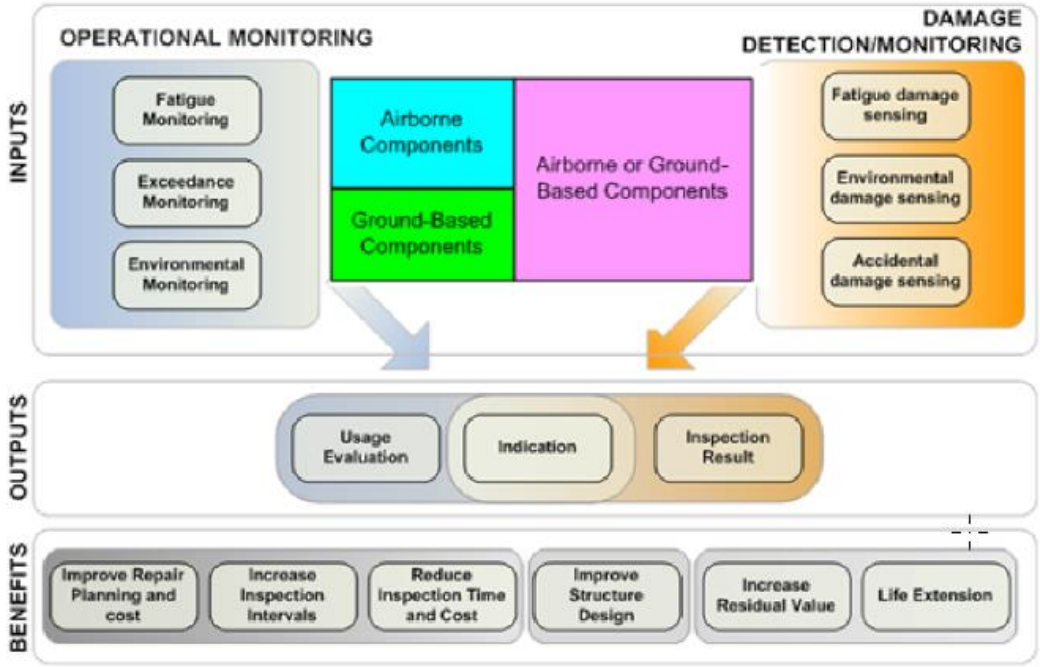
Improve design assumptions for future developments

Further safety improvement of aircraft operations

Condition Based Maintenance

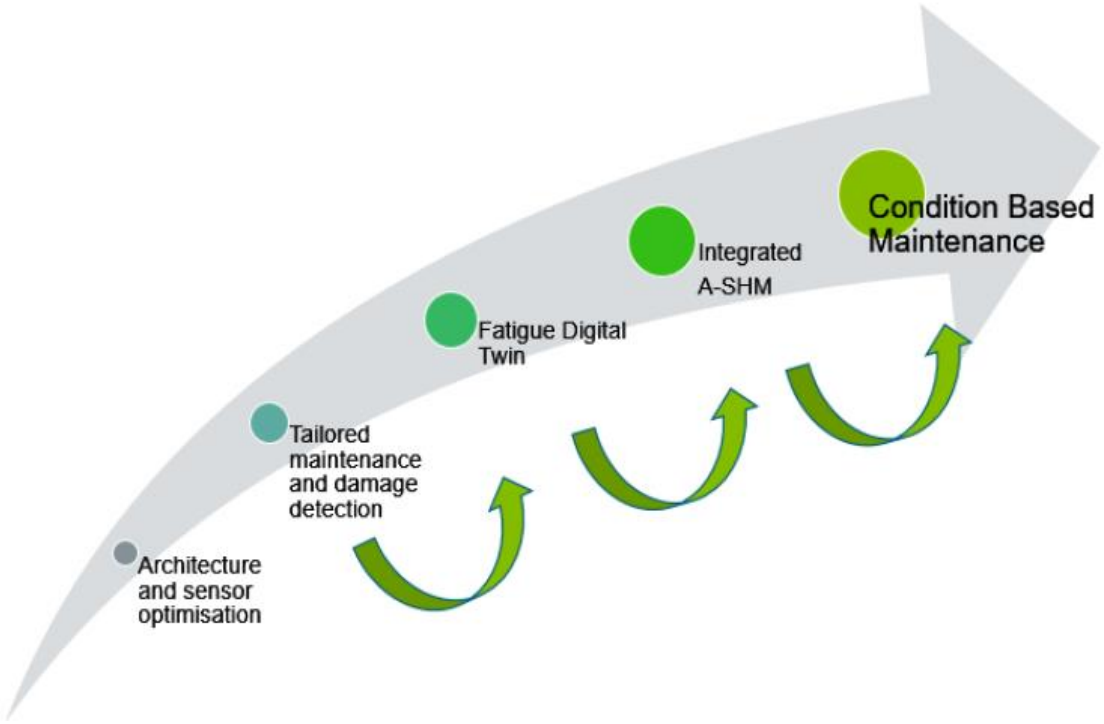
The target is to inspect Airframe only when required…

