

# 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  
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# Speakers



## Daniel Campbell

Vice President, Model-Based  
Definition

Capvidia

 [dc@capvidia.com](mailto:dc@capvidia.com)

 <https://www.linkedin.com/in/daniel-campbell-051769/>

 [www.capvidia.com](http://www.capvidia.com)



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## George Rendell

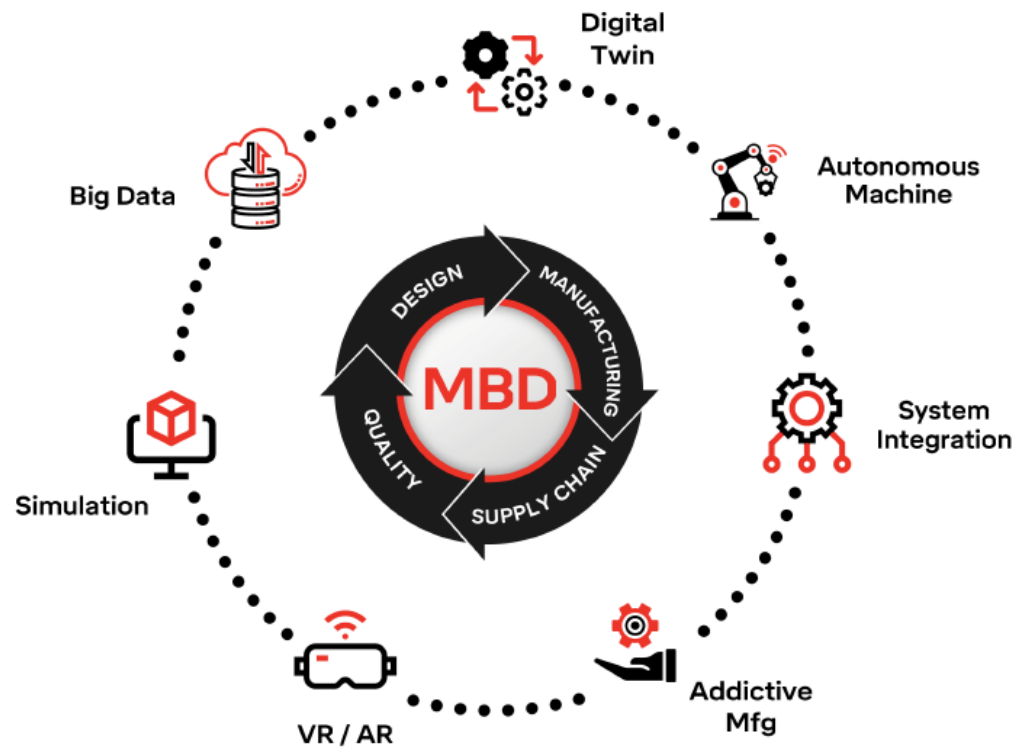
Vice President, product  
management and product marketing

Siemens Digital Industries Software

 [george.rendell@siemens.com](mailto:george.rendell@siemens.com)

 <https://www.linkedin.com/in/george-rendell-a289224/>

 [sw.siemens.com](http://sw.siemens.com)

