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Model-Based Characterization:
Tracing Design Characteristics throughout the Enterprise using QIF and UUIDs

Leveraging MCAD to Enable Characteristics Digital Thread through QIF

Siemens NX & Characteristics & QIF

Daniel Campbell, Capvidia

George Rendell, Siemens Digital Industries Software

MBE and QIF Summit | MxD Chicago
April 18, 2024

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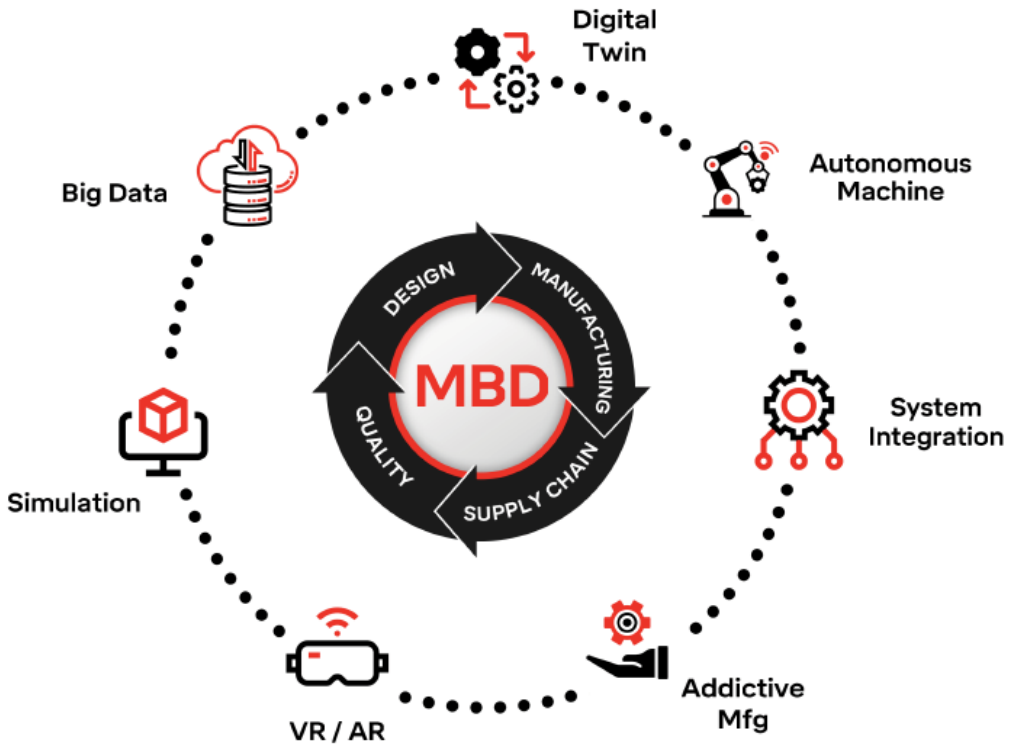
INDUSTRY 4.0
MODEL-BASED DEFINITION (MBD)



Building MBD Workflows with:

Lam Research
General Dynamics
Naval Air Systems Command
Schneider Electric
Cartier
Medtronic
slb
GE Appliances
stryker
Raytheon Technologies
Thales
Pratt & Whitney
Cisco
Lockheed Martin
Toyota

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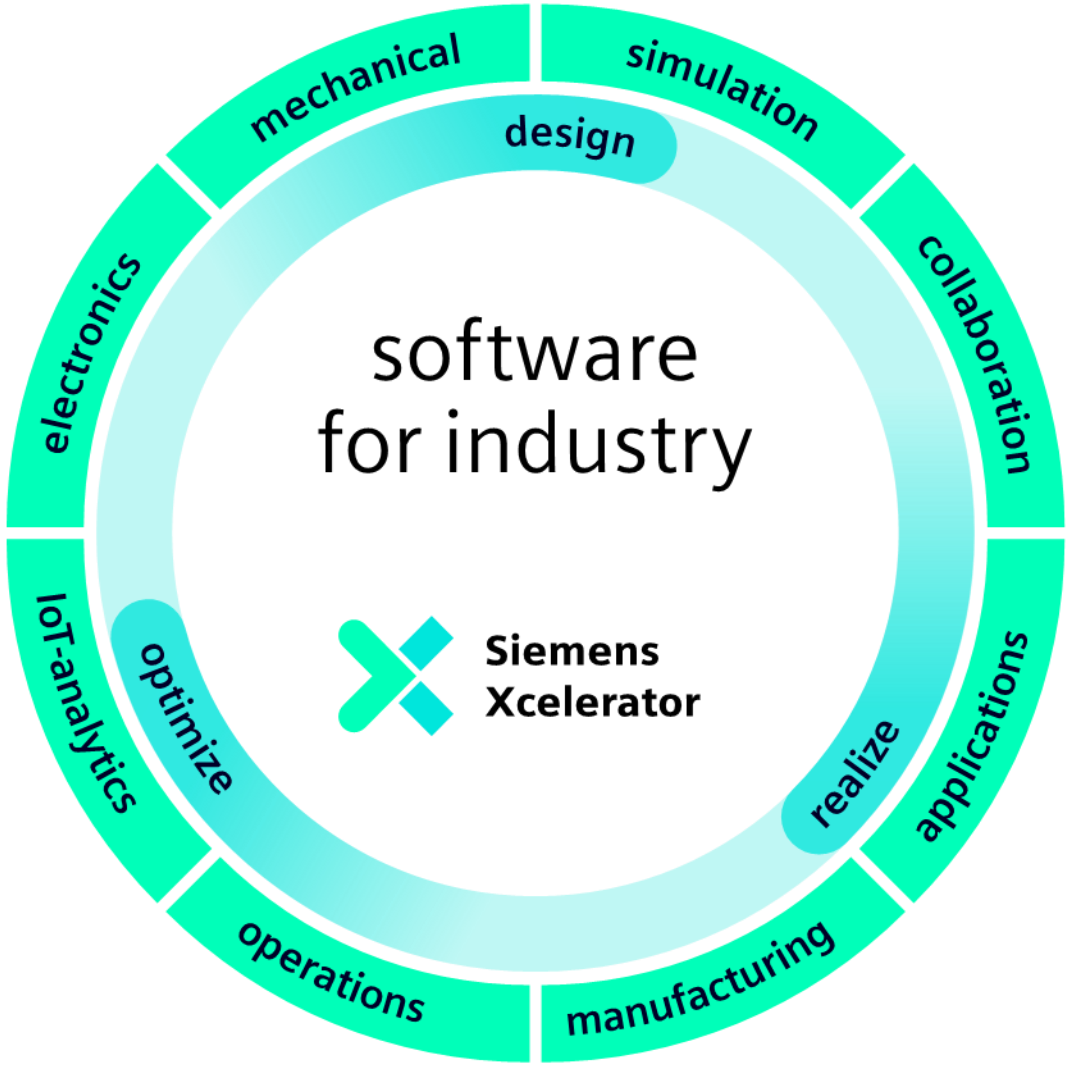
Siemens Digital Industries Software helps organizations of all sizes digitally transform using software, hardware and services from the Siemens Xcelerator business platform. Siemens' software and the comprehensive digital twin enable companies to optimize their design, engineering and manufacturing processes to turn today's ideas into the sustainable products of the future. From chips to entire systems, from product to process, across all industries. Siemens Digital Industries Software – Accelerating transformation.



