EVOLVE OR DISSOLVE...

EFFECTIVE MBD/MBE STRATEGY AND BENEFITS

MBE Summit // April 4, 2017
Puppy
Evolve or Dissolve

Created by Ross Halliday @FizzicalEd

Or

DISSOLVE
Model-Based Consulting and Training

Training

- MBD/MBE EDUCATION – CAD Agnostic
  - Model Based Enterprise (MBE) Overview – What, Benefits, How
  - Introduction to MBD – What, GD&T, How

- PLANNING
  - MBE Implementation
  - MBE Planning and Roadmap Building

- IMPLEMENTING
  - Model Schema and Organization – CAD Agnostic
  - How to Write a Modeling Guide – CAD Agnostic
  - Reading, Commenting and Publishing 3D PDFs

CAD & PDM IMPLEMENTATION: SOLIDWORKS

- Using SOLIDWORKS MBD
- Administration, Set-up, and Best Practices for SOLIDWORKS and Enterprise PDM for MBD
- Model Checking Automation for MBD
- Reading, Viewing, and Reviewing MBD in SOLIDWORKS and eDrawings

CAD IMPLEMENTATION: Creo

- Using Creo MBD
- Model Checking Automation for MBD – ModelCHECK Administration and Best Practice
- Reading, Viewing, and Reviewing MBD in Creo and CreoView

CAD IMPLEMENTATION: NX

- Using NX MBD
What does a fully integrated digital enterprise look like?
Why would I bother with MBD?
How can MBD enable smart manufacturing systems?
What about Suppliers and Manufacturing/Quality?
What does a fully integrated digital enterprise look like?

Why would I bother with MBD?

How can MBD enable smart manufacturing systems?

What about Suppliers and Manufacturing/Quality?
Smart manufacturing requires a **digital enterprise**.

A **digital enterprise** requires **digital data**.

**Digital data** for product definition is called **Model-Based Definition (MBD)**.
Use MBD to Automate Inspection

Desired Functionality
In Creo Native:
Compare Actual to Source

Creo with MBD

QIF MBD

QIF MBD defined as:
• Geometry
• Annotations
• Metadata
• Presentation
• Bill of Characteristics (BoC)

QIF PLAN

QIF PLAN defined as:
• How to perform measurements
• BoC turned into measurement items
• QPIDS created

DMIS Execution File

DMIS Output File

Measurement Execution

CMM:
• Part Program
• Measurement Instructions
• Inspection Results

QIF Results

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Model-Based Inspection Process – Using QIF
What is MBD?

Model-Based Definition (MBD) is a model with Product Manufacturing Information (PMI) and consisting of:

1) **3D geometry** (serves as the basic dimensions)
2) **annotations*** (displayed notes, dimensions and tolerances or GD&T)
3) **attributes*** (metadata and queried data)
4) **presentation*** (saved views, presentation organization)

*As defined in ASME Y14 Series
How is MBD different from drawings?

Drawings REQUIRE experience

We naturally see in 3D
How is MBD different from drawings?

The 3D model is the basic dimension

Drawings REQUIRE all basic dimensions
How is MBD different from drawings?

Drawings are **AMBIGUOUS**

The 3D model is **ABSOLUTE**
Anatomy of a Data Package (DD)

Data Package Elements

**3D Geometry** that is mathematically accurate provides graphical visual representation and dimensional representation

**Related Files** (3D and 2D) in a variety of formats (STEP, Parasolid, STL, Native CAD, more…)

**Annotations:**
- Datums
- Tolerances
- Notes
- Product Characteristics

**Metadata**
- Part Number, Description, Revision, Tolerance
- Block, Material, Finish, Organization Information
- Bill of Materials (BOM) or Parts List (PL)
- Option for encoded data (e.g. Color, IP Rights, Model Precision, CAD Format Compatibility)
Assembly Layout Example