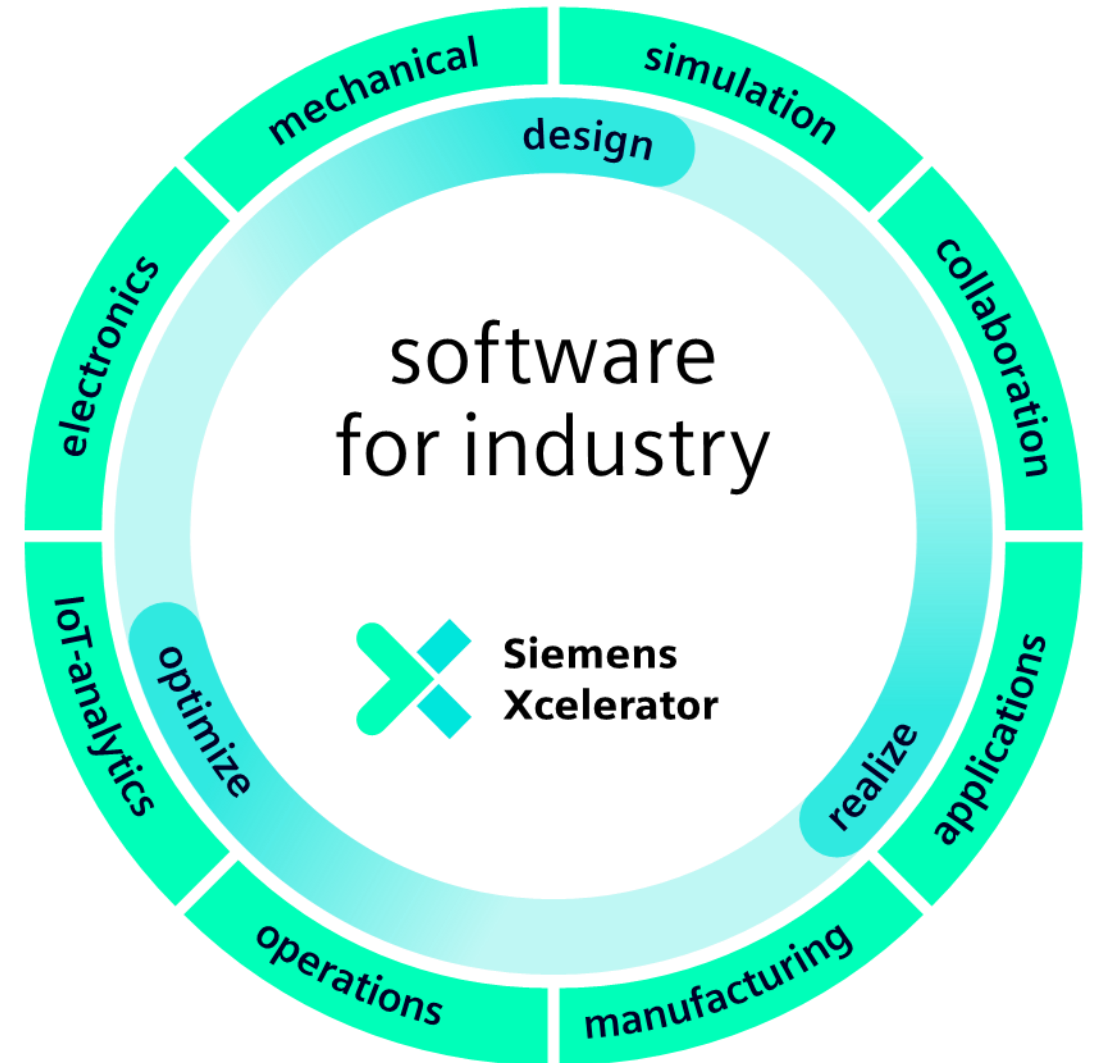


Building MBD Workflows with:



## About Siemens Digital Industries Software

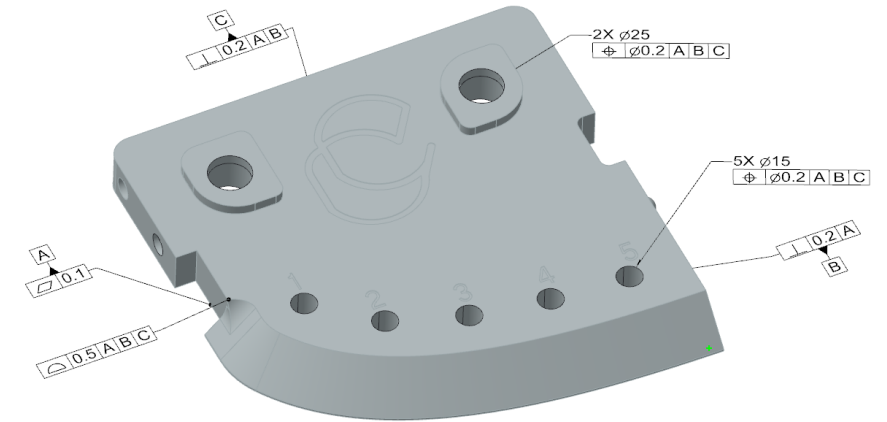
**Siemens Digital Industries Software** helps organizations of all sizes digitally transform using software, hardware and services from the Siemens Xcelerator business platform. Siemens' software and the comprehensive digital twin enable companies to optimize their design, engineering and manufacturing 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.



# 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]

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	-

# NX delivers world-class mechanical engineering solutions that enable you



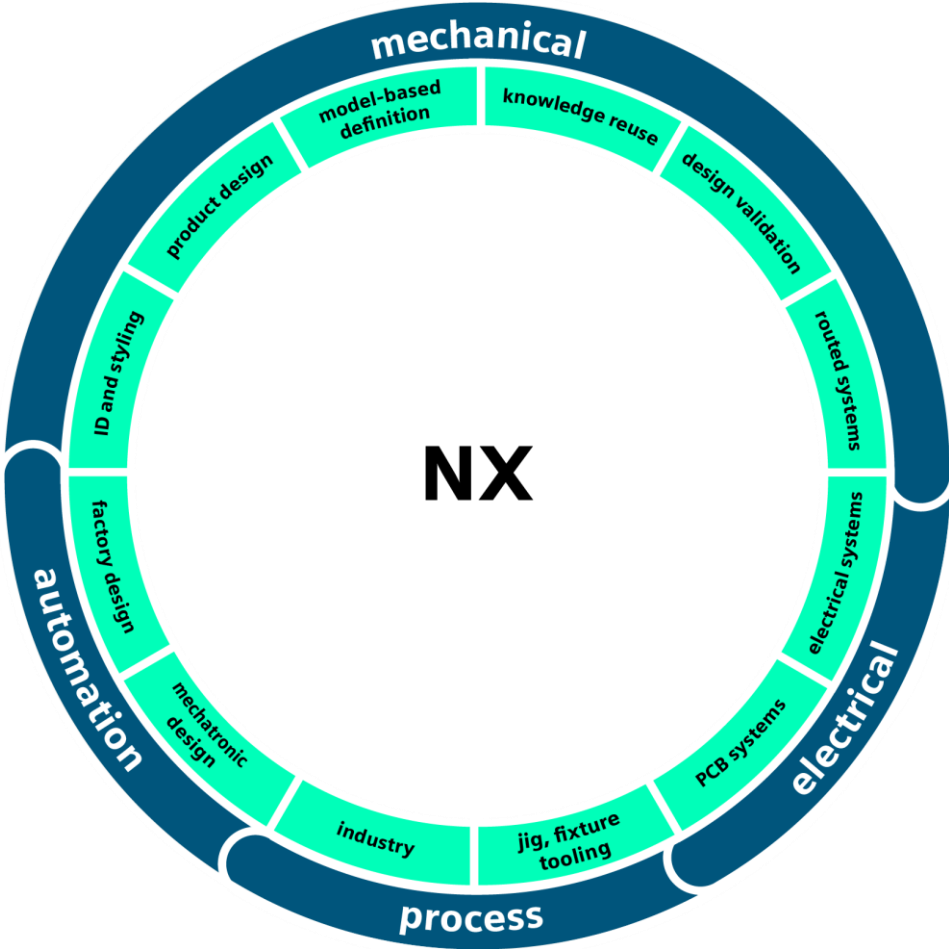
- to build the richest most comprehensive digital twin of your product