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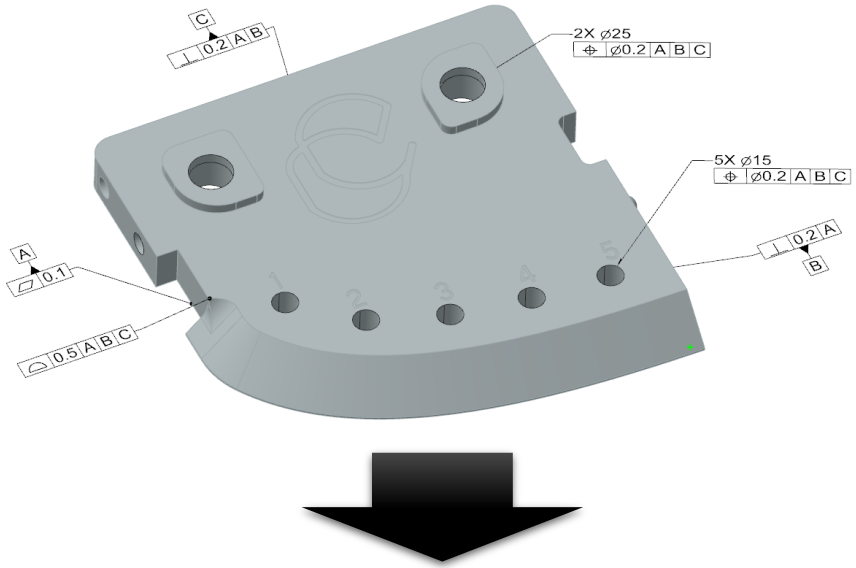
Model Based Characterization

Product Characteristics as Enterprise Data

- **Legacy State**: atomic unit of product enterprise data is **the part**
- **New State**: more granularity — atomic unit of product data is **the characteristic**
  - Primarily managed in PLM, but tracked in other domains: requirements, manufacturing (MES), quality (QMS, ERP), supply chain, program management, sustainment, etc.
- Track your **Bill of Characteristics** (BOC) across your enterprise
- QIF provides the data structure to manage your BoC (with features & characteristics)



Bill of Characteristics [de3c0c81-e54b-4649-bb1e-2cbd071f0f47]

ISIR | Report Type | Report Camera | Reset | Decolorize | Hide | Re-Balloon | Export | Import | Bind | HTML Report | 3D HTML Report | PDF Report | Net-Inspect

Tag	Saved View	Feature Name	Annotation Name	GD&T	(-)	/	(+)	DRF	Criticality
1	Datums1	Plane 5077	Feature Control Fram...	⊥ 0.2 A B	-	-	0.2	A/B	
2	Datums1	Plane 5088	Feature Control Fram...	▱ 0.1	-	-	0.1	-	
3	Datums1	Plane 5076	Feature Control Fram...	⊥ 0.2 A	-	-	0.2	A	
7.1	Spec1	Cylinder 5089	Radial Dimension (30)	Ø25	-	25	-	-	
7.2	Spec1	Cylinder 5087	Radial Dimension (30)	Ø25	-	25	-	-	
8.1	Spec1	Cylinder 5089	Feature Control Fram...	⌖ Ø0.2 A B C	-	-	0.2	A/B/C	
8.2	Spec1	Cylinder 5087	Feature Control Fram...	⌖ Ø0.2 A B C	-	-	0.2	A/B/C	
9.1	Spec1	Cylinder 5085	Radial Dimension (18)	Ø15	-	15	-	-	
9.2	Spec1	Cylinder 5084	Radial Dimension (18)	Ø15	-	15	-	-	
9.3	Spec1	Cylinder 5083	Radial Dimension (18)	Ø15	-	15	-	-	
9.4	Spec1	Cylinder 5082	Radial Dimension (18)	Ø15	-	15	-	-	
9.5	Spec1	Cylinder 5081	Radial Dimension (18)	Ø15	-	15	-	-	
10.1	Spec1	Cylinder 5085	Feature Control Fram...	⌖ Ø0.2 A B C	-	-	0.2	A/B/C	
10.2	Spec1	Cylinder 5084	Feature Control Fram...	⌖ Ø0.2 A B C	-	-	0.2	A/B/C	
10.3	Spec1	Cylinder 5083	Feature Control Fram...	⌖ Ø0.2 A B C	-	-	0.2	A/B/C	
10.4	Spec1	Cylinder 5082	Feature Control Fram...	⌖ Ø0.2 A B C	-	-	0.2	A/B/C	
10.5	Spec1	Cylinder 5081	Feature Control Fram...	⌖ Ø0.2 A B C	-	-	0.2	A/B/C	
11	Spec1	Other Surface 5145	Feature Control Fram...	⌓ 0.5 A B C	-	-	0.5	A/B/C	

