Semantic MBD Workflows

CAPVIDIA

How the use of Model Based Definition can help bring about Digital Transformation for the modern manufacturing enterprise

www.capvidia.com

Overview



- What is MBD?
- QIF how MBD is implemented
- MBD Workflows
 - Digital FAI with Supply Chain
 - MBD-Based CMM Workflow
- Questions

Model Based Definition (MBD)

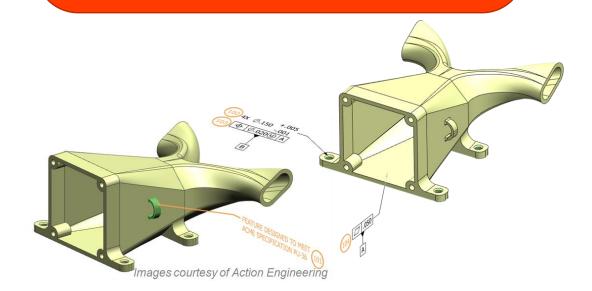


What is MBD, and why is it important?

Model Based Definition (MBD)



Using the **3D CAD** model, managed in the context of a PLM workflow, as the "**single source of truth**" for **product and process data**



From Wikipedia:

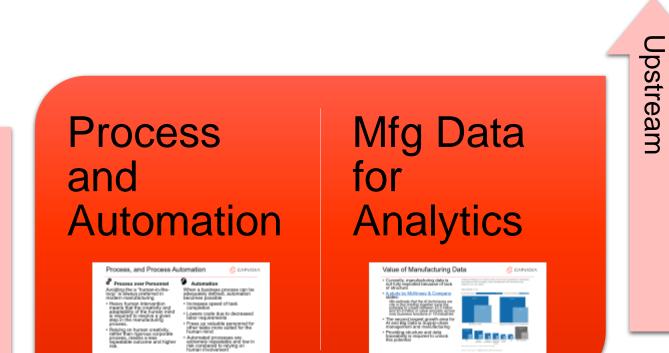
Model-based definition (MBD),

sometimes **digital product definition**, is the practice of using <u>3D models</u> (such as solid models, 3D <u>PMI</u> and associated metadata) within 3D <u>CAD</u> software to define (provide specifications for) individual components and product assemblies. The types of information included are <u>geometric dimensioning and</u> tolerancing (GD&T), component level materials, assembly level <u>bills of materials</u>, engineering configurations, design intent, etc. By contrast, other methodologies have historically required accompanying use of 2D <u>engineering</u> drawings to provide such details.^[1]

Wikipedia contributors. (2018, October 9). Model-based definition. In Wikipedia, The Free Encyclopedia. Retrieved 19:27, June 8, 2019, from <u>https://en.wikipedia.org/w/index.php?title=Model-based_definition&oldid=863182909</u>

Looking to the Future: What is the Value of MBD?





Model Based Definition provides a source of value in the downstream direction from design, and in the upstream direction from operations and deployment

Downstream

5

Process, and Process Automation



Process over Personnel

Avoiding the a "human-in-theloop" is always preferred in modern manufacturing

- Heavy human intervention means that the creativity and adaptability of the human mind is required to resolve a given step in the manufacturing process.
- Relying on human creativity, rather than rigorous corporate process, means a less repeatable outcome and higher risk.

Automation

When a business process can be adequately defined, automation becomes possible

- Increases speed of task completion
- Lowers costs due to decreased labor requirements
- Frees up valuable personnel for other tasks more suited for the human mind
- Automated processes are extremely repeatable and low in risk compared to relying on human involvement

