Benefits of Optimizing Maintenance Intervals

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Maintenance Economics/ Boeing Professional Services
October 17-19, 2012
Atlanta, GA
Outline

• Perspective on Maintenance Check Intervals and Cost

• Check Intervals can be optimized beyond MPD

• Boeing’s new Statistical Analysis (SASMO*) Technology

• Benefits of Optimizing your Check Intervals

*SASMO: Statistical Analysis for Schedule Maintenance Optimization
Sample Operating Cost Distribution

- Total Revenue
- CAROC
- (Cash Airplane Related Cost
- Ownership Cost
- System Cost
- Payload Cost
- Flight Crew
- Landing
- Cabin Crew
- Nav
- Station
- Fuel
- Maintenance
- Profit
- TOC
- AROC
- 787-8
- 3,000 nm Trip
- Fuel: $3.75/USG (2012)
- US International Rules

Maintenance check interval optimization can significantly improve profit
Scheduled Checks are 16% of Total Maintenance Cost
- Can be optimized

- 737-800W
- Stage Length: 800nm (2 Fhr/Trip)
- Labor Rate: All Contract @ $55/Mhr
- No LLP, No Overhead
Can Operator Check Intervals be optimized?

Yes!

Requires:
- FAA allows and operators do it for their benefit
- Requires Operator In-Service data analysis

Benefits:
- Maintenance Cost reduction
- Airplane availability for revenue generation
Leveraging In-Service Data to Drive Maintenance Efficiency

Operator Maintenance Data
- Scheduled Maintenance
- Delay & Cancellation
- Component Removal
- Log Book
- Shop records
- Maintenance Cost

Data Analysis
- Predictive Modeling
- Economics Analysis
- Risk Analysis
- Age Analysis
- Utilization Analysis
- Root Cause Analysis

ISDP Data

Optimized Airline Operation

Airplane Production & Retrofit

Note: (1) Boeing Patent 2010070237 (3/10)
Aircraft Maintenance Philosophy Evolution

**History of Continuous Improvement**

**1968**
Scheduled Mx. Logic
- Overhaul
- Hard time limits

**1970**
“Component“ Oriented
- Bottom Up
- On condition
- Condition monitoring (non safety)

**1980 - Current**
“System” Oriented
- MSG-3
  - Multiple Revisions
  - Top Down
  - Reliability centered
  - Damage tolerance
  - Corrosion prevention
  - Zonal analysis
  - Structural health
  - Fatigue damage

**MSG**

- MSG-1
- MSG-2
- MSG-3

Efficiency

Time
Aircraft Maintenance Philosophy Evolution

**History of Continuous Improvement**

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  - Scheduled Mx. Logic
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  - Structural health
  - Fatigue damage

- **2008**
  - "Statistical Intervals"
  - IP 44
  - MSG-3 Supplement
  - Representative sample
  - Comprehensive data set:
    - Scheduled
    - Unscheduled
  - Spec 2000 or equivalent
  - Statistical analysis engine
  - Engineering judgment
  - Example solution:
    - Boeing SASMO
Outline

• Perspective on Maintenance Check Intervals and Cost
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• Boeing’s new Statistical Analysis (SASMO) Technology
• Benefits of Optimizing your Check Intervals
How Does SASMO Work?

SASMO Application + OEM Engineering

ISDP Data

• Scheduled Maintenance
• Log Book
• Component Removal
• Delay & Cancellation
• Shop records
• Maintenance Cost

Task Intent / Mapping

• MSG-3
• Task Procedure

Data

• Processing
• Mining
• Categorization

SASMO(1) Statistical Analysis Engine

SASMO Statistical Output

• IP-44 Compliant
• Optimal intervals
• Regulatory justification

Note: (1) Boeing Patent 2010070237 (3/10)
Setting Optimal Maintenance Intervals

System Degradation

Significant Finding (System Failure)

Minor Defect (Latent Failure)

Early inspection - NFF

Time

Effective Interval

T_{MF}

T_{SF}

Opportunity For Preventative Maintenance

Minimize Looking Too Early (NFF) and Too Late (In-Service Failures, Unscheduled Maintenance)

Significant Finding

• Reduction in functionality or unacceptable operational / economic penalties

Minor Finding

• No immediate functional, operational, or economic impact

High probability of Unscheduled Maintenance

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Interval Selection Example

Boeing SASMO Maintenance Statistical Analysis Engine

As Opportunity increases, Risk increases (though not at the same rate)
Boeing SASMO Interval Recommendations