**Parts List**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Part Description</th>
<th>Part Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>122333</td>
<td>Bulkhead Mount</td>
<td>1</td>
</tr>
<tr>
<td>332221</td>
<td>QIF Bracket</td>
<td>1</td>
</tr>
<tr>
<td>444555</td>
<td>QIF Shaft</td>
<td>1</td>
</tr>
<tr>
<td>467788</td>
<td>QIF Strut</td>
<td>2</td>
</tr>
<tr>
<td>60358861</td>
<td>Ball Bearing</td>
<td>1</td>
</tr>
<tr>
<td>4179211</td>
<td>Corrosion Resistant</td>
<td>1</td>
</tr>
<tr>
<td>741312208</td>
<td>Side Mount External</td>
<td>2</td>
</tr>
<tr>
<td>R88926-8</td>
<td>Washer</td>
<td>2</td>
</tr>
<tr>
<td>313981663</td>
<td>Alloy Steel Shoulder</td>
<td>1</td>
</tr>
<tr>
<td>R5201043-06</td>
<td>Hexagon Nut</td>
<td>1</td>
</tr>
<tr>
<td>456987</td>
<td>Bearing Shaft</td>
<td>1</td>
</tr>
<tr>
<td>74131270</td>
<td>Side Mount External</td>
<td>1</td>
</tr>
</tbody>
</table>

**Notes and/or Work Instructions**

REV.

REV DESCRIPTION

A

INITIAL

2016-09-05

PROJECT NUMBER: Q1F101

ACTION ENGINEERING, LLC
5009 S ELLIS CT
LAKESIDE, CO 80228

CUBS approved: 2016-09-05

M2 DEVELOPMENT: A-1 NONE

MANUFACTURING: A1-NONE

APPLICATION ATTACHMENT: G2-FULL

MATURE MANUFACTURING: 555444

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What does a fully integrated digital enterprise look like?

**Why would I bother with MBD?**

How can MBD enable smart manufacturing systems?

What about Suppliers and Manufacturing/Quality?
Improve Product Data Quality with MBD

Drawing-based method
★ Rework required due to human mis-interpretation

Model-based method
★ Built as modeled

Fig. 7 Comparison of a delivered test case 1 part showing the addition of an unintended through-hole in the drawing-based part

MBD Benefits at a Large Scale

- Migrating to MBD provides quantifiable benefits
- MBD can reduce scrap rate and reduce engineering changes
- Using a minimally annotated model reduces product definition authoring time

REFERENCE: http://www.lifecycleinsights.com/study/the-design-and-documentation-study/

2014 DATA

Assessing why parts don’t fit together
4.9 fewer times per month

<table>
<thead>
<tr>
<th>Strongly 2D Drawing Reliant</th>
<th>Mostly 2D Drawing Reliant</th>
<th>Balanced Release Deliverables</th>
<th>3D Annotated Model Reliant</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.3</td>
<td>7.0</td>
<td>7.2</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Figure 3: Average times per month the organization assesses why parts don’t fit as a result of engineering documentation


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2016 ROI of MBD Study

MBD ADOPTION

34%
33%
21%
12%

- Drawing exclusive
- Drawing with model
- Drawing with MBD deliverable
- Drawingless

REFERENCE: http://www.lifecycleinsights.com/study/the-design-and-documentation-study/
Reduce Changes, Scrap, and Non-Conformances

2016 DATA

- Reduce clarification requests: 36%
  - Drawing Based: 15%
  - Model Based: 23%
  - MBD Based: 23%

- Reduce change orders: 30%
  - Drawing Based: 21%
  - Model Based: 20%
  - MBD Based: 20%

- Reduce scrap: 35%
  - Drawing Based: 15%
  - Model Based: 16%
  - MBD Based: 16%

- Reduce non-conformances: 33%
  - Drawing Based: 16%
  - Model Based: 16%
  - MBD Based: 16%

REFERENCE: http://www.lifecycleinsights.com/study/the-design-and-documentation-study/

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Search-ability

**CHALLENGE**: Engineers spend too much time searching for data

**SOLUTION**: Consistently applied MBD can increase the “google-ability” of 3D data
What is your pain?

- High cost & schedule engineering changes
- High scrap rate
- Poor product quality
- High tribal knowledge
- Chaotic Design
  - Engineer To Order (ETO)
  - Configure To Order (CTO)
Topics

What does a fully integrated digital enterprise look like?

Why would I bother with MBD?

How can MBD enable smart manufacturing systems?

What about Suppliers and Manufacturing/Quality?
What does a fully integrated digital enterprise look like?