… but it requires a transformation of the maintenance environment



Structural Health Monitoring following ARP 6461

Step by step development and implementation



Incremental Development of Maintenance Optimisation and Pilot Projects for Airframe Structural Health Monitoring (A-SHM) introduction

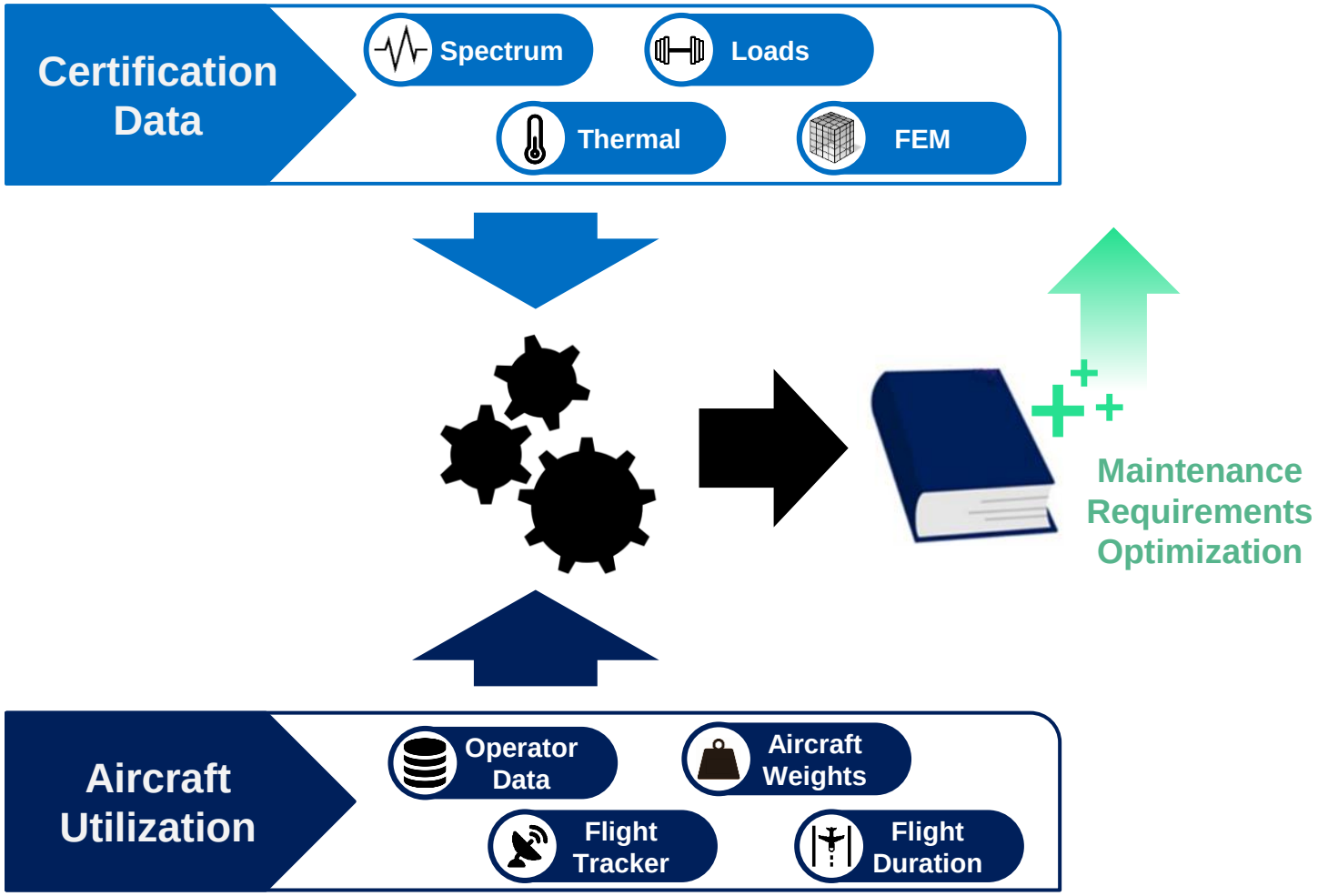
Step by step approach

- Controlled in-service introduction
- De-risk implementation, gain confidence and maturity faster
- Focus on use cases with direct business impact
- Quickly gather operators feedback and capture needs

