

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 Maintenance, Repair, Overhaul



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

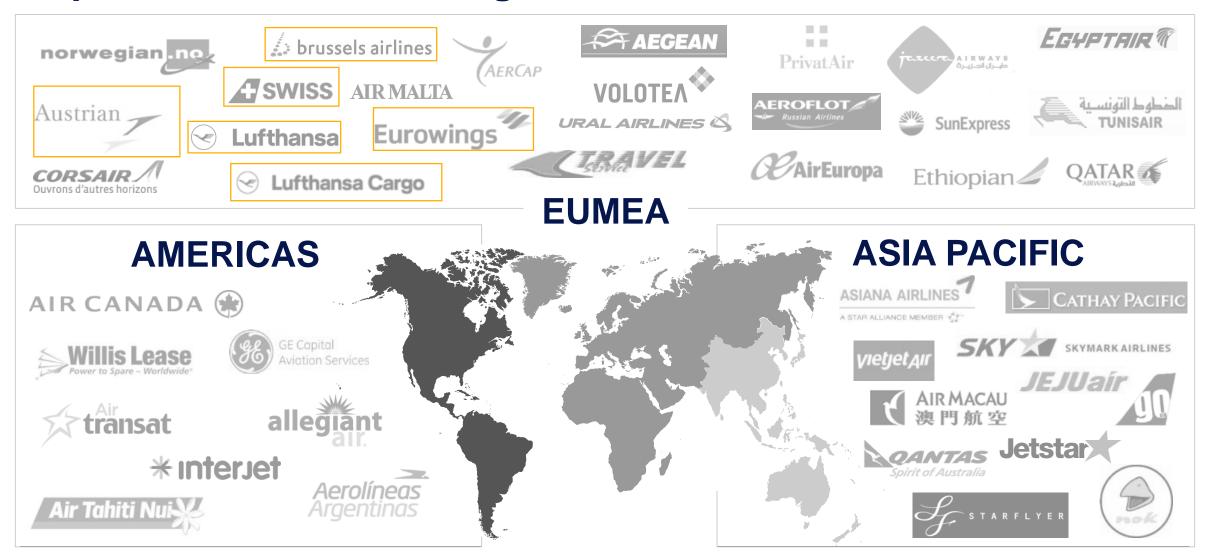


VIP & Special Mission Aircraft Services



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

A complex Task

Engine Fleet Management

- Removal forecast
- · Work Scope forecast
- Scenario Analysis



A complex Task

Aircraft Fleet

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



Engine Fleet Management

- Removal forecast
- · Work Scope forecast
- · Scenario Analysis



Engine Fleet

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





Customer

Engine Service

A complex Task

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Service Contract Commercial Parameter

- Price Model
- **Customer Work Scopes**
- **Customer Requirements**
- Lease Return Conditions