- to engage with personalized adaptable software, and



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



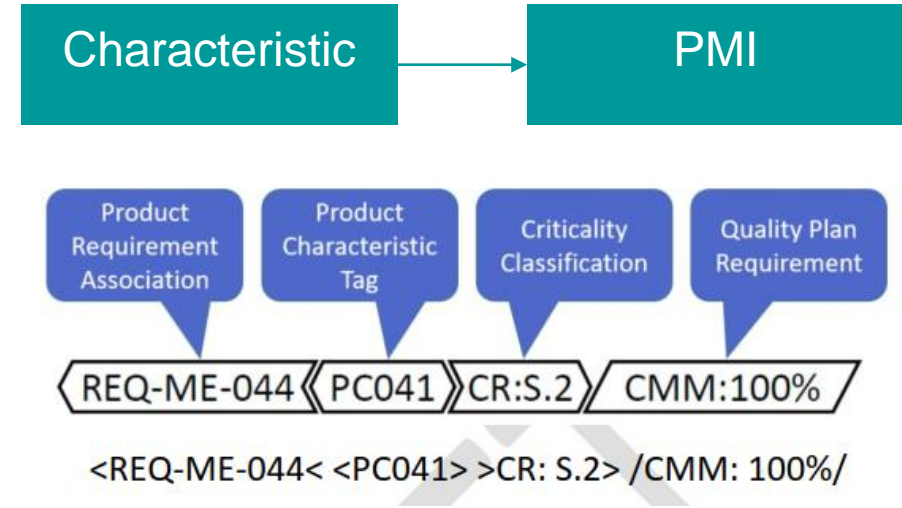
# NX Design and Characteristics Data Model

## 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

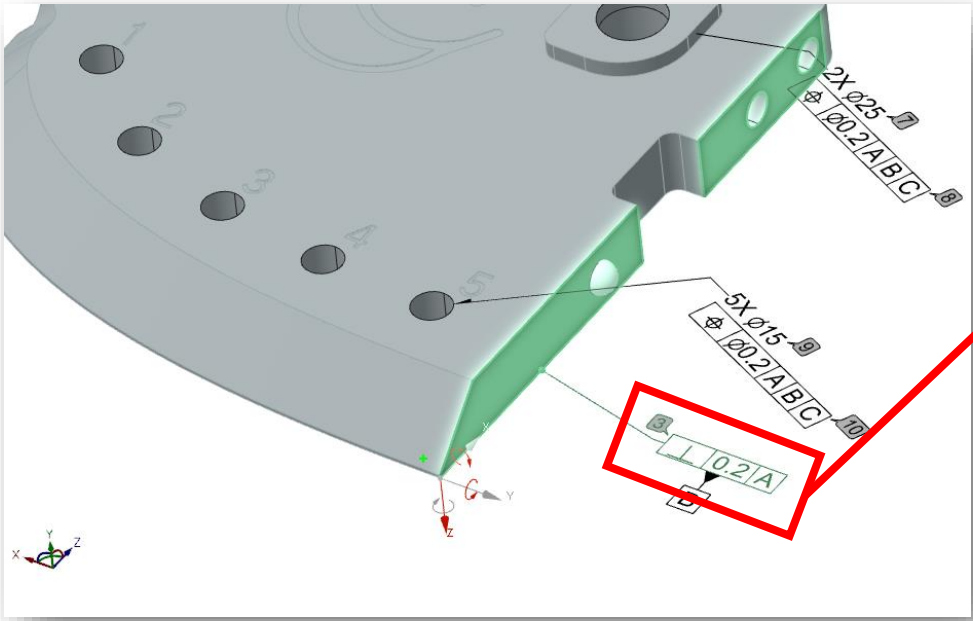
- Model-Based vs Drawing-Based
- Lifecycle Discipline
  - Product Characteristic
  - Operation Characteristic
  - Service Characteristic
- Augmentation Based Characteristics
  - Critical Characteristic
  - Driven Characteristic
  - Verification Characteristic



PC Tag (Base)	Tag (Ext)	PC UUID (Base)	UUID (Ext)	Description
PC001	N/A	6F5FE3F3-CEFF-4BE4-8B69-D4DDA1230143	N/A	Flatness .12 on Datum Feature A
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 Report Type Report Camera Reset Decolorize Hide Re-Balloon Export Import Bind HTML Report 3D HTML Report PDF Report

<input checked="" type="checkbox"/>	Tag	Saved View	Feature Name	GD&T	(-)	/	(+)	DRF	Criticality
<input checked="" type="checkbox"/>	⊥ 1	Datums1	Plane 5077	⊥ 0.2 A B	-	-	0.2	A/B	
<input checked="" type="checkbox"/>	∠ 2	Datums1	Plane 5088	∠ 0.1	-	-	0.1	-	
<input checked="" type="checkbox"/>	⊥ 3	Datums1	Plane 5076	⊥ 0.2 A	-	-	0.2	A	
<input checked="" type="checkbox"/>	∅ 7.1	Spec1	Cylinder 5089	∅25	-	25	-	-	
<input checked="" type="checkbox"/>	∅ 7.2	Spec1	Cylinder 5087	∅25	-	25	-	-	
<input checked="" type="checkbox"/>	∅ 8.1	Spec1	Cylinder 5089	∅0.2 A B C	-	-	0.2	A/B/C	
<input checked="" type="checkbox"/>	∅ 8.2	Spec1	Cylinder 5087	∅0.2 A B C	-	-	0.2	A/B/C	
<input checked="" type="checkbox"/>	∅ 9.1	Spec1	Cylinder 5085	∅15	-	15	-	-	
<input checked="" type="checkbox"/>	∅ 9.2	Spec1	Cylinder 5084	∅15	-	15	-	-	

Datums Non-Measurable Main

Characteristic ID

Presentation State

Feature

Product and Manufacturing Information (PMI)

Datum Reference Frame (DRF)

Criticality



# NX Design and Characteristics

The screenshot displays the Siemens NX software interface for a 3D model of a flange. The 'Characteristic Navigator' on the left lists various characteristics:

Title	Base...	Type
<PC0029> (Radial Dimension)	29	Radial Dimension
<PC0030> (Linear Dimension)	30	Linear Dimension
<PC0031> (Linear Dimension)	31	Linear Dimension
<PC0032> (Linear Dimension)	32	Linear Dimension
<PC0033> (Linear Dimension)	33	Linear Dimension
<PC0034> (Linear Dimension)	34	Linear Dimension
<PC0035> (Linear Dimension)	35	Linear Dimension
<PC0036> (Linear Dimension)	36	Linear Dimension
<PC0037> (Angular Dimens...	37	Angular Dimension
<PC0038> (Linear Dimension)	38	Linear Dimension
<PC0039> (Linear Dimension)	39	Linear Dimension
<PC0040> (Radial Dimension)	40	Radial Dimension
<PC0041> (Radial Dimension)	41	Radial Dimension
<PC0042> (Linear Dimension)	42	Linear Dimension
<PC0043> (Linear Dimension)	43	Linear Dimension
<PC0044> (Linear Dimension)	44	Linear Dimension
<PC0045> (General Note)	45	General Note
<PC0046> (General Note)	46	General Note
<PC0047> (SurfaceFinish A1...	47	SurfaceFinish A1, Surface...
<PC0048> (SurfaceFinish A1...	48	SurfaceFinish A1, Surface...

The 3D model features several dimensions and surface finish specifications:

- Radial dimension:  $\varnothing 44,6$
- Linear dimensions: 9.6, 18.9, 25.5, 41.3, 46.6
- Surface finish:  $Ra\ 0,025$  and  $\sqrt{A1}$
- Geometric tolerances:  $\perp\ \varnothing 0,08(M)\ A$

**NOTES:**

1. MATERIAL: 1020 HRS WELDED CONSTRUCTION
2. SRRESS RELIEVE
3. FINISH: BLACK OXIDE PER SPECIFICATION. CLASS 1 WITH SUPPLEMENTARY OIL TREATMENT.
4. ALL FILLET WELDS TO BE SMOOTH FOR COSMETIC APPEARANCE
5. STEEL WELDS SHALL BE IN ACCORDANCE WITH THE LATEST REVISION OF ANSI/AWSD1.1 STRUCTURAL WELDING CODE - STEEL
6. STAMP PART NO. AND REVISION LEVEL WITH .125 MIN HIGH CHARACTERS. USE EITHER RUBBER STAMP WITH PERMANANET CONTRASTING COLOR OR STEEL STAMP LEGIBLY, BUT NOT SO DEEP AS TO DISTORT FINISHED PART.

# QIF Application areas

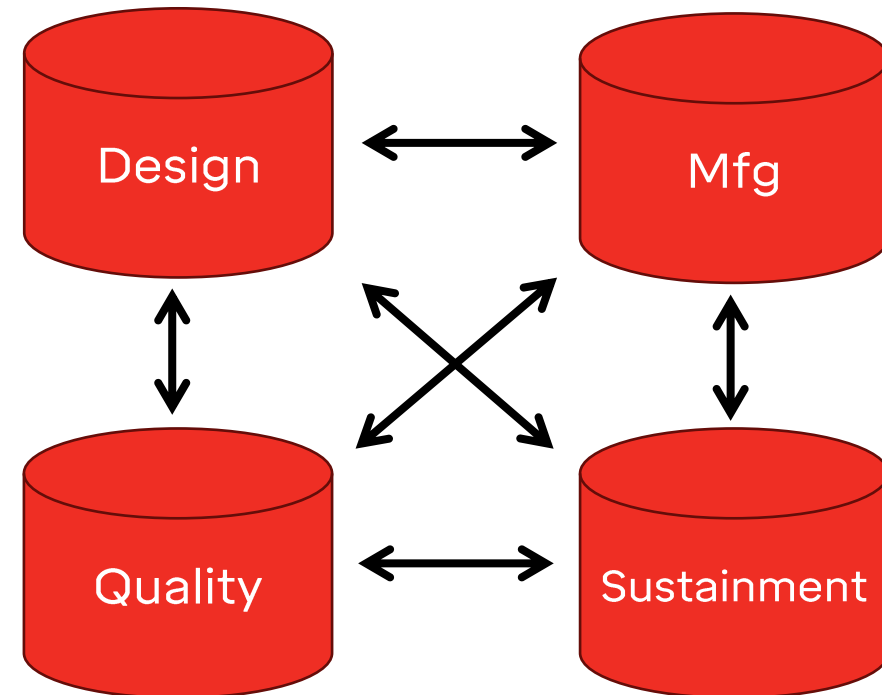
- QIF file format requirements
  - Solid modeling geometry
  - Product & Manufacturing Information (PMI)
  - (NEW) Characteristics
- Capvidia NX QIF bi-directional translator



# 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!



# Workflow Overview

Characterize PMI in NX



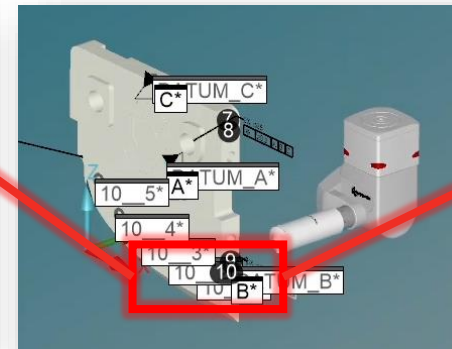
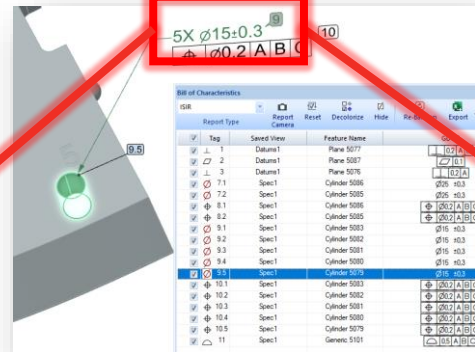
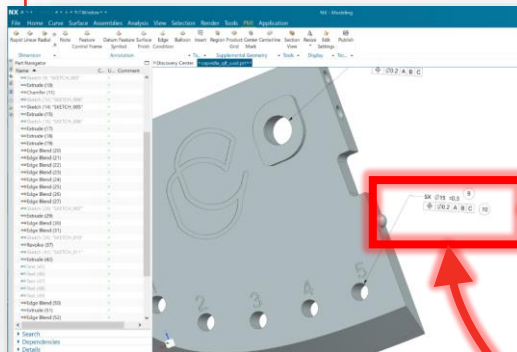
Generate QIF and view BoC in MBDVidia