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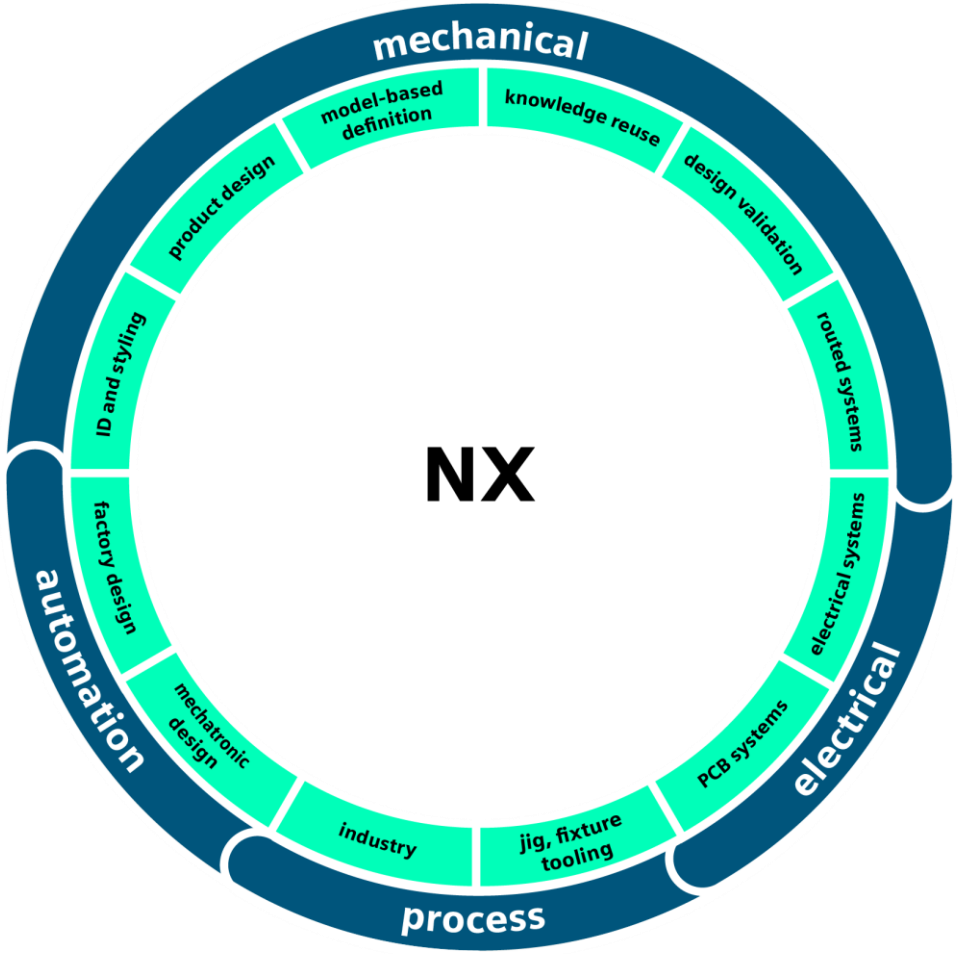
NX delivers world-class mechanical engineering solutions that enable you

- to build the richest most comprehensive digital twin of your product

- to engage with personalized adaptable software, and

- to use the best solutions built on a flexible Open Ecosystem



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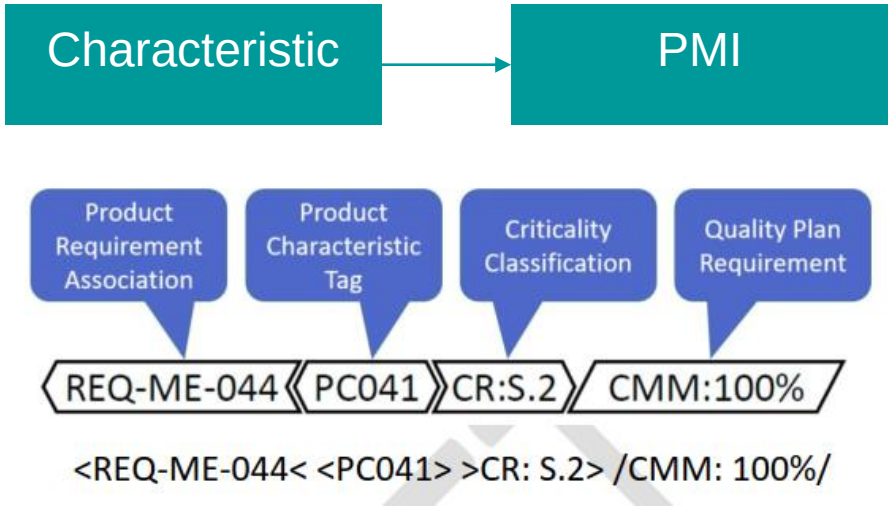
NX Design and Characteristics Data Model

What is it

- Characteristic -- A trait, quality, or attribute on an element of a feature such as its size, location, form, or property, which may be a specification limit, a dimension with tolerance etc.
- Bill of Characteristics -- a list of all the characteristics applied to a product

Types

- Model-Based vs Drawing-Based
- Lifecycle Discipline
  - Product Characteristic
  - Operation Characteristic
  - Service Characteristic
- Augmentation Based Characteristics
  - Critical Characteristic
  - Driven Characteristic
  - Verification Characteristic



