AI/ML for Reliability and Supply Chain Using Spec2000 Data

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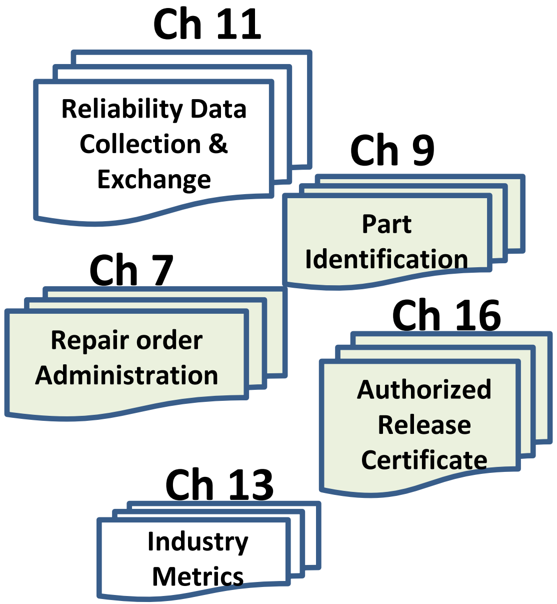
Spec2000 Enablers for Aircraft Maintenance

ATA e-Biz Topics of Interest Related to this Talk:

- Provisioning, procurement and materiel management
- Repair process management
- Aircraft and component reliability
- Maintenance repair effectiveness
- Part identification
- Electronic logbook and Work Package
- Operational metrics
- And many more…

Maintenance Analysis Data Ecosystem

Spec2000 Messages



Business Objectives

- Standardized data
- Required elements
- Enables sharing
- Performance metrics
- ***Improvement!***

This is much harder to do than one might think!

A Good Place to Start

Spec2000	Data Management	Data Analytics

- Usage (Hours)
- LRU Removals

Ch 11 Data exchange

- Relevant Removals History
- Aircraft Usage

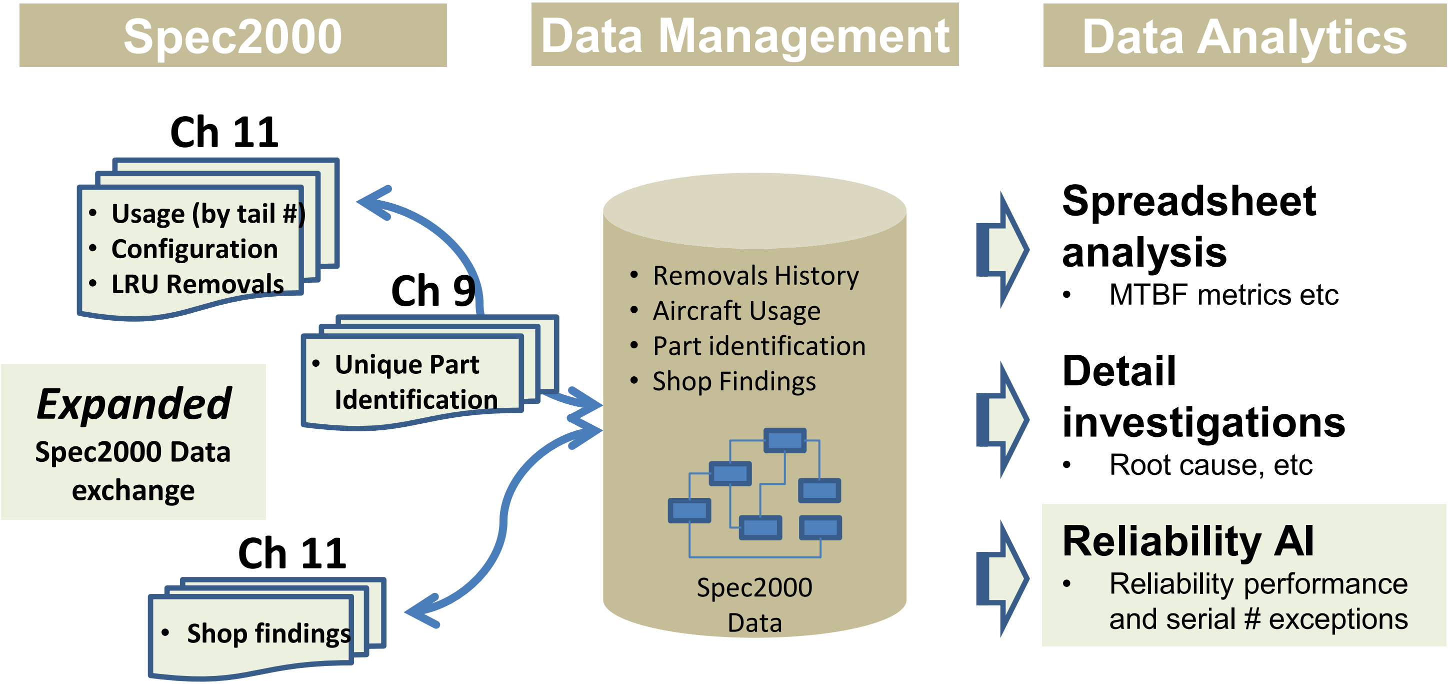
Spreadsheet analysis

- MTBUR metrics etc

Detail investigations

- Root cause, etc

A Highly Desirable Goal!