Single Source of Truth

DESIGN
ANALYSIS
DOC CONTROL
SYSTEMS
MANUFACTURING
QUALITY
PROCUREMENT
SUPPLIER
Success with Digital Data Requires the Entire Enterprise

**Standards**
- ASME Y14 Series

**Processes**
- CAD Agnostic Modeling Processes
- Part-Specific Process Specifications & Derivative Models
- Defining, Commonly Understood & Executed
- Culture Fosters Adherence to New Rules and Methods

**Tools**
- CAD Software
- CAM Software
- Defined, Commonly Understood & Executed
- Culture Fosters Adherence to New Rules and Methods

**People & Culture**
- Defined Method to Manage Information Throughout Enterprise
- ASME Y14 Series
- Defined Methods to Acquire MBD Parts
- PDM and PLM

**Design**
- ASME Y14 Series

**Manufacturing**
- STEP
- ASME Y14

**Quality**
- QIF
- ASME Y14
- STEP

**Procurement**
- QIF
- ASME Y14
- STEP

**Data Management**
- Defined Method to Manage Information Throughout Enterprise
- ASME Y14 Series
- Defined Methods to Acquire MBD Parts
- PDM and PLM
### Organizational Readiness: Evaluate Current & Target States

**Digital Design Model**

<table>
<thead>
<tr>
<th>Relative Business Case</th>
<th>Level 1 - Low Capability</th>
<th>Level 2 - Medium Capability</th>
<th>Level 3 - Best in Class Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master Data Set</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Authoring &amp; Review</td>
<td>Single point of entry for all data: Enables data flow accuracy, Enables downstream efficiency &amp; accuracy, Allows for automation</td>
<td>2D Drawing is Master, Modeling is apparently used or not used at all, no digital association between Drawing &amp; Model - Y14.100 - Classification Code 1 or 2</td>
<td>3D Model is Master for Geometry, PMI is still in Drawing, Digital associativity is enabled between Model &amp; Drawing, Drawing is derivative of Model - Y14.100 - Classification Code 3</td>
</tr>
<tr>
<td>Data Consumption</td>
<td>Everyone creates and understands the data in the same way, No or inconsistently applied methods for producing consistent documentation</td>
<td>Some and inconsistently applied methods for producing consistent documentation</td>
<td>Defined, repeatable and consistently applied methods for producing consistent documentation</td>
</tr>
</tbody>
</table>

**SCORE Current State**

- Level 1 - LOW
- Level 2 - MEDIUM
- Level 3 - BEST IN CLASS

**SCORE Target State**

- Level 3 - BEST IN CLASS

**REFERENCE:** Digital Thread Capability & Maturity Model, Action Engineering, LLC & DSA

- **[Low]** Undefined & Out-of-date
- **[Basic]** Defined & Repeatable
- **[Best-in-Class]** Measured & Continuously Improving
The Value Add of MBE Maturity

**Low**
Criteria are undefined, out of date, or both

**Medium**
Criteria are defined, under change control, repeatable, and continuously improving

**Best-in-Class**
Criteria are defined, under change control, repeatable, measurable, and continuously improving

Maturity and Capability
Top 3 Focus Areas… and Why

Software Tools and Maintenance
Define and Execute Consistently
Robust CAD Source, Derivative and Interoperability Strategy
Software Tools & Maintenance

- Research
- Select
- Test
- Deploy
- Maintain

⚠️ It is critical to “KEEP UP”

Define and Execute Consistently

Road Map for Implementation

- Include all stakeholders: Design, Manufacturing, Quality, Data & Change Management, Procurement, Product Lifecycle Management, People & Culture

3D Product Definition

- 3D modeling standard
- Sophisticated understanding of GD&T
- Sophisticated approach to inspection criteria
- CAD agnostic processes for MBD

Stakeholder Engagement

- It’s all about the people!
  - Make jobs less frustrating
  - Improving the quality of the end product
  - Build loyalty
Robust CAD Source, Derivative and Interoperability Strategy
What does a fully integrated digital enterprise look like?

Why would I bother with MBD?

How can MBD enable smart manufacturing systems?

What about Suppliers and Manufacturing/Quality?
Manufacturing & Quality Readiness

- Internal Suppliers
- External Suppliers

MBE Summit Manufacturing & Quality Track

MBD Supplier Readiness

Tuesday, April 5, 2017 4:20-4:40 pm
What did you learn?
Find Out More…
Re-Use Your CAD™

Model-Based Business Process Coaching & Planning

- Model-Based Engineering & Enterprise (MBE) Planning
- PDM & PLM Process Implementation
- Tailor Business Practices and PDM/PLM Workflows to include 3D CAD
- Apply Configuration Management Directly to 3D Model Data Sets
- Strategies to Create and Consume MBD Models