Customer

Engine Service

A complex Task

Aircraft 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

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Customer

Engine Service

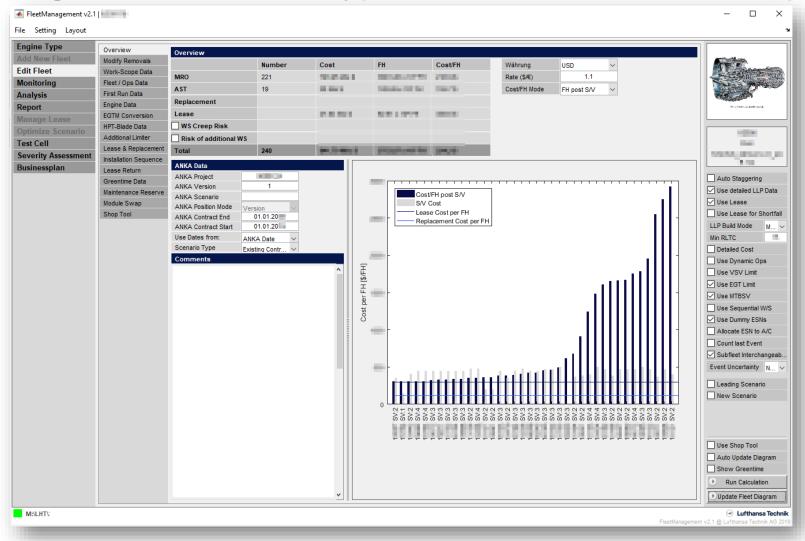
MATLAB GUI as Platform for Calculations

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

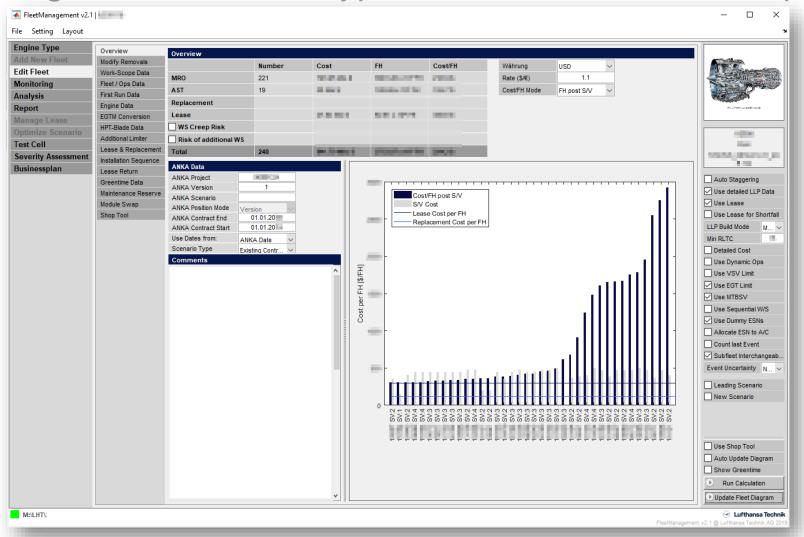
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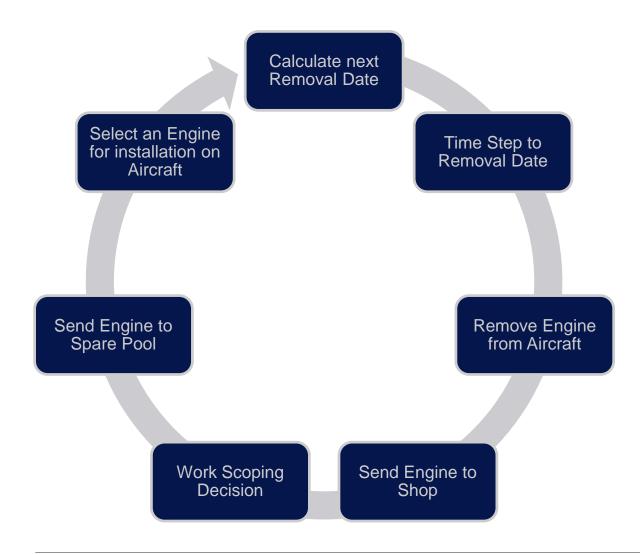


- Robust Framework
 - Developed and integrated with
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 - Quickly adjustable
 - Modular