PC Tag (Base)	Tag (Ext)	PC UUID (Base)	UUID (Ext)	Description
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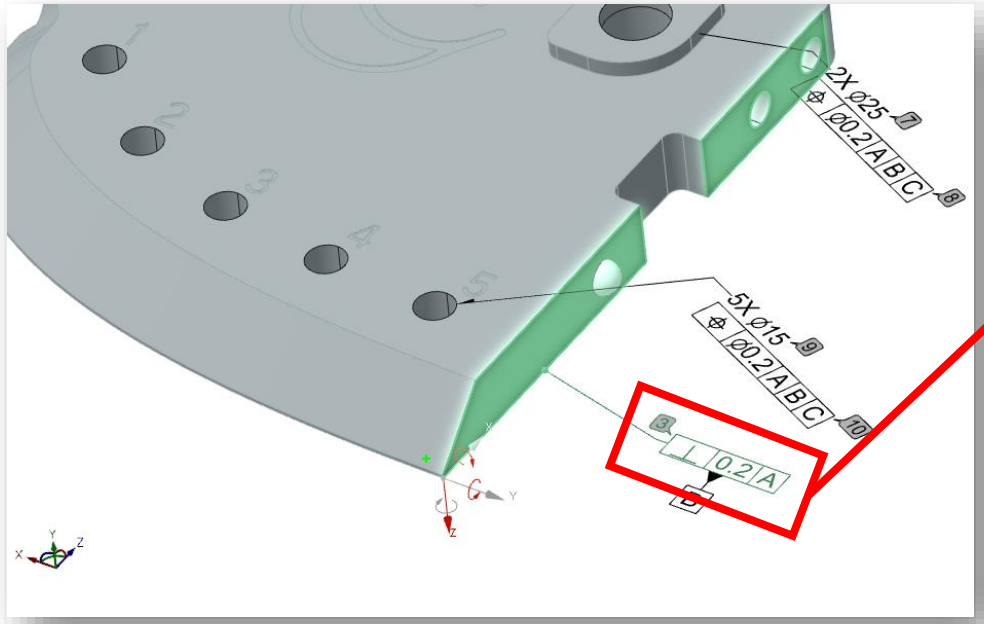
PC002	N/A	6878BC7C-84B9-4D4D-8413-95ADC14D9156	N/A	Perpendicular w.r.t. A on Datum Feature B
PC003	N/A	6F63FE5A-A79F-42FD-B02A-BE35E502D829	N/A	Hole Size 88 +0.15 – 0.0 on Datum Feature B.
PC004	1	DA8612FE-B1E4-423B-8191-B746E224C595	1	Hole Size 16 +0.3 – 0.1 on Hole Feature 1
PC004	2	DA8612FE-B1E4-423B-8191-B746E224C595	2	Hole Size 16 +0.3 – 0.1 on Hole Feature 2
PC004	3	DA8612FE-B1E4-423B-8191-B746E224C595	3	Hole Size 16 +0.3 – 0.1 on Hole Feature 3
PC004	4	DA8612FE-B1E4-423B-8191-B746E224C595	4	Hole Size 16 +0.3 – 0.1 on Hole Feature 4
PC005	1	BCA322EA-A95C-4EEA-822B-98DD8B1A5EA9	1	Position 1.4 w.r.t. AB on Hole Feature 1
PC005	2	BCA322EA-A95C-4EEA-822B-98DD8B1A5EA9	2	Position 1.4 w.r.t. AB on Hole Feature 2
PC005	3	BCA322EA-A95C-4EEA-822B-98DD8B1A5EA9	3	Position 1.4 w.r.t. AB on Hole Feature 3
PC005	4	BCA322EA-A95C-4EEA-822B-98DD8B1A5EA9	4	Position 1.4 w.r.t. AB on Hole Feature 4

Characteristics: Data Model Examples

Design Model



Bill of Characteristics

Bill of Characteristics [de3c0c81-e54b-4649-bb1e-2cbd071f0f47] — Universal Unique Identifier (UUID)

ISIR

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2	Datums1	Plane 5088	⏥ 0.1	-	-	0.1	–	
3	Datums1	Plane 5076	⊥ 0.2 A	-	-	0.2	A	
7.1	Spec1	Cylinder 5089	Ø25	-	25	-	–	
7.2	Spec1	Cylinder 5087	Ø25	-	25	-	–	
8.1	Spec1	Cylinder 5089	⌖ Ø0.2 A B C	-	-	0.2	A/B/C	
8.2	Spec1	Cylinder 5087	⌖ Ø0.2 A B C	-	-	0.2	A/B/C	
9.1	Spec1	Cylinder 5085	Ø15	-	15	-	–	
9.2	Spec1	Cylinder 5084	Ø15	-	15	-	–	

Datums | Non-Measurable | Main

- Characteristic ID
- Presentation State
- Feature
- Product and Manufacturing Information (PMI)
- Datum Reference Frame (DRF)
- Criticality

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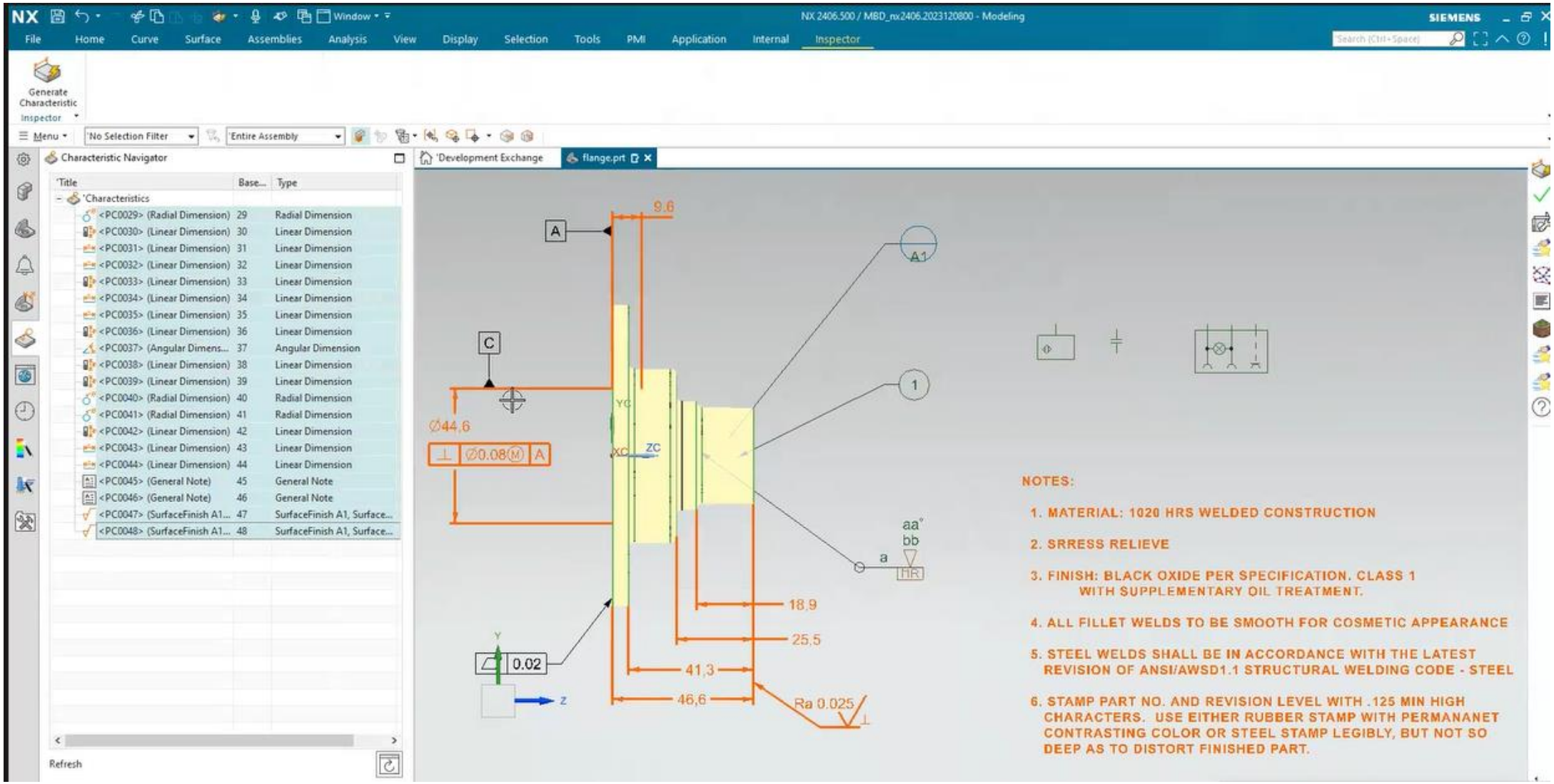
NX Design and Characteristics



