Minimum Model-Based Definition (MBD) for Type Design Certification

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Aerospace & Defense PLM action group

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Workgroups:

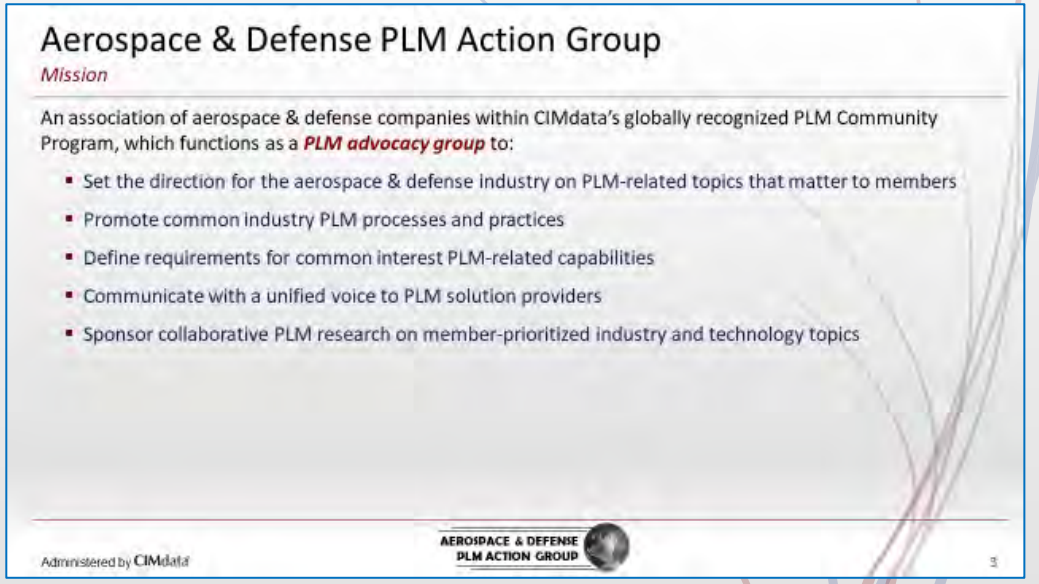
Multi View BOM

Standards

MBSE

MBD

Global Collaboration



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MBD Project Team

Current members and other significant contributors

- Pierre Duchier – Airbus
- Brandon Sapp, John Van Horn, Timothy Brennan, Thomas Burns, Tom Meek – Boeing
- Ken Versprille – CIMData
- Jelka Pasic Holm - GKN
- Lee Nash – Gulfstream
- Ian Parent, Robert Gutwein, Lloyd Waldron – Pratt & Whitney Canada
- Amilcare Pinto - SAFRAN

Industry drivers

Impact

- Although a widely used capability, MBD is still maturing and evolving. As other domains progress through their journey to transform their enterprise the industry will see changes to process & methods, data structures and visualizations.

- Interoperability of this information through the lifecycle is critical as it drives our configurations and certification basis.

MBD Project

Goal

- Establish a set of requirements for the A&D community that details the minimum information required for an MBD that supports the following Use Cases:
  - Visual Build & Inspection
  - Feature Based Manufacturing
  - Statistical Process Control
  - Submittal of a Technical Data Package to a Regulatory Agency

Use Case: Visual Interpretation and Visual Consumption

- Description: Visual consumption of the MBD contents during the build and inspection processes. Manual comparison between physical and virtual.

- Sample Process Flow: As a manufacturing process planner I want to define the sequence of steps to manufacture the product so that I can create part demand build orders.

Use Case: Feature-Based Manufacturing

- Description: Models are rich with intelligent form features (e.g., holes, slots, plys). Feature-Based Machining/Manufacturing allows the programmer to set up parameters ahead of time for these features to be used in manufacturing and inspection process

- Sample Process Flow: As an NC programmer I want to create a high quality program directly consuming the defined features from the MBD. I want the program to call stored procedures based on the feature type and determine appropriate tool, path and speed for the job.

Use Case: Statistical Process Control

- Description: Statistical Process Control (SPC) is a data-driven methodology for analysis and an improvement methodology for measuring and controlling quality during the manufacturing process.