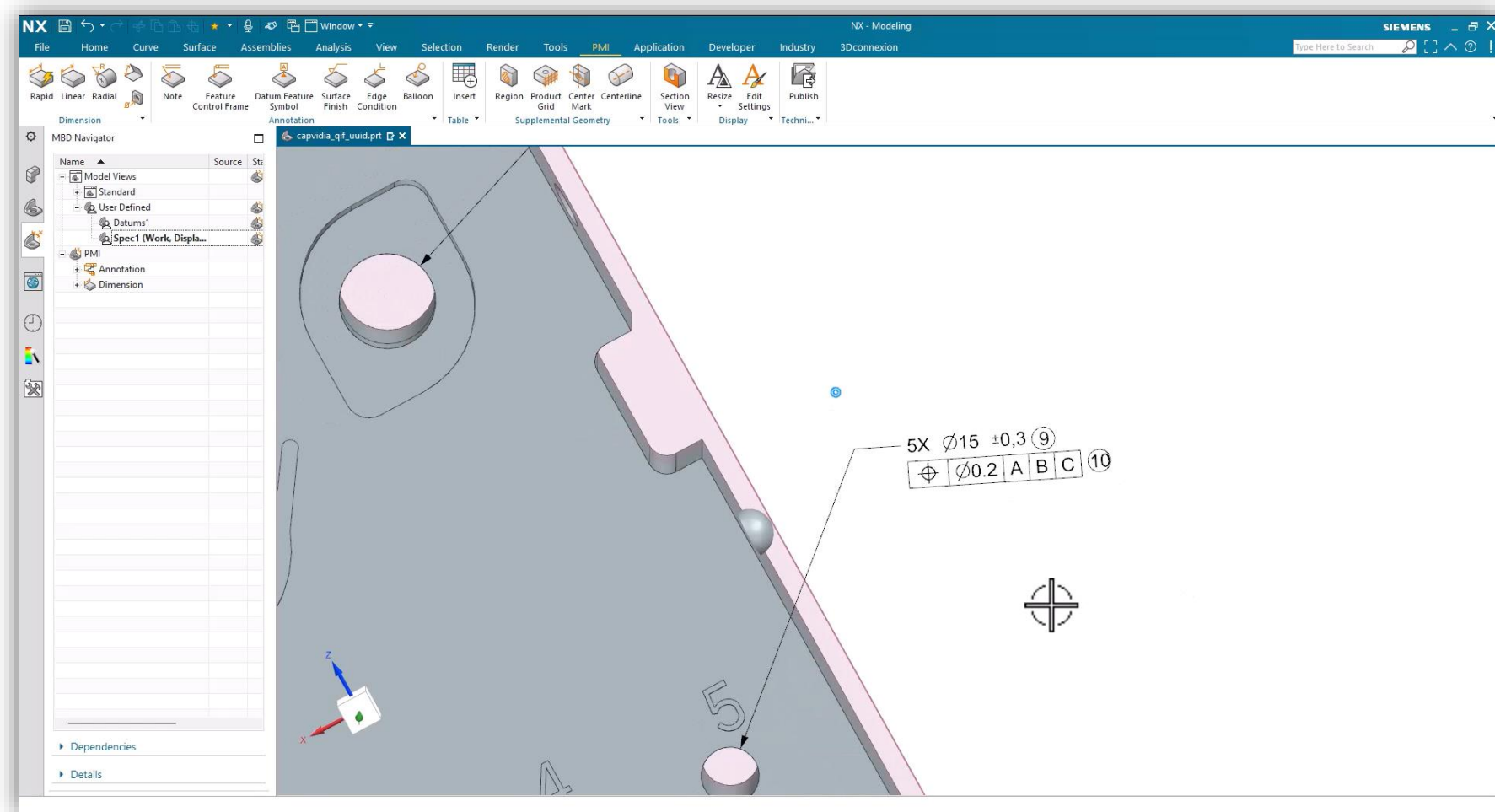
Author CMM Program in PC DMIS with QIF



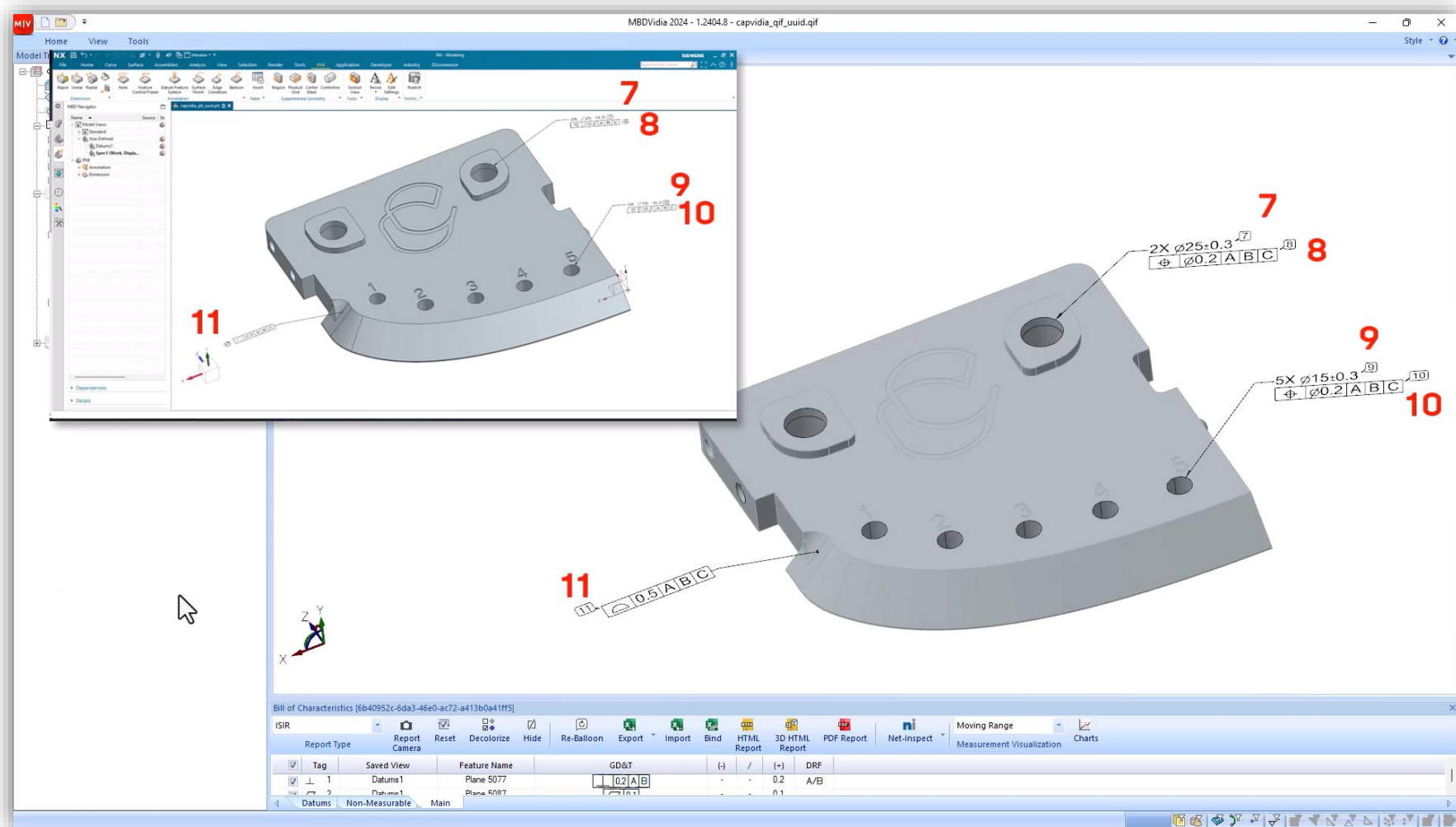
Track Inspection Results using QIF



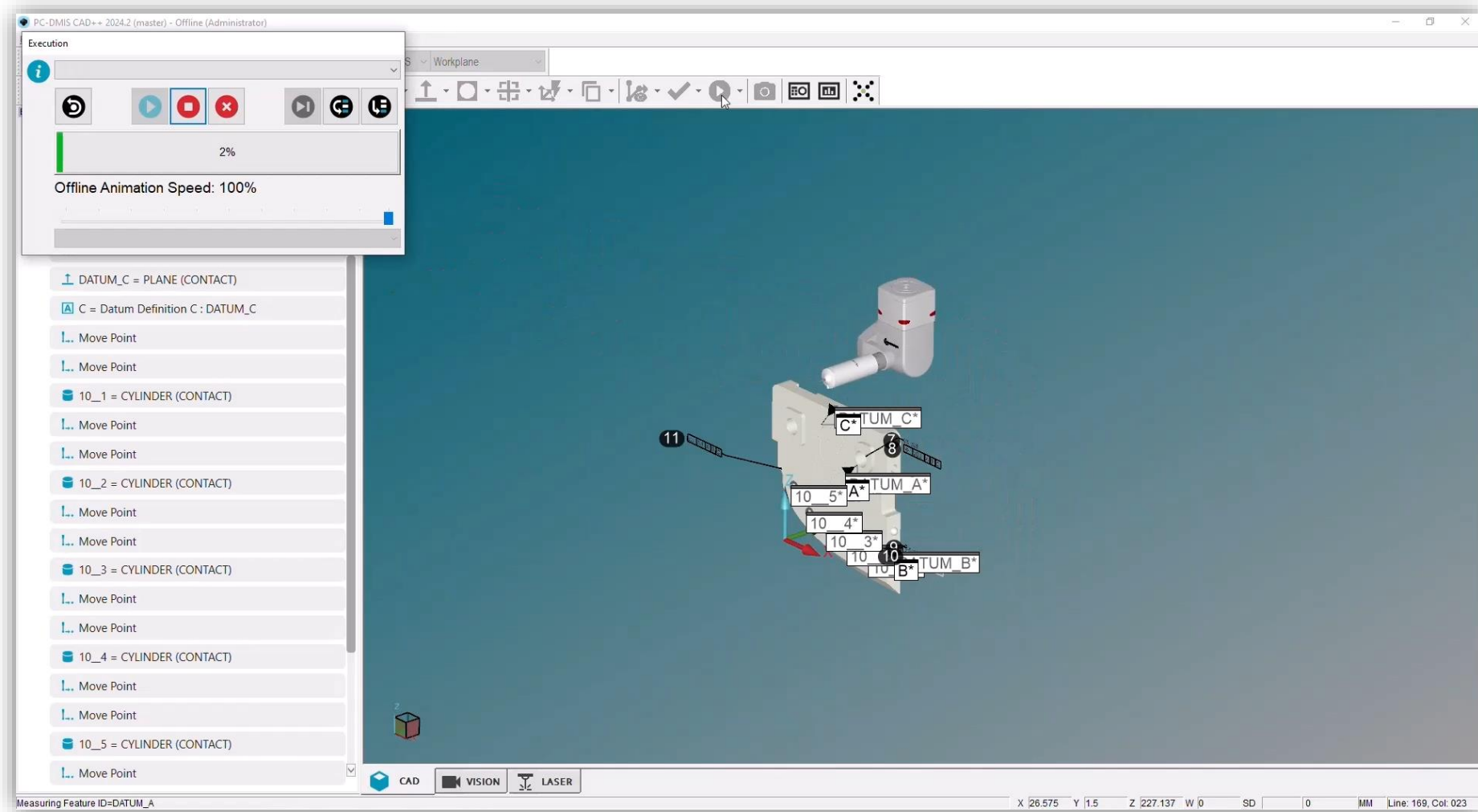
# Characterize PMI in NX



# Generate QIF and view BoC in MBDVidia



# Author CMM Program in PC DMIS with QIF



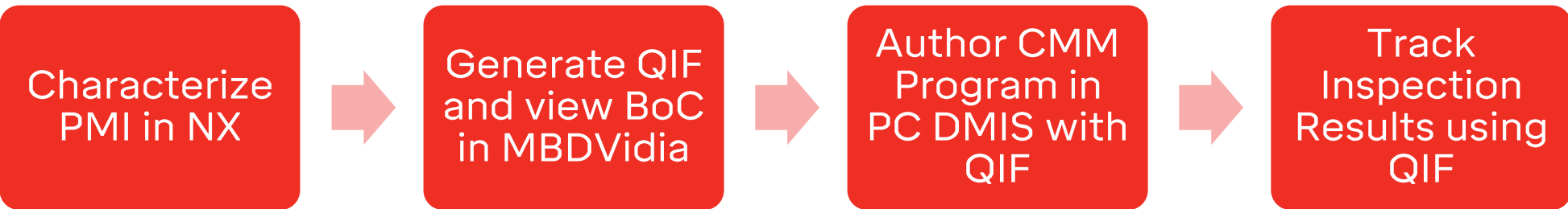