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QIF Application areas

- QIF file format requirements
  - Solid modeling geometry
  - Product & Manufacturing Information (PMI)
  - (NEW) Characteristics
- Capvidia NX QIF bi-directional translator

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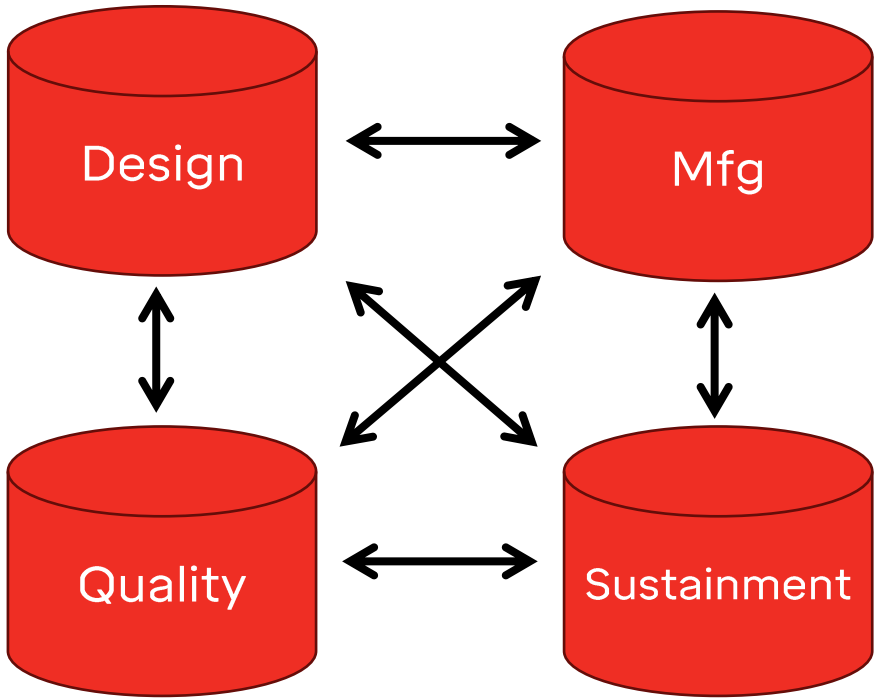
What about UUIDs?

What problem do they solve?

- Enterprise data is managed in various silos
- *Some* enterprise-level data needs to be traceable through more than 1 silo
- E.g.: Part number
  - Part number **is an ID**, it is **unique**, it is **universal**
- So really, the question is: ***what data needs to be tracked across my enterprise?***
- A UUID is a very good way to tag these entities
- Model Characteristics need to be tracked across your enterprise!



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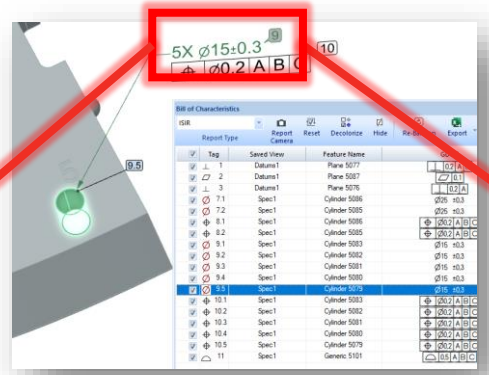
Workflow Overview