Value of Manufacturing Data



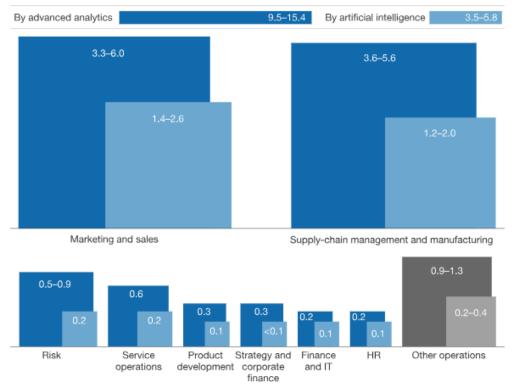
- Currently, manufacturing data is not fully exploited because of lack of structure
- <u>A study by McKinsey & Company</u> states:

We estimate that the AI techniques we cite in this briefing together have the potential to create between \$3.5 trillion and \$5.8 trillion in value annually across nine business functions in 19 industries

- The second largest growth area for AI and Big Data is Supply-chain management and manufacturing
- Providing structure and data traceability is required to unlock this potential

Artificial intelligence's impact is likely to be most substantial in marketing and sales as well as supply-chain management and manufacturing, based on our use cases.

Value unlocked, \$ trillion



Note: Figures may not sum to 100%, because of rounding.

McKinsey&Company | Source: McKinsey Global Institute analysis



Quality Information Framework – QIF

QIF – and ANSI and DIS ISO standard for implementing Model Based Definition workflows

What is QIF?







XML Technology: Simple Implementation and Built-In Code Validation





Data semantically linked to Model for full data traceability to CAD

QIF Application Areas





QIF Application Areas



Reference a bundle of QIF Results sets and specify a statistical analysis method to be carried out. Can optionally include the results of the statistical analysis as well

Measurement results data, associated with the MBD! This can be just tolerance evaluation results, and can even include all the point cloud data from the features

DMIS is <u>not</u> part of QIF, but it has been updated to harmonize with the data traceability mechanisms in QIF



Create measurement templates—e.g.: If a Surface Profile tolerance value is less than **x**, use at least **y** number of points/sq. in. for CMM measurement QIF MBD is the base for providing traceability to authority CAD data. It is not required for basic QIF use cases. Considered to be the strongest semantic CAD+PMI standard available

Wide range of optional levels of detail for measurement plans:

- Bill of characteristics
- Assign measurement resources
- Specify sampling point locations

Specify basic or highly detailed information about available measurement equipment (e.g., CMMs, probes, calipers, gages, etc.). As always, this data is contextual and semantic

Workflow Example

Process Stage 1:

Search the PMI applied to the QIF MBD model, and identify the necessary measurement tasks. This list of tasks is called a Bill of Characteristics

Process Stage 2:

Using a set of organizational Measurement Rules and a list of available Measurement Resources, assign measurement resources to measurement tasks.

Process Stage 3:

Generate a DMIS inspection program from the high level plan for any CMM measurement tasks that have been assigned.

Process Stage 4:

Evaluate the point clouds from the CMM or other dimensional measurement equipment against the GD&T assigned to each feature.

Process Stage 5:

Carry out statistical analysis of a set of measurement results according to organizational procedures.

All QIF data generated throughout the entire process is linked to the authority model.

This fulfills traceability requirements, and provides fertile opportunities for data mining.