Reliability
Digital Twin (RDT)

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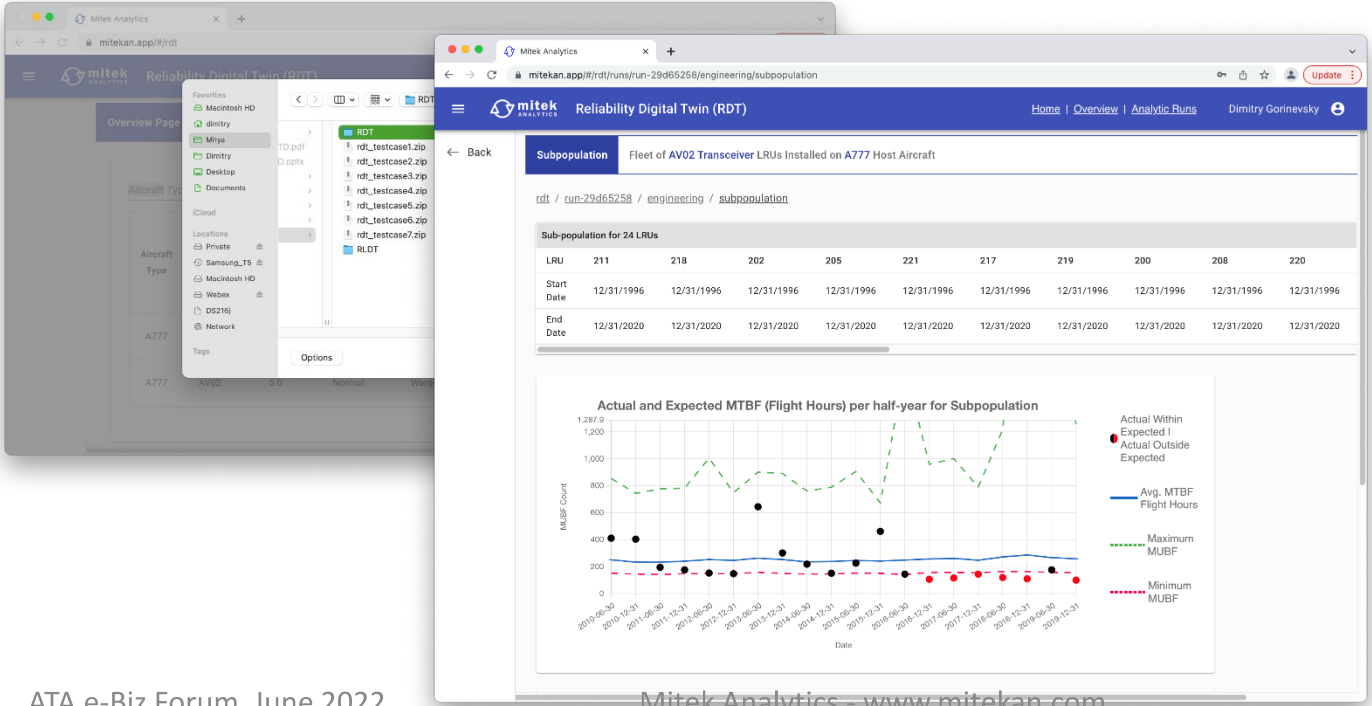
Reliability Digital Twin Example

Do parts that went through special procedure have better reliability?