→ Migration from individual GUI to robust framework was worthwhile

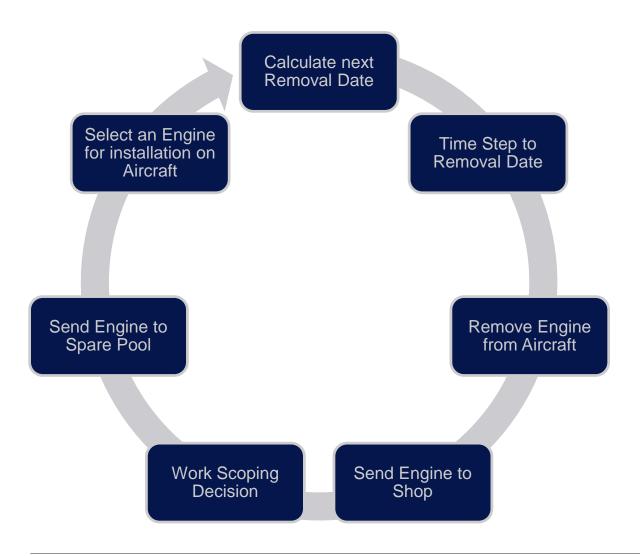
Core Functionality – Removal Planning Algorithm

Simulation of Aircraft and Engine Fleet Operation for Contract Period



Core Functionality – Removal Planning Algorithm

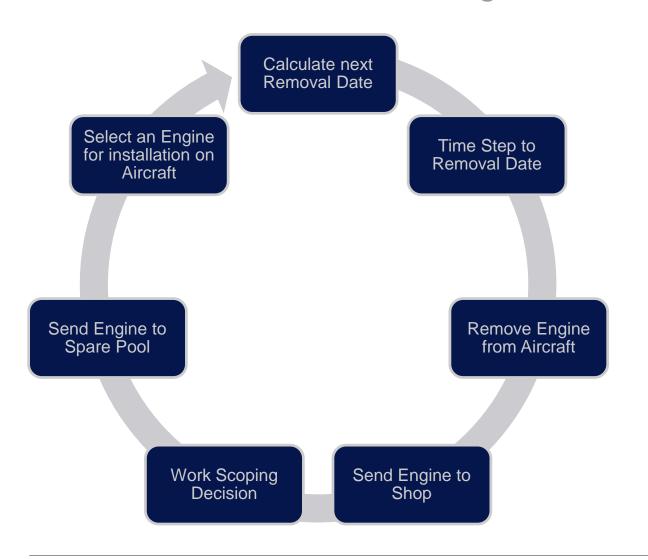
Simulation of Aircraft and Engine Fleet Operation for Contract Period



- 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

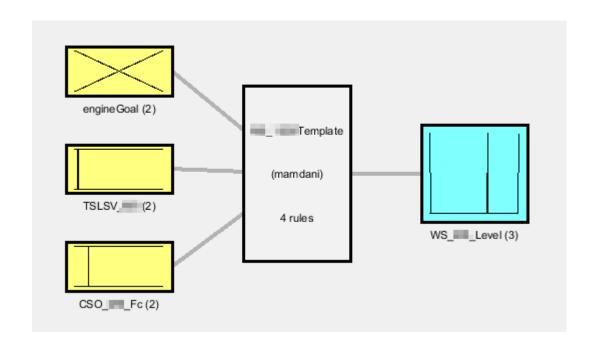


- Growing complexity by introduction of new Features due to increasing user demand
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→ Reorganization of Data Structure and algorithm in progress

Core Functionality – Work Scoping Decision

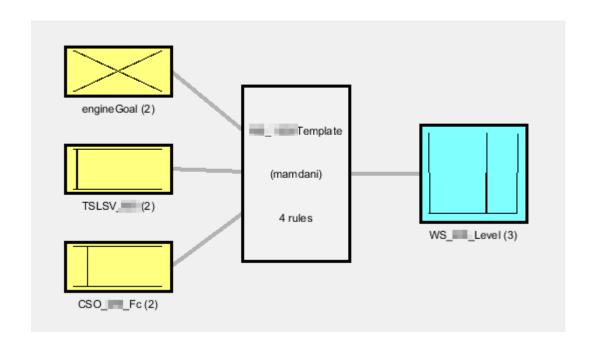
Decision making based on a Fuzzy Logic algorithm



- 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
- Dynamically adjusted Templates
- Modelling of Uncertainties
- → Integration of Fuzzy Logic Toolbox
- → New algorithms and features can be integrated with a moderate effort