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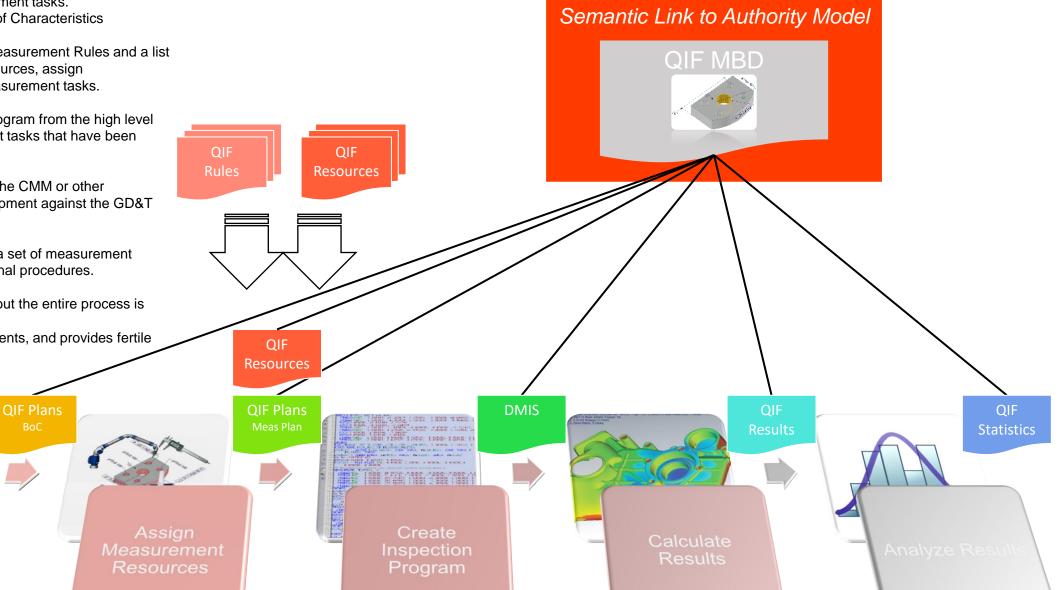
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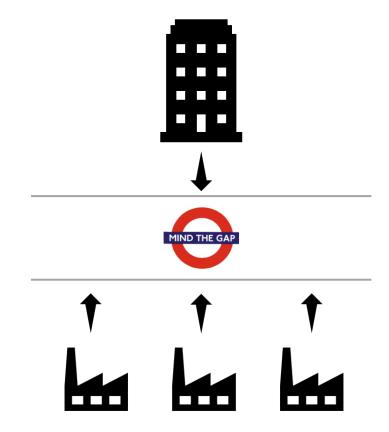






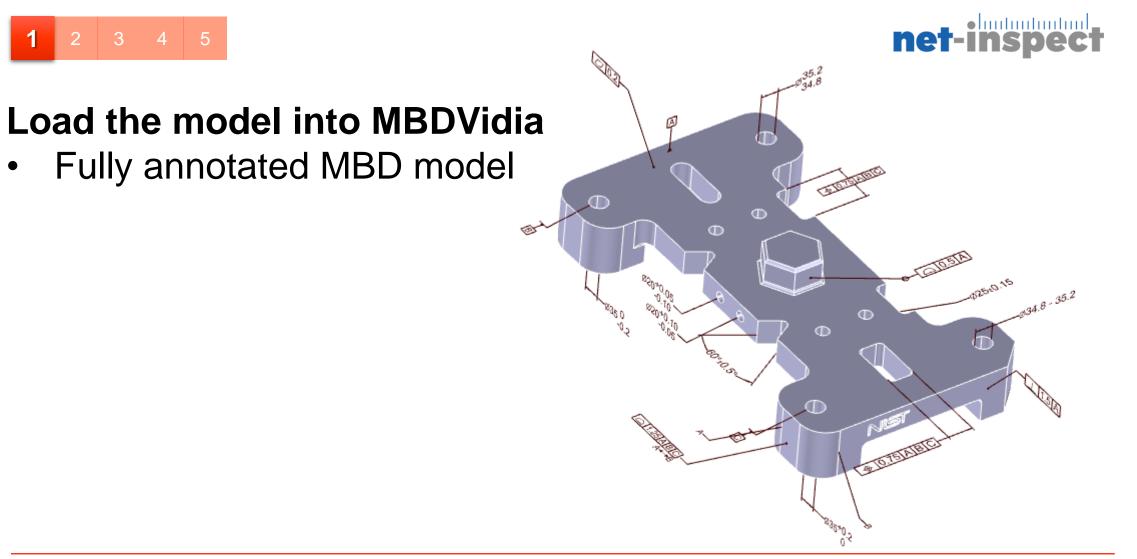
Bridging the data gap between an OEM and its supply chain





- Manufacturing is global and distributed
- But data is fragmented
- 70-90% of manufacturing is typically executed outside the walls of an OEM



