Capturing Product Behavioral and Contextual Characteristics through a Model-Based Feature Information Network (MFIN)

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Capturing Product Behavioral and Contextual Characteristics through a Model-Based Feature Information Network (MFIN)
Project Background

Problem: Build Data is in various formats from various sources

Result: Inconsistencies And/or Incomplete Data Packages

- Manual, Error-prone Processing
- Increased Production Costs
Project Background

Unintelligent Links Make Data Transfer Difficult To Communicate & Interpret Accurately

Result: Inconsistencies And/or Incomplete Data Packages

• Manual, Error-prone Processing
• Increased Production Costs
Project Goals

- Expand MBD beyond geometry & PMI
  - Include all aspects of data in the product’s lifecycle
- Automate data retrieval
- Feature-level linkage between CAD model and related data
- Educate the workforce on the benefits of intelligent data
- Release developed technology/methodology via software tools
Project Benefits

• Single, digital source to locate connected data

• Any required Information for activities available through the product lifecycle

• More efficient retrieval of necessary data

• Reduced Interpretation Error And Manufacturing Cycle Times

• Neutral framework to be implemented & customized by any software
How is this different than PLM?

• PLM is a process

• MFIN is a model-centric file with semantic organization of data

• Similar to Semantic Web Concept
How is this different than PDM?

• PDM is how you store the data
  • Data revisions, Security, Backup

• MFIN is information with semantic organization of data

• Yes – PDM systems could read MFIN data if you set it up to
  • New CAD revision = new MFIN file?
Architecture
MFIN – QIF XML Schema

Model-Based Feature Information Network (MFIN)

• Based on ANSI 2.1 Standard for QIF
  
  • ANSI - American National Standards Institute
  
  
  • XML - Extensible Markup Language
    
    • Lightweight
    
    • Human-readable and machine-readable
    
    • Free & open non-proprietary standard developed by World Wide Web consortium
MFINT Data Model

The “glue” that connects the data to the authority model

<table>
<thead>
<tr>
<th>MFIN Example Dashboard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Search</strong></td>
</tr>
<tr>
<td>Part Number:</td>
</tr>
<tr>
<td>Part Description:</td>
</tr>
<tr>
<td>Engine Program:</td>
</tr>
<tr>
<td><strong>Design</strong></td>
</tr>
<tr>
<td>Review part number, description, revision, material, etc.</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
</tr>
<tr>
<td>Review scan data, results, reports, etc.</td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
</tr>
<tr>
<td>Review Bill of Process, Mfg actuals, etc.</td>
</tr>
<tr>
<td><strong>Inspection</strong></td>
</tr>
<tr>
<td>Review results, FAI, etc.</td>
</tr>
<tr>
<td><strong>Assembly/Test</strong></td>
</tr>
<tr>
<td>Review data</td>
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<tr>
<td><strong>Operation/Maintenance</strong></td>
</tr>
<tr>
<td>Review data</td>
</tr>
<tr>
<td><strong>Service/MRO</strong></td>
</tr>
<tr>
<td>Review Service Manual, Overhaul actuals</td>
</tr>
</tbody>
</table>

Distribution A – Approved for public release: distribution is unlimited
What does the MFIN look like?

• How can you access info in the MFIN?
  • API
  • Python
  • C#
  • C++

• Example GUI
**MFIN GUI Concept**

Home page

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*This is a conceptual representation only of what an MFIN GUI might look like based on Rolls-Royce operation.*
MFIN Dashboard – Design Data

- Design
- View engine status
- View hardware dispositions
- Analysis
- View inventory
- Manufacture
- Inspection
- Assembly
- Operation
- Service

*This is a conceptual representation only of what an MFIN GUI might look like based on Rolls-Royce operation.*
MFIN Dashboard – Design Data

Design Data –
Third Level information

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MFIN GUI concept

Design Data –
Second level choices

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Design Data –
Second level choices

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MFIN Dashboard – Design Data

View Hardware Dispositions

Filter
Plot

Selection: View Operation View Inspection

Design
Analysis
Manufacture
Inspection
Assembly
Operation
Service

Design Data –
Third Level Information

MFIN GUI concept

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<table>
<thead>
<tr>
<th>Select</th>
<th>Eng S/N</th>
<th>Work request #</th>
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<td>CAE130xyz</td>
<td>999999</td>
<td></td>
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</tr>
</tbody>
</table>
MFIN GUI concept

Analysis Data –
Second level choices

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MFIN GUI concept

Manufacturing Data –
Second level choices

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MFIN Dashboard – Inspection Data

MFIN GUI concept

Inspection Data –
Second level choices

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Assembly/Test Data –
Second level choices

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Operation/Maintenance Data – Second level choices

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Service/MRO data –
Second level choices

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MFIN Dashboard – Service/MRO Data

Service/MRO data –
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Service/MRO data –
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Summary
MFIN is a Framework Utilizing the QIF Schema to Expand MBD

Analysis

Assembly

Data Collection

Inspection

Maintenance / Repair

End of Life

Design Changes

Version A

Version A R1

Version A R2

Version B

Version B R2

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MFIN is a Framework Utilizing the QIF Schema to Expand MBD.
Use Case: Maintenance & Repair Operation

- Sustainment Engineer or Field Support Specialist
  - Utilize the MFIN to upload and access lifecycle data
  - Supporting sustainment activities

- Result: This will streamline diagnosis of quality defects or part failures in the field
  - Drive design optimization efforts
Test/Clean/Inspect

Part with issue identified

Part repairable?

Yes
Repair
Test Re-assemble

No
Damage Disposition

Out of Design Limit
Replace Part

Out of Repair Limit

Out of Service Limit

Tech Variance Request

Service Investigation

Repair Part

Investigation complete

Record of Investigation

MFIN Data (PLM Database)

MFIN API LAYER

Maintenance Repair Overhaul (MRO) Workflow
Use Case: Process Planning

- **Process Planner**
  - Utilize the MFIN to automate the generation of process planning documentation
  - Leveraging relevant PMI and associated data libraries (standard text, specifications, etc.) linked within the MFIN.

- **Result:** This will reduce the amount of labor and errors associated with legacy processes
  - Link results back to specific geometry via MFIN.
Manufacturing Process Planning Workflow

1. Part Code
2. Define / Locate Part Family
3. Prepare / Retrieve Part Process Plan
4. Complete Process Plan

Results mapped to model via MFIN API

MFIN Data

MFIN API LAYER

Standard Process Plans & Part Process Plans
The MFIN is an Evolution of MBD
MFIN Solutions Will Vary
Lessons Learned to Date

• Learning Curves associated with different schema, software products, etc.
  • Reviewed standards/documentation to drive QIF solution

• Settling on best formatting/structure for data consumption
  • Project will focus mostly on linking rather than embedding

• Understanding PMI requirements for broader industry use cases
  • Schema structure is customizable for accommodating broader applications
  • Open source MFIN tools/utilities to enable expanded applications
Lessons Learned to Date

• Supportable Implementation
  • Proprietary Software Would Leverage MFIN as an Interoperability format
  • Allows end users to string together a digital thread based on independent best in class solutions
Technology Transition Plan

- Develop and demonstrate a “neutral” framework for semantic PMI and feature-level linkages that extend MBD through the product lifecycle.
  - Organizations would adapt their methods and tools to support their needs
- Develop a user interface and utilize multiple workflows to demonstrate the benefits of embracing MBE
- Lessons learned will be shared with QIF standards body
Thanks!

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Project team consists of approximately 40 DMDII members from various companies and universities.

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