Progressive development and implementation

- **Tailored Maintenance**: few key parameters only
- **Damage Monitoring**: sensors, damage diagnostics
- **Predictive Maintenance**: more detailed usage monitoring
- **Condition Based Maintenance**: inspect airframe only when required

Engineering data for Structural Maintenance optimization



Engineering Data…

Evaluate key parameters affecting fatigue behavior

Parametric Study to cover:

> Mission Duration

> Weights

> Fuel Quantity

… combined with few key in-service indicators

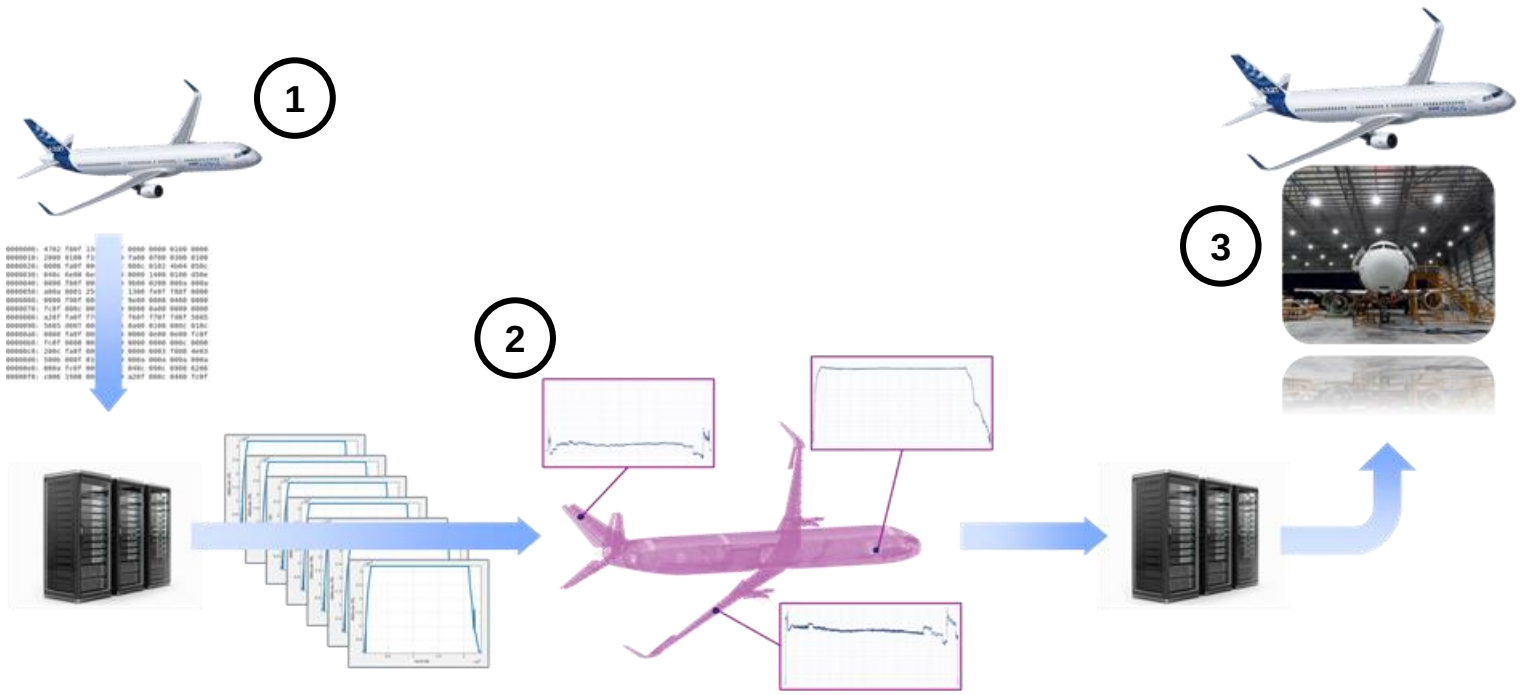
Actual flights duration per aircraft

Weight & balance information

Available operator data

enabling to revise maintenance requirements based on individual aircraft usage with simple approaches