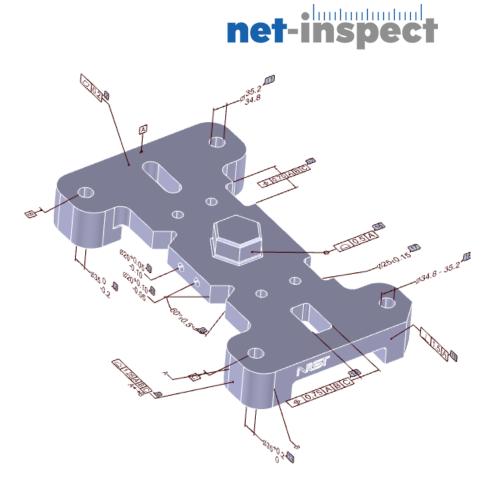


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Generate Bill of Characteristics

- Automatic ballooning
- Data sorted into organized Bill of Characteristics

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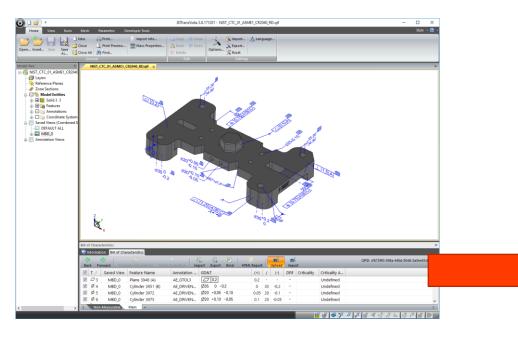




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Publish

- FAIR automatically generated/filled
- Linked to MBD



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MBD Workflows: **Digital FAI with Supply Chain**

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Bubble Number: 8 GenericFeatureNominal 3964

Bubble Number: 9

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rofileSurface (< 1.25) mm

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- See Net-Inspect data on model
- Net-Inspect data now traceable to authority MBD dataset

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Demonstration: QIF and Net-Inspect

Round trip MBD workflow using QIF and Net-Inspect:

- Auto-generate BoC from MBD and publish to Net-Inspect
- Execute CMM program
- Upload raw results data to Net-Inspect
- Import results back into MBD model to complete the round trip



Click here to watch video online

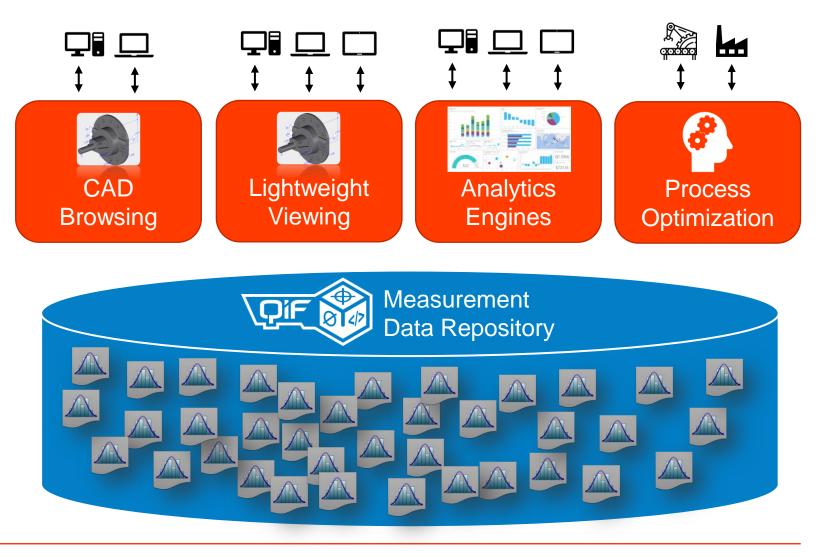


What's the end game?

Measurement process and results data, mapped to the "single source of truth": the MBD model.

This creates a continuous digital thread from design to inspection.

Bringing your supply chain into the digital thread can be accomplished using ubiquitous software: Excel.