Customer Objectives
- Technical Requirements
- Business Objectives
- Operational Capabilities

Engineering Expertise
- OEM Detailed Aircraft Design Knowledge
- Aircraft Certification Limits

SASMO Interval Recommendation

Statistical Analysis
IP-44 Compliant

SASMO / IP44 Approval
SASMO Optimization Process

SASMO Engagement

Gather Data
- Operator specific
- Reliability program
- Mx. planning
- Schedule data
- Non-routine

Optimize Tasks
- Rationalize tasks
- MPD correlation
- Task escalation / de-escalation
- Statistical rigor

Update Program
- Customer objectives
- Unique tasks
- Mx. program packaging

Regulatory Approval
- OEM Support
- Review of analysis
- SASMO justifications
- APM approval

Transition Aircraft
- Transition package to new AMP
- Training customer staff
- Re-bridge as needed

SASMO Statistical Output
- Accelerated process
- Optimal intervals
- MPD tailored to your capabilities & operation
- Regulatory justification and support

4-6 months
### Airline Benefits of Boeing SASMO

<table>
<thead>
<tr>
<th>Task Intervals</th>
<th>Optimized</th>
<th>Airplane Bridging</th>
<th>Yes</th>
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<tbody>
<tr>
<td>Maintenance Labor Hours</td>
<td>Down</td>
<td>Reliability Program</td>
<td>Review</td>
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<tr>
<td>Aircraft Availability</td>
<td>Up</td>
<td>Maintenance Program</td>
<td>Review</td>
</tr>
<tr>
<td>Reliability</td>
<td>Up</td>
<td>Add’l. Revenue Potential</td>
<td>Up</td>
</tr>
<tr>
<td>Implementation Speed</td>
<td>Up</td>
<td>Maintenance Cost</td>
<td>Down</td>
</tr>
</tbody>
</table>

A Tailored Opportunity Assessment Can Be Created For Your Airline
Why Partner With Boeing?

- OEM airplane knowledge
- Regulatory relationships
- Maintenance programs
- Reliability programs
- OMP experience
- Execution ready

OEM Engineering support
- Statistically rigorous
- Regulator approved
- IP-44 compliant

SASMO Optimized Maintenance Program

Global Feet & OEM Data
- OEM Design Data
- Global Fleet Maintenance Data

Boeing Expertise
- Multiple fleets
- Typically many responsibilities
- 50+ fleets
- Focused and ready

Data
- Airline fleet
- Airline engineering
- Global fleet
- OEM engineering

Tools
- SASMO IP-44 Compliant
- ?

Get Further, Faster With an OEM-backed Maintenance Program
Outline

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Check Interval Optimization

<table>
<thead>
<tr>
<th></th>
<th>Original Check Interval</th>
<th>After Optimization (25%)</th>
<th>Checks Saved in 24 Years</th>
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<tbody>
<tr>
<td>A-Check (Days)</td>
<td>90</td>
<td>113</td>
<td>24</td>
</tr>
<tr>
<td>C-Check (FHRS)</td>
<td>6,000</td>
<td>7,500</td>
<td>3</td>
</tr>
<tr>
<td>D-Check (Years)</td>
<td>8</td>
<td>10</td>
<td>1</td>
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</tbody>
</table>

Per Airplane! INTEGRATED COST ANALYSIS SYSTEM

First Public View
With Optimization unit A-Check cost reduces 20%
All Checks unit costs reduces ~ 25%
1.2 additional days per year for revenue service

Days-Out-of-Service - 24 year Life Cycle (DoS)

- **DoS Original**
  - Days Out of Service:
    - A-Check: 36.5
    - C-Check: 56.0
    - D-Check: 19.2
    - Total: 121.7

- **DoS Optimized**
  - Days Out of Service:
    - A-Check: 36.5
    - C-Check: 56.0
    - D-Check: 19.2
    - Total: 122.3

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For a Fleet, Cost Saving are tremendous

- Check cost saving of $16.42/Fhr = $0.5 million
  (@3,020 Fhrs/Year over 10 year)

- Profit Opportunity: 1.2 days/Year = $0.4 million
  (@ $36,000 per day over 10 year)

- Benefit for Fleet of 30 737-800W = $28 million

Minimum Expenses – estimated $5 million for bridging checks and data analysis
Summary:

Benefit for Fleet of 30 737-800W = $28 million

Lower Maintenance Cost & more Revenue Service
Questions?

For more information

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