- Process Flow: As a QA Inspector I want to collect and analyze the SPC data points from the manufactured product data in real time so that I can determine if any corrections need to be made.

Use Case: OEM Submission of TDP to Certification Authority

- Description: The gathering, organizing and presentation of all technical data representing the physical definition of the type design that was used to manufacture and conform the product.

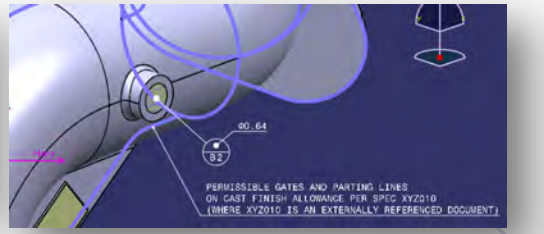
- Process Flow: As an FAA representative (e.g., ODA) I will perform first article inspection of the product using the engineering definition in the submitted Technical Data Package.

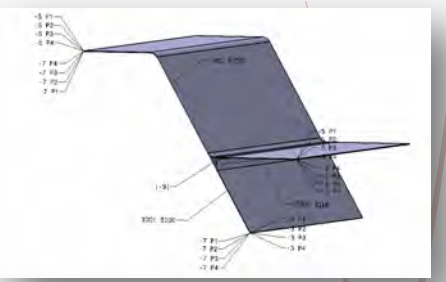
Information Requirements

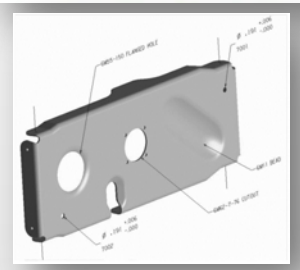
- The use cases are the business requirements – the reason why we are investigating
- The use cases have identified the key requirement of digital data continuity.
- The primary part types are the execution of those requirements and how we achieve that data continuity. Which requires an evolution of processes and information handling within those models.
- The goal was to achieve a semantic representation and presentation that requires the information to be human/computer interpretable, consistent and clear to the consuming systems.

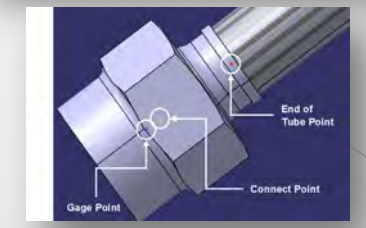
Primary Part Types

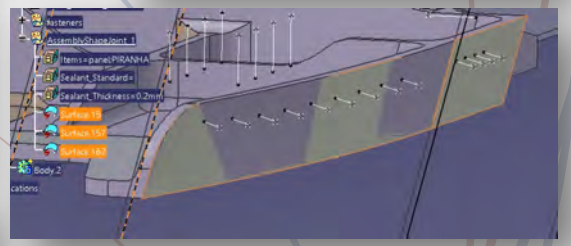
- General MBD
- Machined
- Casting/Forging/Molded
- Sheet Metal
- Composite with LLAI
- Electrical Wire Harness
- Mechanical Systems – Tubing Transport Elements
- Structural Assembly/Installation

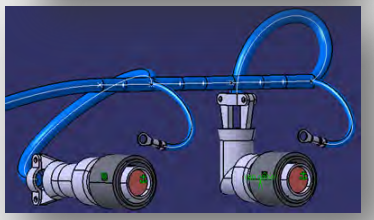








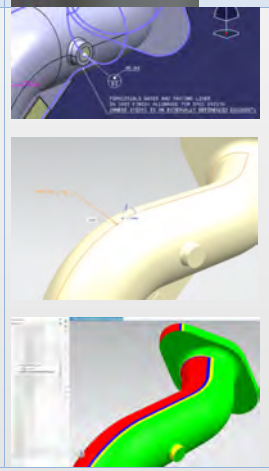




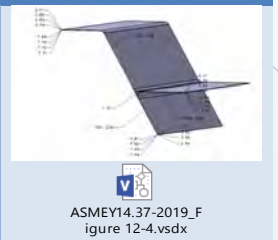
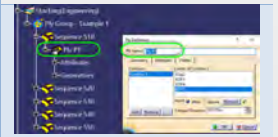
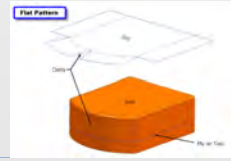
Example of Semantic Representation