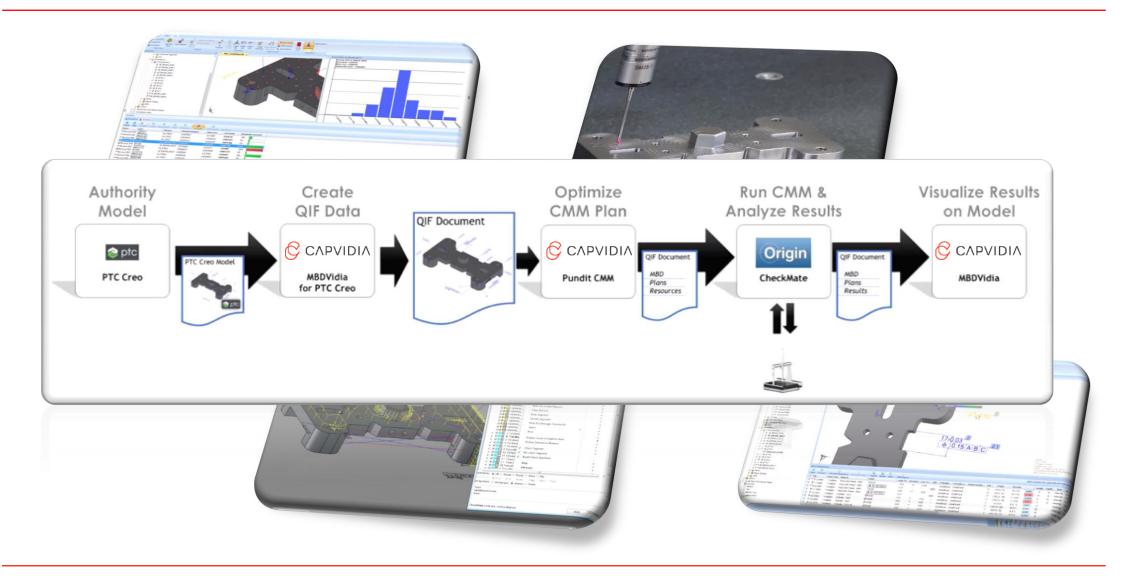
MBD Workflows: MBD-Based CMM Workflow



Using MBD to drive automation and optimization in CMM measurements

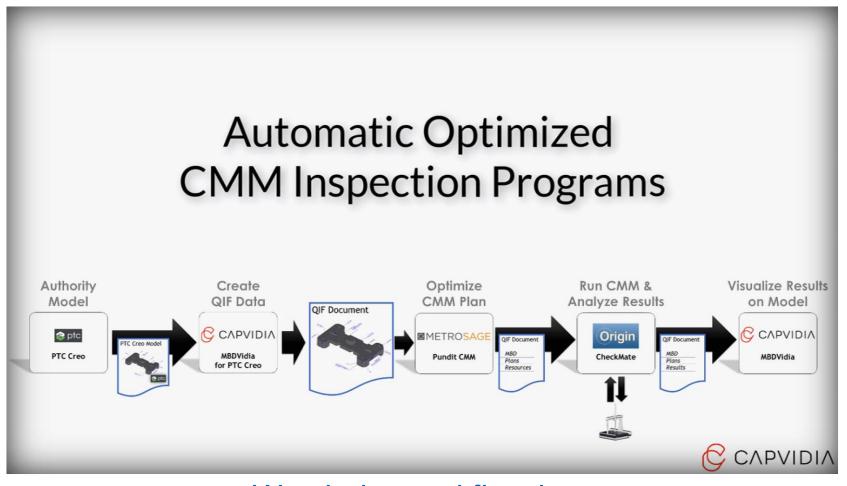
MBD-Based CMM Workflow





Video demonstration





Watch the workflow here

Raytheon Pilot Workflow



Raytheon

Creo: MBDVidia for Creo Plugin

- 1. Starting point: MBD model in Creo
- Export to Quality Information Framework (QIF) standard using "MBDVidia for Creo" plugin (Capvidia)