Airline Benefits from RDT

Idea

Address both part reliability issues and “demand for maintenance”

- Automatically
- Month over month

Benefits

Detect reliability changes and trends early

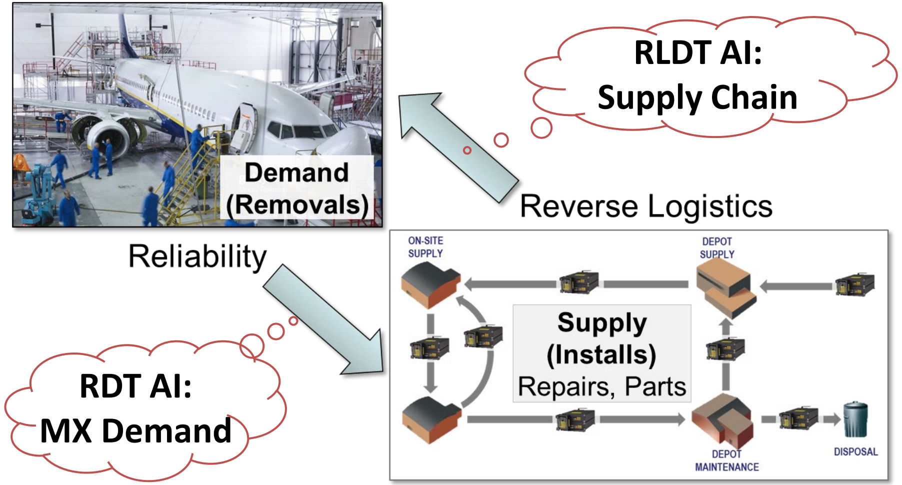
Account for several types of “no fault found” events

Capture performance of line maintenance troubleshooting

Find bad actors and evaluate subpopulations

AI for Maintenance Supply Chain

RDT (Reliability Digital Twin): maintenance & reliability
RLDT (Reverse Logistics Digital Twin): supply chain



Reverse Logistics Digital Twin (RLDT)

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Extended Analysis of Supply Chain

Spec2000

Ch 11
- Usage (fleet)
- LRU Removals
- Aircraft Events (delays, AOGs)

Ch 7
- Ship dates
- Receive dates
- TAT

Ch 16
- Authorized Release dates

Ch 13
- Reliability metrics
- Repair metrics

Data Management

- Removals History
- Aircraft Usage
- Part identification
- Repair Process
- Shop Findings

Spec2000 Data

Data Analytics

Spreadsheet analysis
- MTBF metrics etc

Detail investigations
- Root cause, etc

Supply Chain AI
- Logistics and repair cycle performance

Reverse Logistics Digital Twin Example

Can actually observed spares allocation be improved?

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Content

4 IMPACT OF STATION REALLOCATION

4.1 Optimized Reallocation

Total (fleet-wide) MICAP rate may be reduced by reallocating the existing st between Stations.

s is a convex optimization problem, meaning that there exists one optimal all that minimizes the total MICAP rate for each time sample.

The number of spares at each station for every month in the range is given by the corresponding MICAP and Demand rates, see Appendix B. Computing Ef Spares as described in Section 2.2 can be expressed as

Station Spares = RBS(MICAP Rate, Demand Rate)

The following optimization problem is solved given Demand at each Station number (the sum) of Effectively Used Spares

minimize Total MICAP Rate Across the Stations

subject to Allocated Spares add up to the Total

This is a convex optimization problem and can be efficiently solved numerica problem, there exists one optimal allocation of spares that minimizes the total each time sample. The solution yields, at each time sample (month),

- Reallocated Spares at each Station that add up to the same Total as act
- Predicted MICAP Rates at each Station that add up to improved Total

The top plot of Figure 4-1 shows predicted impact if the stock of spares were computed solution MICAP for the optimal allocation (dashed line) is compa MICAP trend (solid line). The bottom plot of Figure 4-1 shows the total numb month that must be reallocated to different Stations for the optimal allocation.

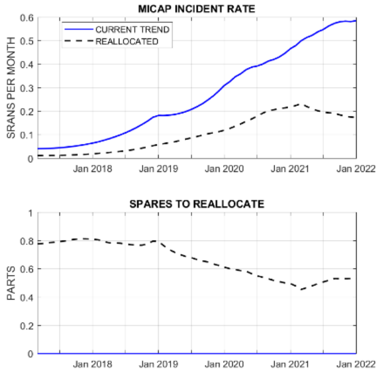

Figure 4-1: Optimal reallocation of spares

4.2 Reallocated Station Spares

Reallocating existing spares across Stations reduces MICAP at some stations and increases MICAP at other stations. The total risk of MICAP across all stations is reduced, however.

A cross-station view of the impact of reallocating existing spares is illustrated by Figure 4-2. In the top chart, the relative change in spares per station is shown (adds up to 1). In the bottom chart, the change in MICAP is shown (MICAP after reallocation minus MICAP before reallocation). The two bar charts show averages at each Station from the last 4 months.

Airline Benefits from RLDT

Idea

Manage performance of supply chain across stations for ever-changing supply and demand dynamics

- Automatically
- Month over month

Benefits

One-stop insight into root cause of maintenance delays/ AOGs

Prediction of AOGs caused by emerging demand-supply imbalances, by station

Operational adjustment of strategic parts allocation, based on execution results