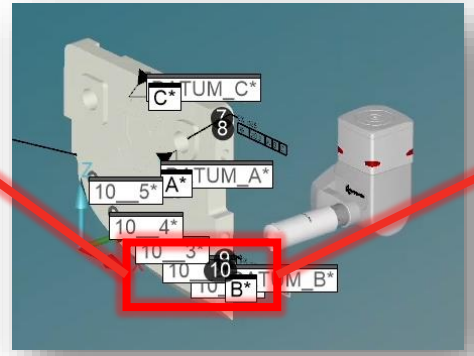
Characterize PMI in NX

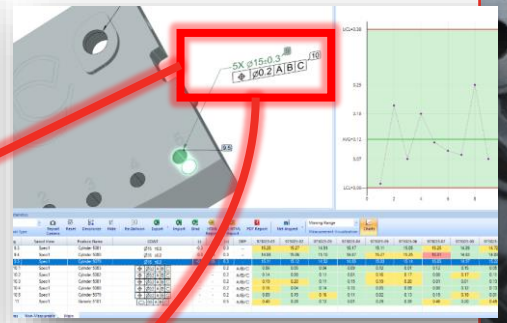
Generate QIF and view BoC in MBDVidia

Author CMM Program in PC DMIS with QIF

Track Inspection Results using QIF







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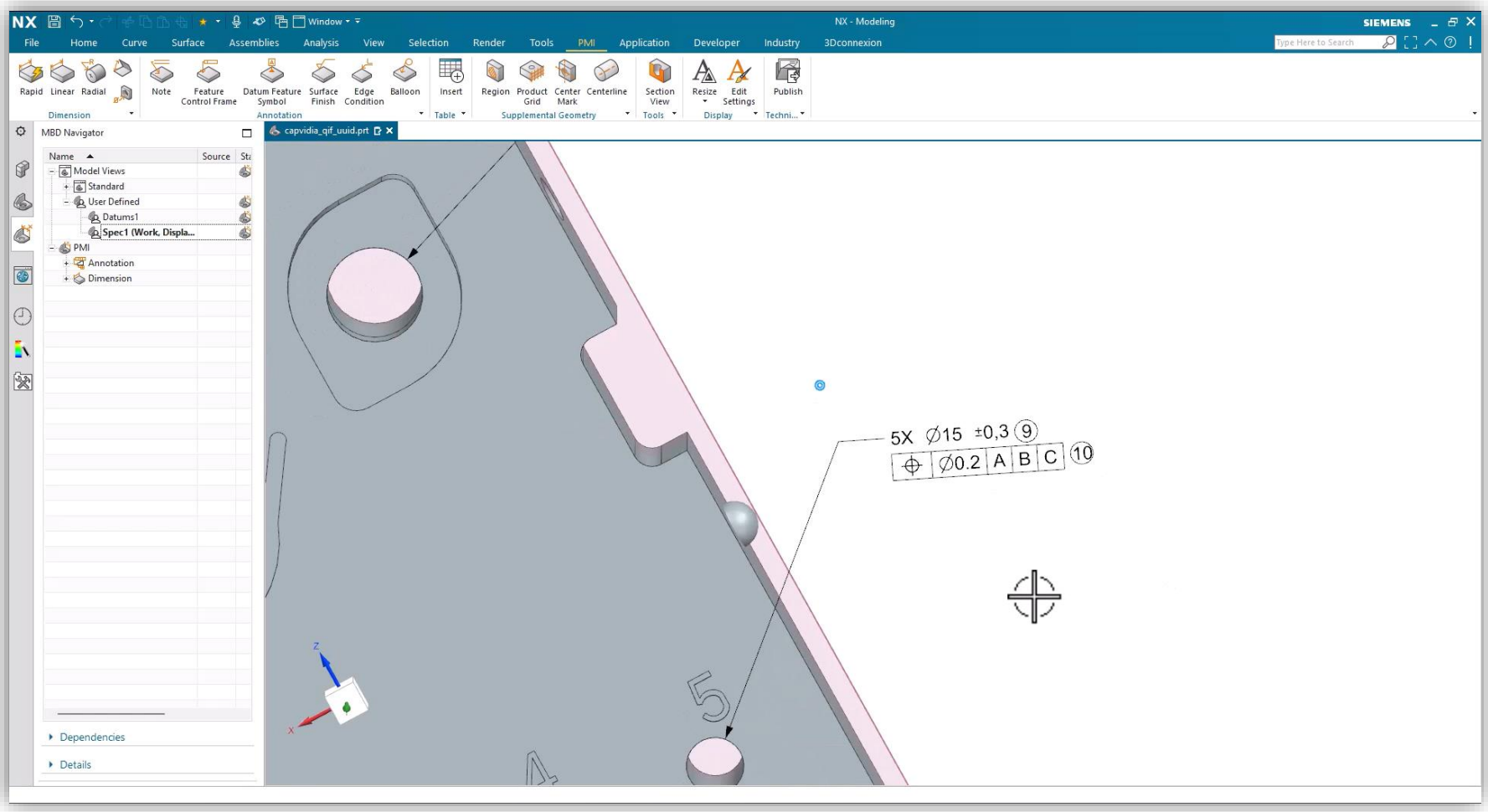
Characterize PMI in NX



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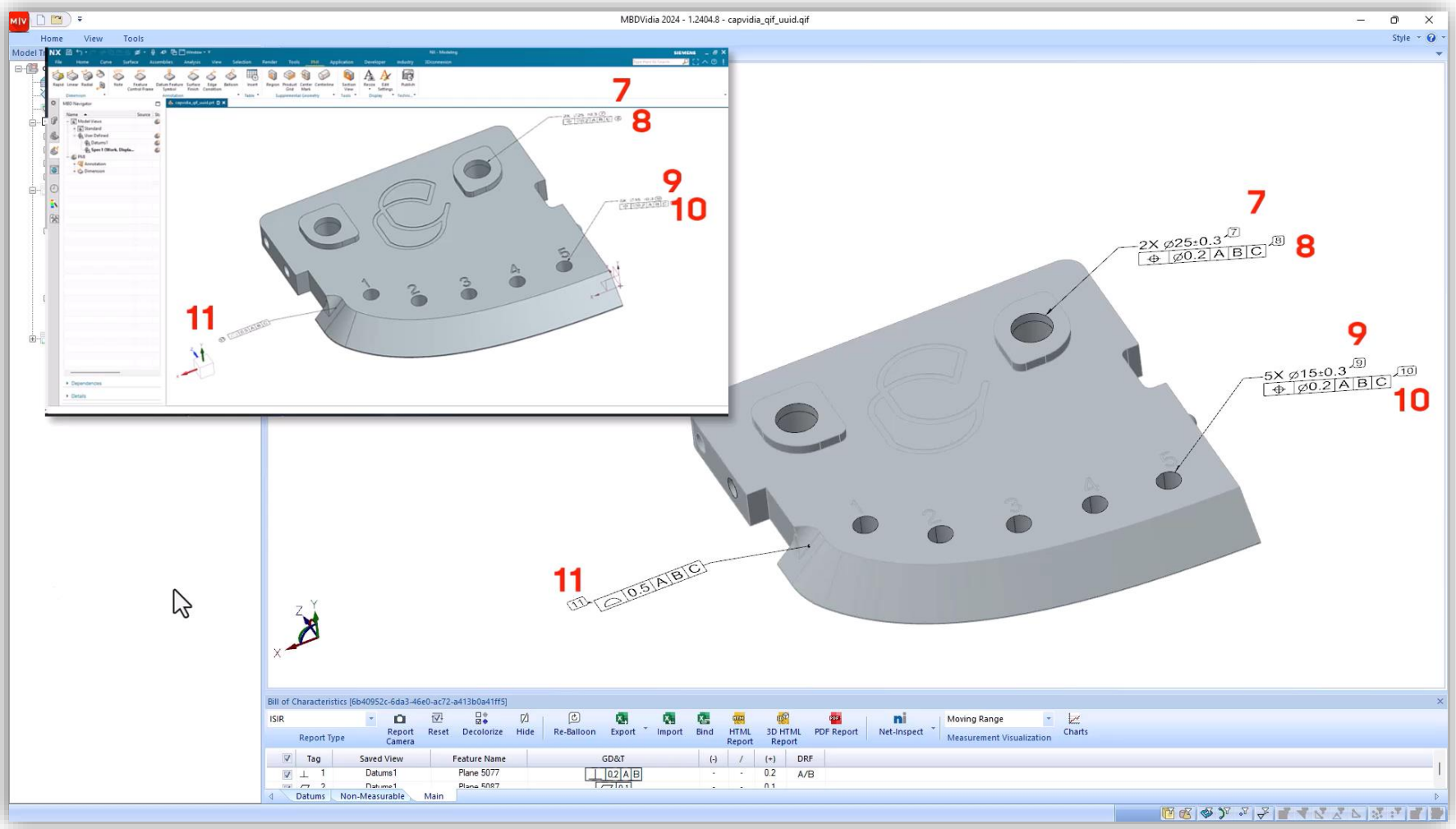
Generate QIF and view BoC in MBDVidia