Model-Based Training and Education

- Basic Training is CAD Agnostic and Focuses on MBE Philosophy
- Intermediate and Advanced Training is Software-Specific and Customized to Your Organization
- Understanding Model-Based Definition (MBD) and Technical Data Packages (TDP), per ASME Y14.41 and MIL-STD-31000A
- CAD Modeling Best Practice for MBE

CAD, PDM, PLM Software Selection Consulting

- Software Beta Testing
- User-Based Feedback and Improvement for Software Tools
- Assess and Recommend Software Tools for Compatibility with 3D Model-Based Engineering (MBE)
## CAD Agnostic Course Listings

<table>
<thead>
<tr>
<th>MBD/MBE EDUCATION</th>
<th>Course Number</th>
<th>Suggested Format</th>
</tr>
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<tbody>
<tr>
<td>Model Based Enterprise (MBE) Overview – What, Benefits, How</td>
<td>101</td>
<td>Live or Online</td>
</tr>
<tr>
<td>Introduction to MBD – What, GD&amp;T, How</td>
<td>102</td>
<td>Live or Online</td>
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<tr>
<td><strong>PLANNING</strong></td>
<td></td>
<td></td>
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<tr>
<td>MBE Implementation</td>
<td>103</td>
<td>Live or Online</td>
</tr>
<tr>
<td>MBE Planning and Roadmap Building</td>
<td>104</td>
<td>Live</td>
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<tr>
<td><strong>IMPLEMENTING</strong></td>
<td></td>
<td></td>
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<tr>
<td>Model Schema and Organization – CAD Agnostic</td>
<td>105</td>
<td>Live or Online</td>
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<tr>
<td>How to Write a Modeling Guide – CAD Agnostic</td>
<td>106</td>
<td>Live or Online</td>
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<tr>
<td>Reading, Commenting and Publishing 3D PDFs</td>
<td>107</td>
<td>Live or Online</td>
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CAD Specific Course Listings

<table>
<thead>
<tr>
<th>CAD &amp; PDM IMPLEMENTATION: SOLIDWORKS</th>
<th>Course Number</th>
<th>Suggested Format</th>
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<tbody>
<tr>
<td>Using SOLIDWORKS MBD</td>
<td>201</td>
<td>Live or Online</td>
</tr>
<tr>
<td>Administration, Set-up, and Best Practices for SOLIDWORKS and Enterprise PDM for MBD</td>
<td>202</td>
<td>Live or Online</td>
</tr>
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<td>Model Checking Automation for MBD</td>
<td>203</td>
<td>Live or Online</td>
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<td>204</td>
<td>Live or Online</td>
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<tr>
<th>CAD IMPLEMENTATION: Creo</th>
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<th>Suggested Format</th>
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<tbody>
<tr>
<td>Using Creo MBD</td>
<td>301</td>
<td>Live or Online</td>
</tr>
<tr>
<td>Model Checking Automation for MBD – ModelCHECK Administration and Best Practice</td>
<td>303</td>
<td>Live or Online</td>
</tr>
<tr>
<td>Reading, Viewing, and Reviewing MBD in Creo and CreoView</td>
<td>304</td>
<td>Live or Online</td>
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<table>
<thead>
<tr>
<th>CAD IMPLEMENTATION: NX</th>
<th>Course Number</th>
<th>Suggested Format</th>
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</thead>
<tbody>
<tr>
<td>Using NX MBD</td>
<td>401</td>
<td>Live or Online</td>
</tr>
</tbody>
</table>

*Courses listed are not official SOLIDWORKS, DASSAULT, PTC, or SIEMENS sanctioned courses.*
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Re-Use Your CAD
Online Resources

Blogs
- www.action-engineering.com/blog
- blog.grabcad.com
- MCADCafé.com

LinkedIn Groups
- Model Based Enterprise
- Model Based Definition

Events
- 3D CIC + QIF Summit
  October 3-5, 2017, Golden, CO
Part Layout Example
Identifying Product Characteristics with MBD

7. PRODUCT CHARACTERISTICS (PC) SHALL BE VALIDATED PER AS9102B AND QIF 2.1 AND ARE IDENTIFIED AS: [PC-###].
Creating a Data Package (DP)

CREATE 3D Geometry

CREATE 3D Annotations

ENTER Attributes & Metadata

CREATE Presentation

SPECIFY Inspection

TRANSLATE

CREATE Presentation

NATIVE

STEP

QIF

3D PDF

Parasolid