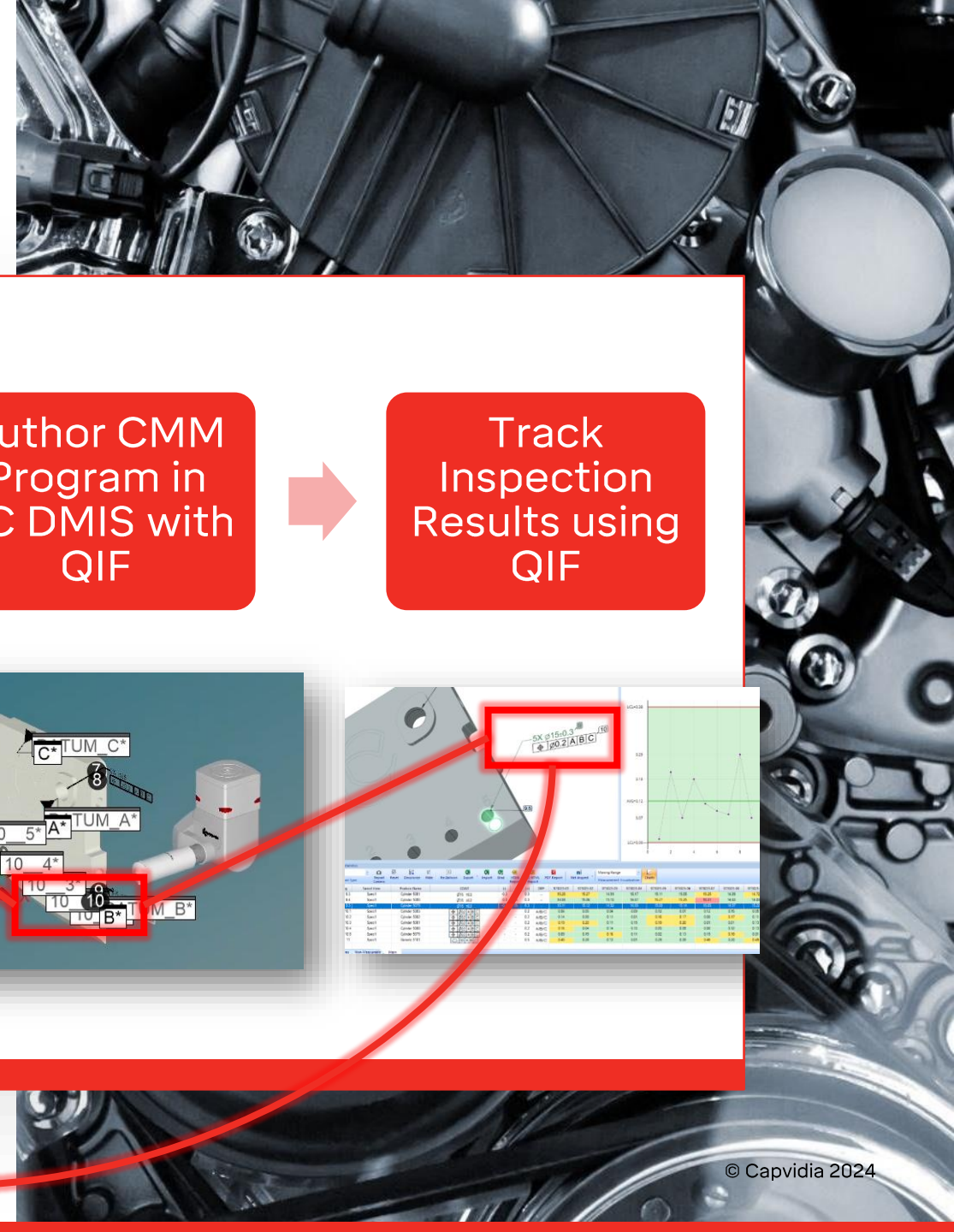
# Export Inspection Results using QIF

The screenshot displays the MBDVida software interface. On the left, a 3D model of a grey part is shown with inspection points 7, 8, 9, 10, and 11. A smaller inset shows a different view of the same part. On the right, a 'Charts: Thermometers' window shows a grid of colored bars representing inspection results for various points. At the bottom, a 'Bill of Characteristics' table is visible, with rows 7 through 10 highlighted in red. The table contains columns for Tag, Saved View, Feature Name, GD&T, and various measurement points (973023-01 to 973023-10).