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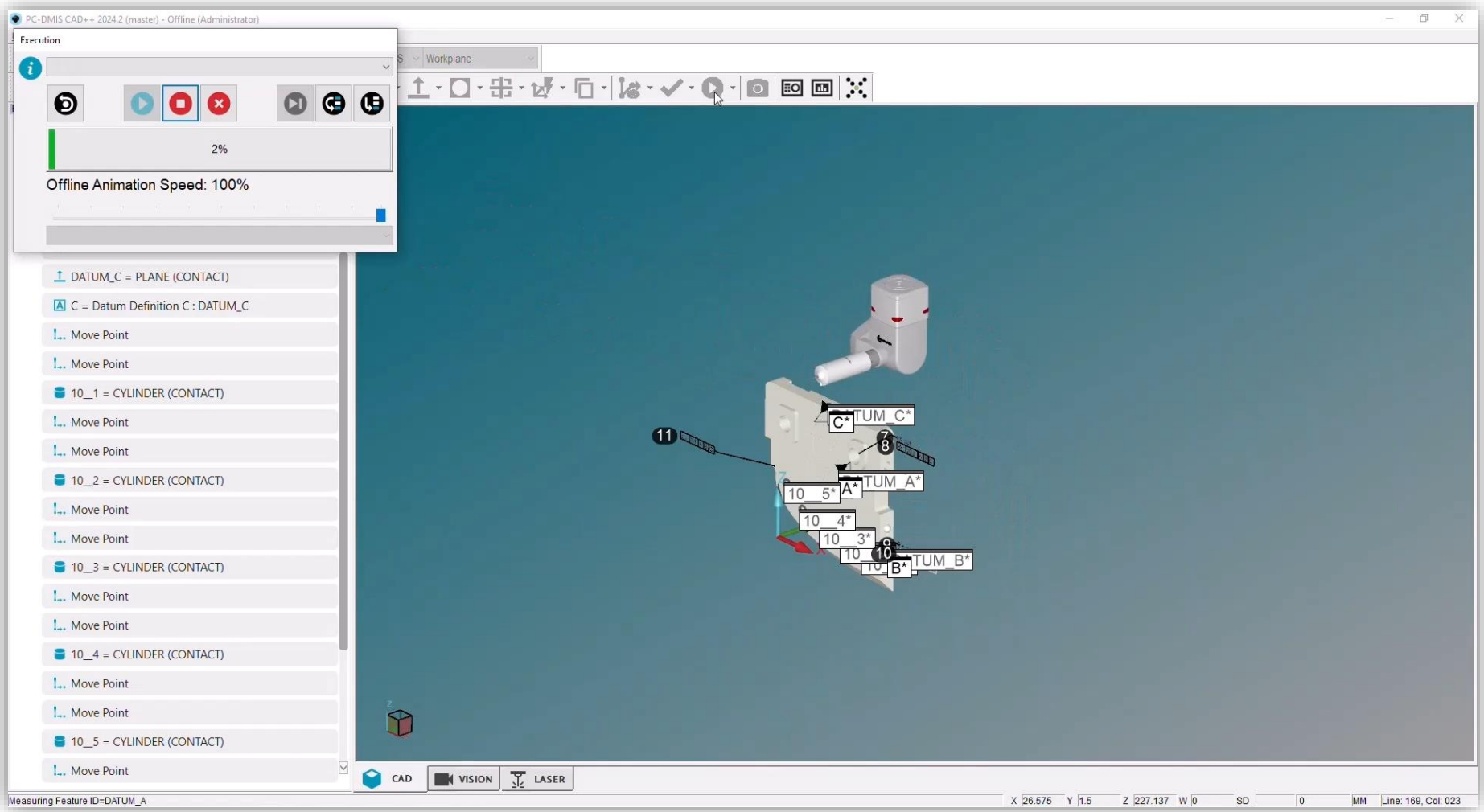
Author CMM Program in PC DMIS with QIF