Operational Monitoring



1. Aircraft data collection and validation

- Retrieve parameters registered during flights
- Continuous / regular data collection
- Long term data storage

2. In-Service data processing

- Exploit validated engineering models
- On-ground / Off-board processing
- Produce *actual in-service loading spectrum*
- Evaluate severity of actual in-service operations

3. Feedback to Operations

- Assessment of maintenance improvements
- Identification of required actions

Main aspects:

- Reduction of maintenance efforts
- Improve investigation of in-service findings
- Anticipation of potential in-service issues

Operational Monitoring

Challenge of large computational needs

Limitation of “classical” approaches

> High computing resources need: physical modelling, finite elements

> Processing time: large volume of data to be processed

Requires introduction of new technical solutions

Global Automation of complex processes

Automatic data processing

Results reproducibility

Systematic checks and process traceability

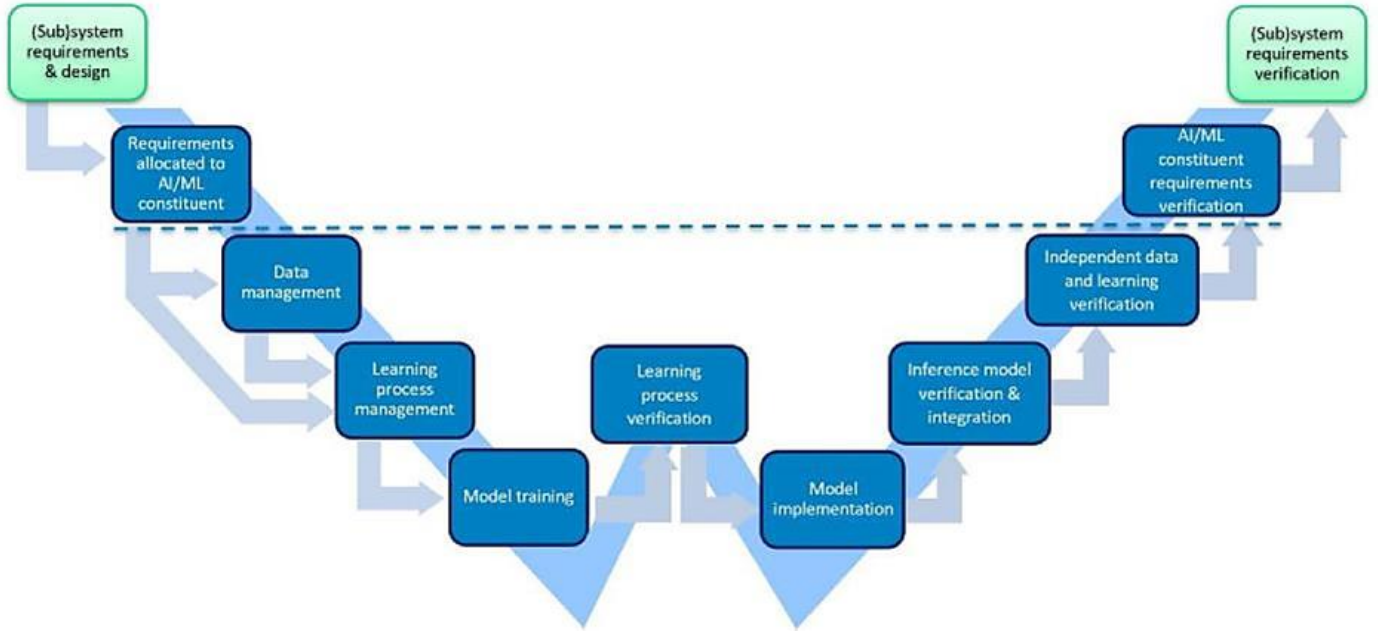
Artificial Intelligence introduction

Alternative for “classical” approaches

Particular requirements to be considered:

> Well known and controlled environment

> Specific criteria for Machine Learning



Learning assurance process proposed in EASA Concept Paper: guidance for machine learning application