Prepare Result for further Analysis

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

Prepare Result for further Analysis



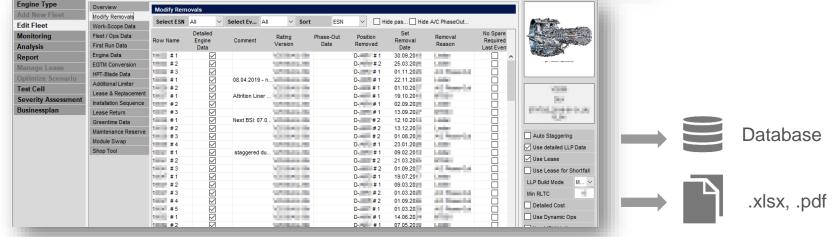
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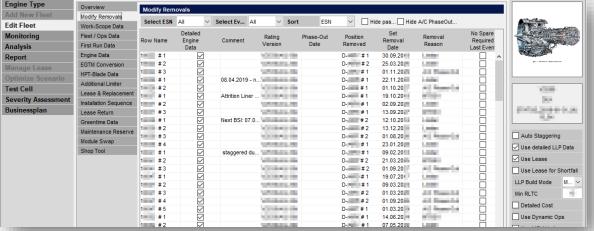


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Prepare Result for further Analysis





- Requirements
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 - Support Decision Making
 - 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

Aircraft Fleet

- Engine Type Rating
- Utilization
- Flight Profile

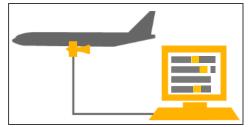
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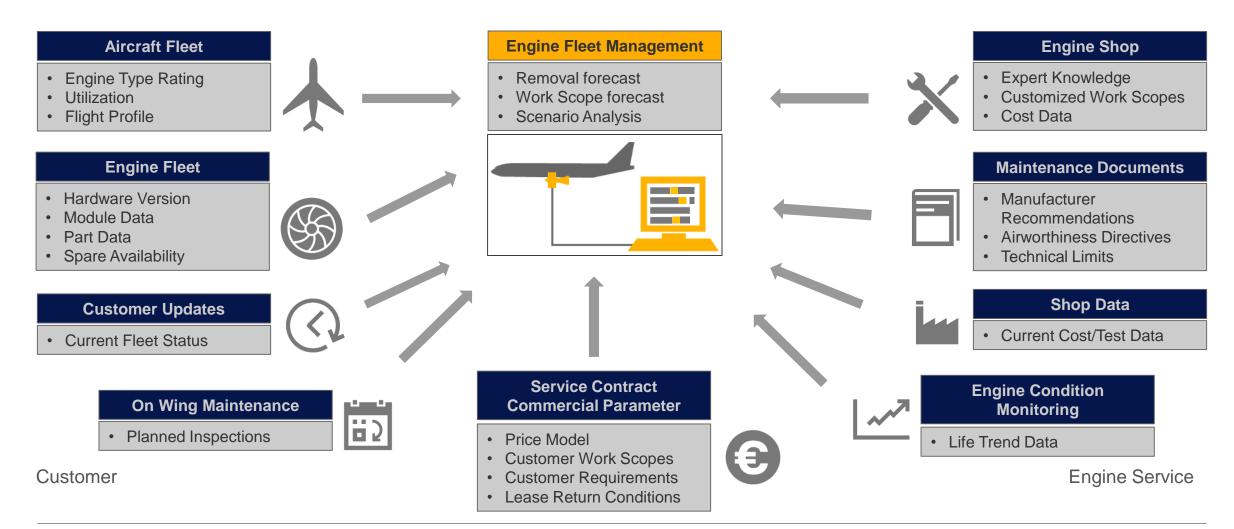


Engine Service

Customer

A growing number of Interfaces

Monitoring of an Engine Fleet



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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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

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