Less than 1 minute

MBDVidia

1. Load the QIF MBD model

2. Check and heal the PMI – make sure that it is *machine readable*

5 minutes (but can be automated)



- 1. Import the machine-readable QIF MBD model
- 2. Enter essential information: probe configurations, CMM setup, etc.
- 3. Auto-generate the CMM program
- 4. Clean up and verify

Less than 3 hours – pilot processed can be drastically streamlined from this baseline effort

Simple ROI Analysis



Current Workflow	
Total hours, existing manual	
workflow	16 Hours
New MBD Workflow	
MBDVidia	5 Minutes
FormatWorks import of Creo file	5 Minutes
Checkmate Setup Parameters	5 Minutes
Checkmate Auto Programming	
Accessibility	15 Minutes
Sorting for dependencies	1 Minutes
Auto Coordinate Systems	1 Minutes
Probe moves/rotations	1 Minutes
Collision detection	20 Minutes
Manual editing (estimate)	120 Minutes
Post process program	5 Minutes
Total, New MBD Workflow	178 Minutes
Total, New MBD Workflow	2.97 Hours

81% Reduction in Time

Today's traditional, manual workflow for this part is estimated at about 16 hours.

The MBD pilot workflow took less than 3 hours.

ROI Analysis

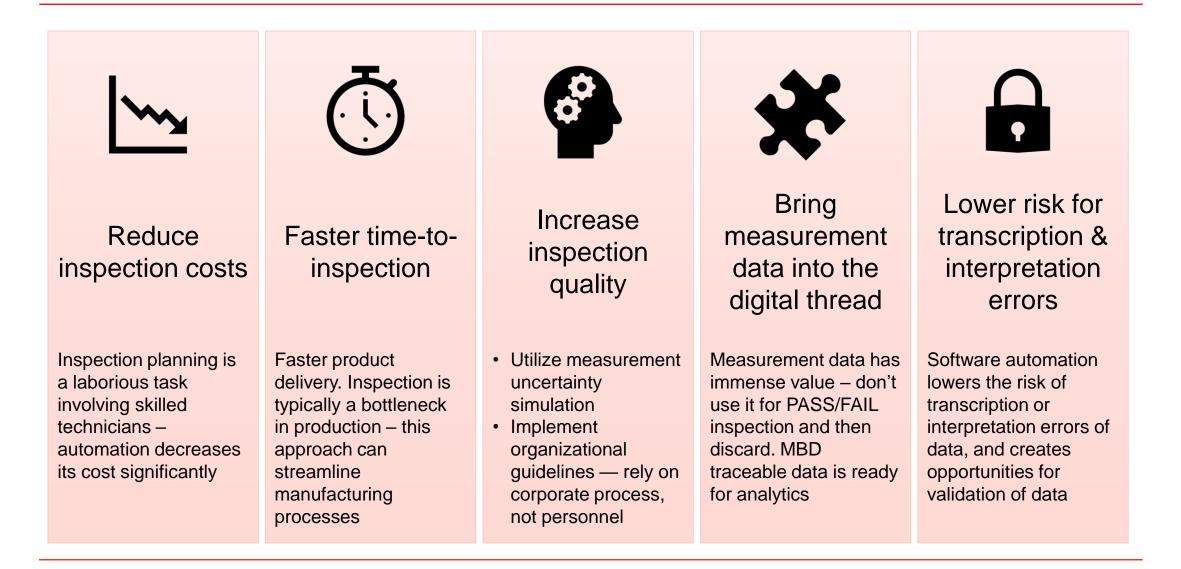
Time reduction	
MBD Workflow time vs. Manual	
Workflow Time	19%
MBD Workflow decreases total	
time by:	81%

ROI Analysis

Hours saved on MBD Workflow	13.03
Number of parts programmed per year	80
Total yearly labor reduction	1,042 hours

Value of MBD Measurement





Thanks!

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