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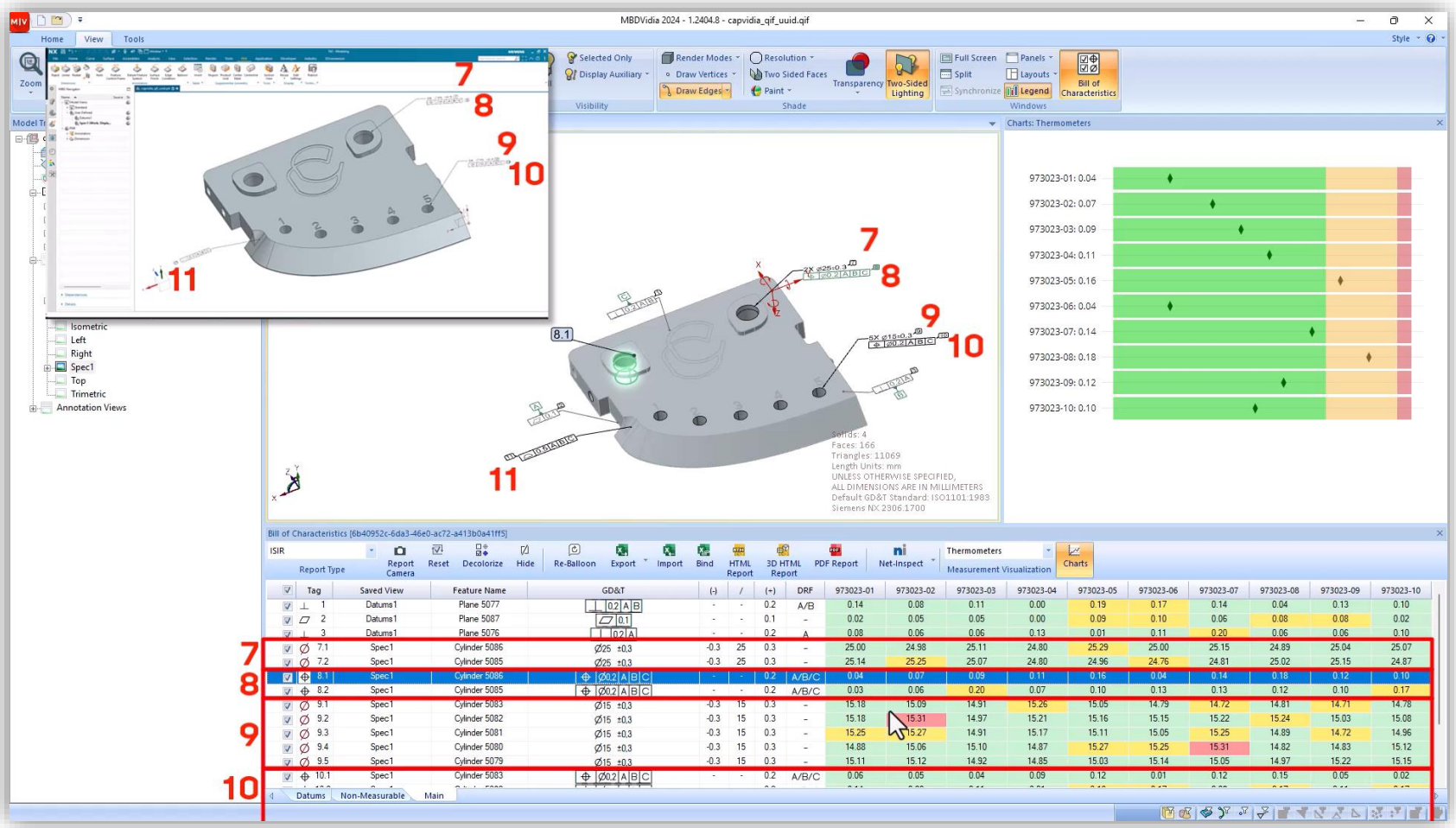
Export Inspection Results using QIF



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Workflow Overview

Characterize PMI in NX

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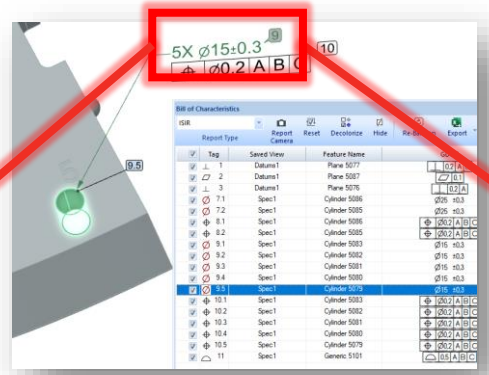

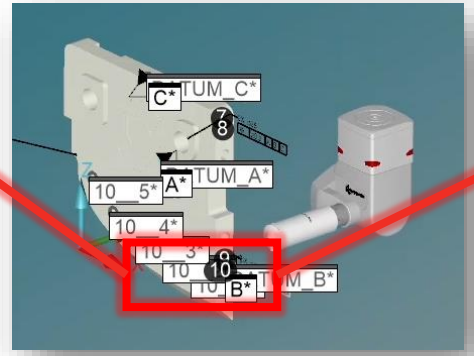

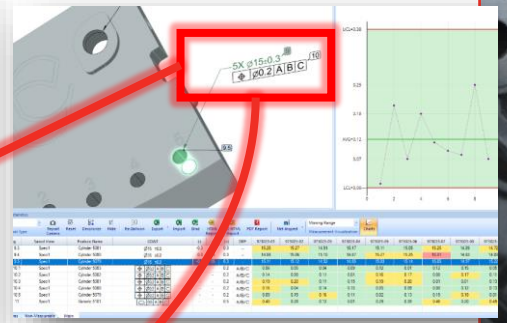

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Digital Thread: Adding Characteristics

VIRTUAL
CONCEPT & ENGINEERING

SERIES DEVELOPMENT

PHYSICAL
MANUFACTURING & OPERATIONS

One platform - unified change, unified configuration, unified digital validation

IDEATION

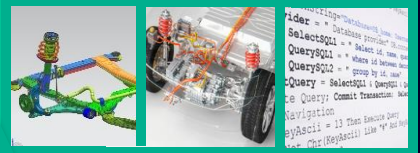
voice of customer
portfolio
resources
budget

SYSTEM

MBSE
requirements
features
architecture

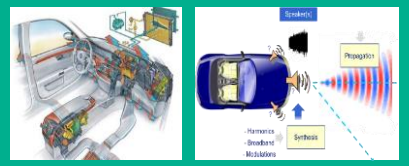
DESIGN

mechanical | software | E/E



ANALYSIS

1D-3D | multi-physics | simulation



multi-domain EBOM

prototype

color parts

manufacturing planning, simulation & execution

MBOM

- Plant MBOM
- Plant BOP
- Plant BOE
- As-built

SBOM

- Service plan
- Spares, kits
- Training
- As-maintained

Physical Assets

over the air updates

service planning, simulation & execution

QUALITY	APQP • PPAP • FAI • root cause • risk management
SUPPLY CHAIN	market intelligence • visibility • selection • integration • logistics
PROGRAM MANAGEMENT	deliverables • work breakdown structures • schedule

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Conclusions and Q&A

1. Model Characteristics are important enterprise business objects
2. Tracking Characteristics with QIF can provide the link between these business objects as authored in the PLM/CAD domain to other areas of your enterprise — including supply chain
3. This is not pie-in-the-sky thinking — commercial tools are emerging to provide this solution.
4. The vision for MBE and QIF is bigger than just reducing manual data re-entry. It is also about providing **digital data**, at a more **granular level**, and across the **entire enterprise**.

Thanks!

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True MBD: Human & Machine
Readable CAD + PMI

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