Minimum Data Element	Description	Example
Part Number & Revision ID	Unique identifier and version of the part	Part numbers and versions are usually stored as properties of the document
Physical Shape	3D solid, surfaces, or wireframe defining the finished shape of the part	
Material	Material ID	Material is, at a minimum, stored as property and/or a parameter; when instantiating from a material catalog it will contain more properties of the material type
Management Data (Part Marking)	Export control, approval status, or company proprietary markings to control usage and access	Stored as an attribute, property or parameter in the model
Notes – Standard	Non-engineering notes used to convey business information (e.g., company address, per ASME/ISO)	Stored as an attribute, property or parameter in the model
Notes – Part	Engineering requirements that apply to the entire part (e.g., general tolerance)	Stored as an attribute, property or parameter in the model.
Axis/ Coordinate System	Coordinate system	
Dimension Tolerances (PMI)	GD&T – definition of the physical dimensions of a component and the allowable variation on those dimensions, includes semantic and non-semantic annotation	
3D Annotations	Non-Semantic 3D notes and symbology	
Saved 3D Views	Saved views of a design model that facilitate presentation of the model and its annotation. A saved view shall have an identifier; be retrievable on demand; may contain a	

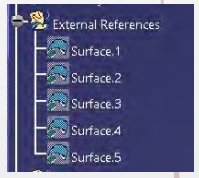
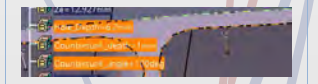
General

Minimum Data Element	Description	Example
Limited Area Application Indicator	Organized group of surfaces that can contain a profile smaller than the total area of the underlying geometries or a boundary area not tied to limits of the total surface	
Parting Surface	A surface group or wireframe boundary with a unique identification as a surface/zone/offset to allow remnants of the parting line (i.e., a differential surface profile zone due to manufacture process. Can carry associated specification reference link)	

Casting/Forging

Minimum Data Element	Description	Example
Product Structure for Bonded Parts	Representation and presentation of co-cured or co-bonded (i.e., multi-stage bonded assemblies)	 ASMEY14.37-2019_Figure 12-4.vsdx
Ply Level	See *ASME Y14.37*-2019 paragraph "3.32 Ply Level" Commonly referred to as a *sequence* in industry and CAD/CAM	
Ply/Item Identification	See *ASME Y14.37*-2019 paragraph "3.31 Ply Identification" and "7.1.2 Ply/Item Identification"	
Ply Flat Pattern Representation	See *ASME Y14.37*-2019 paragraph "7.1.3 Ply Representation (Geometry, Size, and Location)(c)"	

Composite

Minimum Data Element	Description	Example
Assembly/ Install Prod Structure	The assembly structure of all the components and their sub-components	
Reference Geometry	Geometry used to define the structural context of the installation; on drawings these are the "phantom lines." *ASME Y14.41* identifies them as *transparent.* *NOTE: While the physical representation of the mating geometry is required, how it is provided may vary.*	
Drill On Assembly/ Installation – Hole Location	Location of the hole represented as a point	
Drill On Assembly/ Installation – Hole Properties	Properties of the hole represented as PMI or attributes/parameters in the model tree	
Drill On Assembly/ Installation – Hole/Drill Direction	Drill direction of the hole represented as a line/vector	
Drill On Assembly/ Installation –	Activities associated with the drill of the hole; activities include a verb that requires action during preparation,	

Mechanical Structural Assembly/Installation

MBD Project

Next Steps

- Evaluation of industry implementations (e.g., Prime authoring and 3rd Party Integrators)

- Research & Evaluation of impacts on interoperability
  - Process & Methods (e.g., ASME Y14.x)
  - Data Model & Format (e.g., ISO 10303, ISO 23952 – QIF)
  - Terms & Properties (e.g., ISO 14649)
  - 3D Visualization (e.g., ISO 14306 – JT, ISO 14739 PRC)
  - Data Package, Organization & Delivery (e.g., ASME Y14.41, MIL-STND-31000B, HTML)

- Roadmap for development of needed capabilities (standards & technology)

Questions