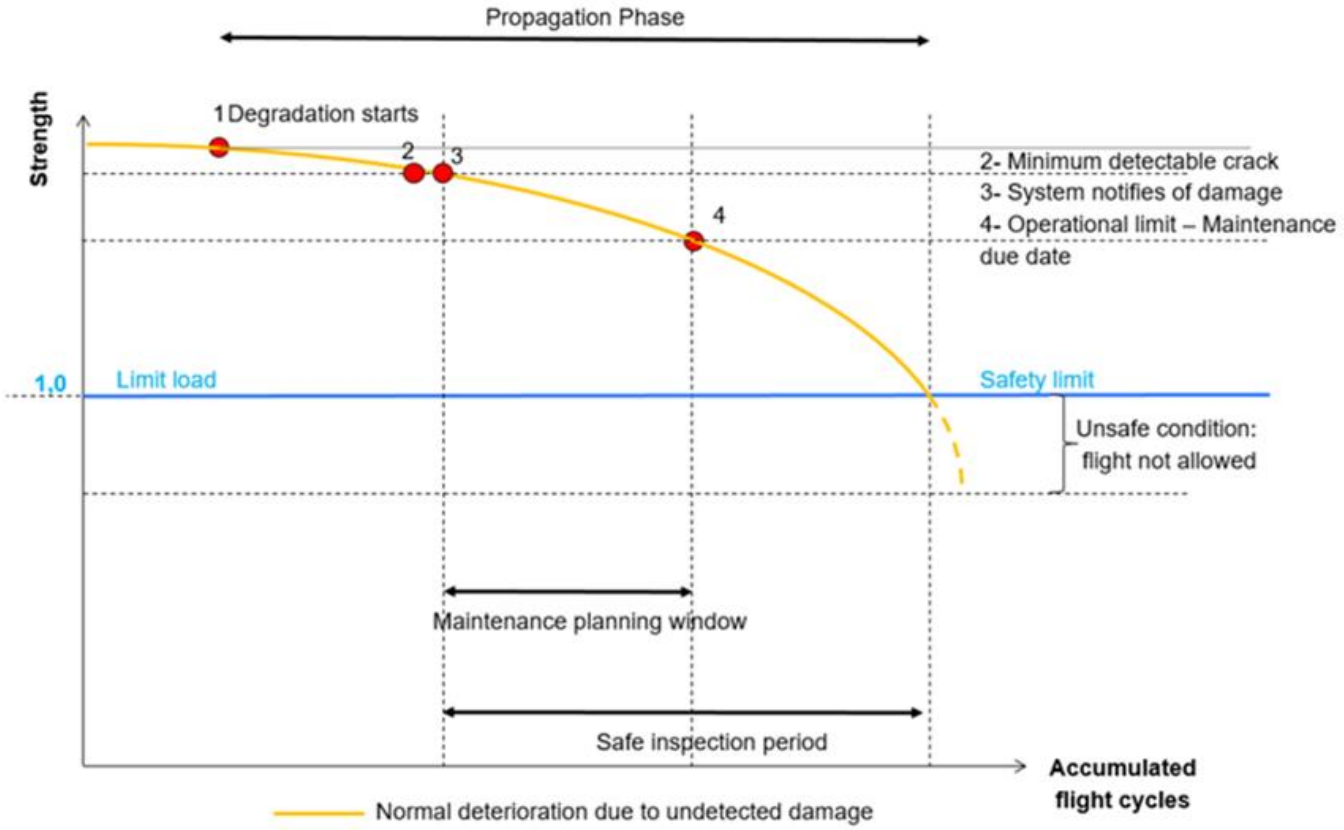
Condition Based Maintenance

Condition Based Maintenance concept

- Reduce fixed maintenance tasks to the minimum required
- Implement actions only after detection
- Perform maintenance at most cost / time efficient point

Certification and Continuous Airworthiness

- Regulatory framework: already enable implementing A-SHM
- Acceptable means to be developed to integrate A-SHM :
  > Policy evolution: allow flying with known cracks
  > Maintenance Planning Window: time to safely operate before maintenance action



Conclusion

Structural Health Monitoring

Maintenance optimisation
Reduce operating costs
Anticipate potential in-service issues

Transformation of maintenance system

Introduction of new technologies
Evolution of Instructions for Continued Airworthiness
Planification and execution

Step-by-step implementation

Incremental developments and deployment
Quickly get feedback from operations
Accelerate maturation

Thank you