Tag	Saved View	Feature Name	GD&T	(-)	/	(+)	DRF	973023-01	973023-02	973023-03	973023-04	973023-05	973023-06	973023-07	973023-08	973023-09	973023-10
1	Datums1	Plane 5077	$\perp$ 0.2   A   B	-	-	0.2	A/B	0.14	0.08	0.11	0.00	0.19	0.14	0.04	0.13	0.10	0.10
2	Datums1	Plane 5087	$\perp$ 0.1	-	-	0.1	-	0.02	0.05	0.05	0.00	0.09	0.10	0.06	0.08	0.08	0.02
3	Datums1	Plane 5076	$\perp$ 0.2   A	-	-	0.2	A	0.08	0.06	0.06	0.13	0.01	0.11	0.20	0.06	0.06	0.10
7.1	Spec1	Cylinder 5086	$\varnothing$ 25 +0.3	-0.3	25	0.3	-	25.00	24.98	25.11	24.80	25.29	25.00	25.15	24.89	25.04	25.07
7.2	Spec1	Cylinder 5085	$\varnothing$ 25 +0.3	-0.3	25	0.3	-	25.14	25.25	25.07	24.80	24.96	24.76	24.81	25.02	25.15	24.87
8.1	Spec1	Cylinder 5086	$\varnothing$ 20.2   A   B   C	-	-	0.2	A/B/C	0.04	0.07	0.09	0.11	0.16	0.04	0.14	0.18	0.12	0.10
8.2	Spec1	Cylinder 5085	$\varnothing$ 20.2   A   B   C	-	-	0.2	A/B/C	0.03	0.06	0.20	0.07	0.10	0.13	0.13	0.12	0.10	0.17
9.1	Spec1	Cylinder 5083	$\varnothing$ 15 +0.3	-0.3	15	0.3	-	15.18	15.09	14.91	15.26	15.05	14.79	14.72	14.81	14.71	14.78
9.2	Spec1	Cylinder 5082	$\varnothing$ 15 +0.3	-0.3	15	0.3	-	15.18	15.31	14.97	15.21	15.16	15.15	15.22	15.24	15.03	15.08
9.3	Spec1	Cylinder 5081	$\varnothing$ 15 +0.3	-0.3	15	0.3	-	15.25	15.27	14.91	15.17	15.11	15.05	15.25	14.89	14.72	14.96
9.4	Spec1	Cylinder 5080	$\varnothing$ 15 +0.3	-0.3	15	0.3	-	14.88	15.06	15.10	14.87	15.27	15.25	15.31	14.82	14.83	15.12
9.5	Spec1	Cylinder 5079	$\varnothing$ 15 +0.3	-0.3	15	0.3	-	15.11	15.12	14.92	14.85	15.03	15.14	15.05	14.97	15.22	15.15
10.1	Spec1	Cylinder 5083	$\varnothing$ 20.2   A   B   C	-	-	0.2	A/B/C	0.06	0.05	0.04	0.12	0.01	0.12	0.15	0.05	0.02	0.02



# Workflow Overview



Report Type	Search View	Feature Name	Value
1	Datum1	Plane 5077	10.0
2	Datum1	Plane 5077	10.0
3	Datum1	Plane 5076	10.0
7.1	Spec1	Cylinder 5086	10.0
7.2	Spec1	Cylinder 5085	10.0
8.1	Spec1	Cylinder 5086	10.0
8.2	Spec1	Cylinder 5085	10.0
9.1	Spec1	Cylinder 5083	10.0
9.2	Spec1	Cylinder 5082	10.0
9.3	Spec1	Cylinder 5081	10.0
9.4	Spec1	Cylinder 5080	10.0
9.5	Spec1	Cylinder 5079	10.0
10.1	Spec1	Cylinder 5083	10.0
10.2	Spec1	Cylinder 5082	10.0
10.3	Spec1	Cylinder 5081	10.0
10.4	Spec1	Cylinder 5080	10.0
10.5	Spec1	Cylinder 5079	10.0
11	Spec1	Generic 5101	10.0

# 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



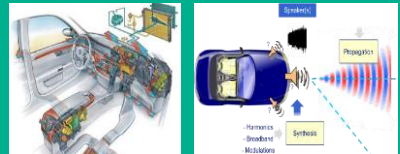
## DESIGN

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

# 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!

### Daniel Campbell

Vice President, Model-Based Definition  
Capvidia

✉ [dc@capvidia.com](mailto:dc@capvidia.com)

in <https://www.linkedin.com/in/daniel-campbell-051769/>

🌐 [www.capvidia.com](http://www.capvidia.com)

### George Rendell

Vice President, product  
management and product marketing  
Siemens Digital Industries Software

✉ [george.rendell@siemens.com](mailto:george.rendell@siemens.com)

in <https://www.linkedin.com/in/george-rendell-a289224/>

🌐 [sw.siemens.com](http://sw.siemens.com)



True MBD: Human & Machine  
Readable CAD + PMI

# Contact Us

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**Daniel Campbell**

Vice President, Model-Based Definition

✉ [dc@capvidia.com](mailto:dc@capvidia.com)

🌐 [www.capvidia.com](http://www.capvidia.com)

# Contact

Published by Siemens DI SW

**George L Rendell**

Vice president, product management and product marketing

Product Engineering Software

2000 Eastman Drive

Milford, OH 45150

United States of America

**Phone +1 513 576 2111**

Mobile +1 513 257 1147

**E-mail [george.rendell@siemens.com](mailto:george.rendell@siemens.com)**



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[www.capvidia.com](http://www.capvidia.com)