Instandhaltungsplanung von Triebwerksflotten
MATLAB Expo 2019

N. Theilig | Engine Services | 15. April 2019

Lufthansa Technik
Lufthansa Group – The business segments

**Passenger transportation**

The Lufthansa Group airlines rank among the world’s leading carriers.

**Logistics**

Lufthansa Cargo – one of the world’s leading cargo carriers in international air traffic.

**Lufthansa Technik**

Lufthansa Technik – leading provider of MRO services in the world’s airline business.

**Catering**

LSG Sky Chefs – leading provider of airline catering and integrated in-flight solutions.

**Other activities**

Lufthansa Aviation Training
Lufthansa AirPlus
Lufthansa Industry Solutions (and many more)
Lufthansa Technik AG – Product Divisions

Aircraft Services (Maintenance, Overhaul)

Engine Services

Component Services

Landing Gear Services

VIP & Special Mission Aircraft Services

Coverage of any conceivable requirement of an aircraft owner or operator
We are experienced in fulfilling customer-specific requirements around the globe
Agenda

Engine Fleet Management

MATLAB GUI as Platform for Calculations

Core Functionality

Visualization and Reporting Functions

A growing number of Interfaces

Summary
Engine Fleet Management

A complex Task

- Removal forecast
- Work Scope forecast
- Scenario Analysis
Engine Fleet Management
A complex Task

**Aircraft Fleet**
- Engine Type Rating
- Utilization
- Flight Profile

**Engine Fleet**
- Hardware Version
- Module Data
- Part Data
- Spare Availability

**Engine Fleet Management**
- Removal forecast
- Work Scope forecast
- Scenario Analysis

Customer

Engine Service
Engine Fleet Management

A complex Task

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Service Contract
- Price Model
- Customer Work Scopes
- Customer Requirements
- Lease Return Conditions

Customer

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Engine Fleet Management
- Removal forecast
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Engine Shop
- Expert Knowledge
- Customized Work Scopes
- Cost Data

Maintenance Documents
- Manufacturer Recommendations
- Airworthiness Directives
- Technical Limits

Service Contract
Commercial Parameter
- Price Model
- Customer Work Scopes
- Customer Requirements
- Lease Return Conditions

Customer

Engine Service
MATLAB GUI as Platform for Calculations

Migration from Prototype to new Framework was performed

- Robust Framework
  - Developed and integrated with MathWorks Consulting
  - Quickly adjustable
  - Modular
MATLAB GUI as Platform for Calculations

Migration from Prototype to new Framework was performed

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MATLAB GUI as Platform for Calculations

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→ Migration from individual GUI to robust framework was worthwhile
Core Functionality – Removal Planning Algorithm
Simulation of Aircraft and Engine Fleet Operation for Contract Period

1. Calculate next Removal Date
2. Time Step to Removal Date
3. Remove Engine from Aircraft
4. Work Scoping Decision
5. Send Engine to Shop
6. Send Engine to Spare Pool
7. Select an Engine for installation on Aircraft
Core Functionality – Removal Planning Algorithm
Simulation of Aircraft and Engine Fleet Operation for Contract Period

- Growing complexity by introduction of new Features due to increasing user demand
  - Stagger Removals
  - Park Aircrafts
  - Insert additional Shop Visits e.g. for Lease Return Requirements
Core Functionality – Removal Planning Algorithm
Simulation of Aircraft and Engine Fleet Operation for Contract Period

- Growing complexity by introduction of new Features due to increasing user demand
  - Stagger Removals
  - Park Aircrafts
  - Insert additional Shop Visits e.g. for Lease Return Requirements

→ Reorganization of Data Structure and algorithm in progress
Core Functionality – Work Scoping Decision
Decision making based on a Fuzzy Logic algorithm

- Combing hard Criteria and Expert Knowledge
- Transparent Decisions
- Dynamically adjusted Templates
- Modelling of Uncertainties
Core Functionality – Work Scoping Decision

Decision making based on a Fuzzy Logic algorithm

- Combing hard Criteria and Expert Knowledge
- Transparent Decisions
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- Modelling of Uncertainties

→ Integration of Fuzzy Logic Toolbox
→ New algorithms and features can be integrated with a moderate effort
Visualization and Reporting Functions
Prepare Result for further Analysis

- Requirements
  - Prepare Overview of Fleet
  - Assessment of Scenarios
  - Support Decision Making
  - Export Results to internal and external Customers
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- Requirements
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  - Export Results to internal and external Customers

→ Preparation of Graphical Output is challenging
→ Flexible Export Function are easy to use

Database
.xlsx, .pdf
A growing number of Interfaces
Monitoring of an Engine Fleet

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**Engine Fleet Management**
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**Engine Shop**
- Expert Knowledge
- Customized Work Scopes
- Cost Data

**Maintenance Documents**
- Manufacturer Recommendations
- Airworthiness Directives
- Technical Limits

**Service Contract Commercial Parameter**
- Price Model
- Customer Work Scopes
- Customer Requirements
- Lease Return Conditions

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Customer

Engine Service
A growing number of Interfaces
Monitoring of an Engine Fleet

Aircraft Fleet
- Engine Type Rating
- Utilization
- Flight Profile

Engine Fleet
- Hardware Version
- Module Data
- Part Data
- Spare Availability

Customer Updates
- Current Fleet Status

On Wing Maintenance
- Planned Inspections

Engine Fleet Management
- Removal forecast
- Work Scope forecast
- Scenario Analysis

Engine Shop
- Expert Knowledge
- Customized Work Scopes
- Cost Data

Maintenance Documents
- Manufacturer Recommendations
- Airworthiness Directives
- Technical Limits

Shop Data
- Current Cost/Test Data

Service Contract
Commercial Parameter
- Price Model
- Customer Work Scopes
- Customer Requirements
- Lease Return Conditions

Engine Condition Monitoring
- Life Trend Data

Customer
- Engine Service

Engine
- Condition
Monitoring

Instandhaltungsplanung von Triebwerksflotten | N. Theilig | Contract Engineering | Engine Services
Summary
Challenges & Conclusions

🚀 Development Speed
→ Urgent Adaption to new Demands

🌐 Complexity of Decisions
→ Many Dependencies

📄 Data Import
→ Unsteady Input Files/Systems

🔍 Data Management
→ Additional Parameter

🔍 Testing of new Functionalities
→ Qualitative Assessment of Calculation result necessary
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Challenges & Conclusions

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❓ Testing of new Functionalities
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➡️ Migration to new GUI
→ Completed and Worthwhile

🔧 Enhancement of Program Structure
→ Transfer to Object Oriented Programming

🗂️ Modular Code

📞 Consulting & Continuous Revision of Code Segments
Thank you for your attention!

Contact Information, e.g. for Internships or B.Sc / M.Sc Thesis within our department

Niklas Theilig
Performance Engineer
Engine Services

Weg beim Jäger 193
22335 Hamburg
niklas.theilig@lht.dlh.de

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