

Bart Vos – BVDesign.be

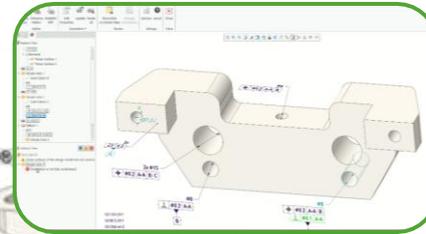
CAD-engineer in PTC Creo, 25+ years experience.
Technical training instructor, 1.430+ participants.

COMMSCOPE®

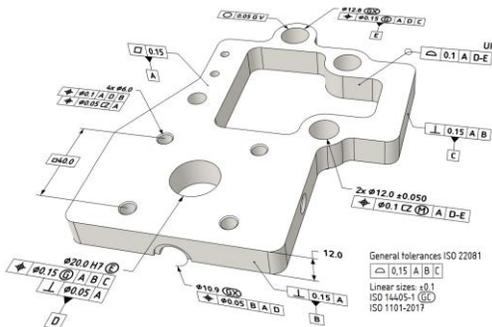
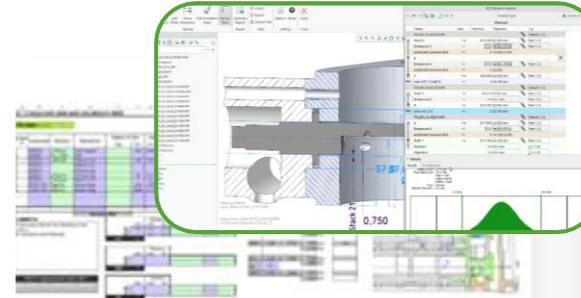
DELPHI
Automotive Systems

hogeschool
VIVES

 **Creo GD&T Advisor**

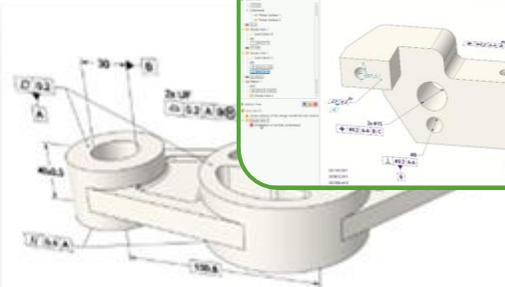


 **Creo EZ Tolerance**



Geometric Dimensioning and Tolerancing (GD&T)

This course is designed for anyone working with GD&T.
ISO and ASME specifications



Model-Based Definition

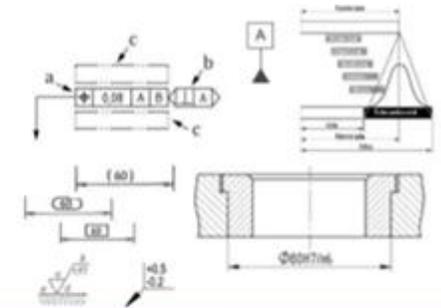
This course covers the dimensioning and tolerancing of a 3D CAD model for downstream use.

Tolerance study

This course is designed for anyone involved in product development business processes.

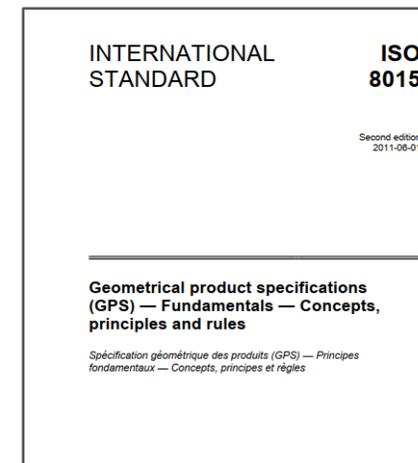
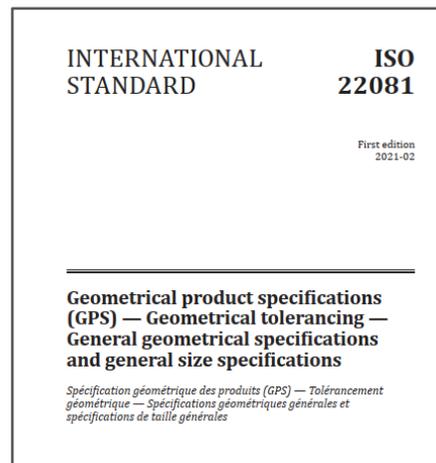
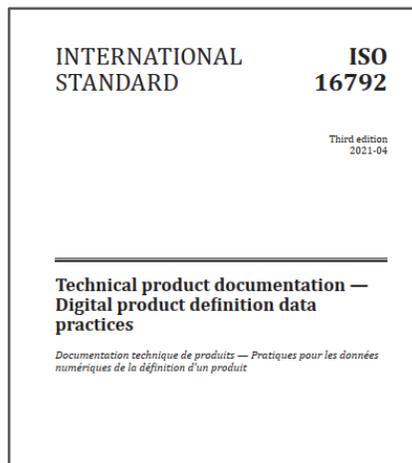
Drawing interpretation

This course is for anyone whose work involves reading technical drawings.



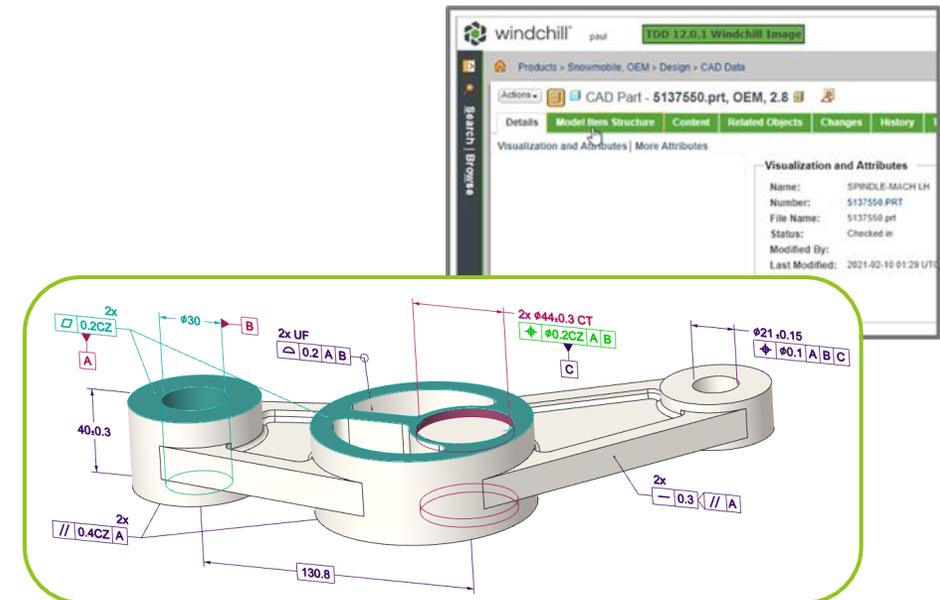
ISO GPS & Model-Based Definition: The key to an unambiguous Product Definition Data set

- ISO GPS (Geometric Product Specification) refers to a set of international standards used to unambiguously define the geometry and tolerances of parts, e.g. GD&T, surface roughness, etc.
- ISO standards now deliver precise definitions, no ambiguities, to deliver machine-readable models.
 - Incorrectly defined tolerances result in time loss and incorrect assumptions.

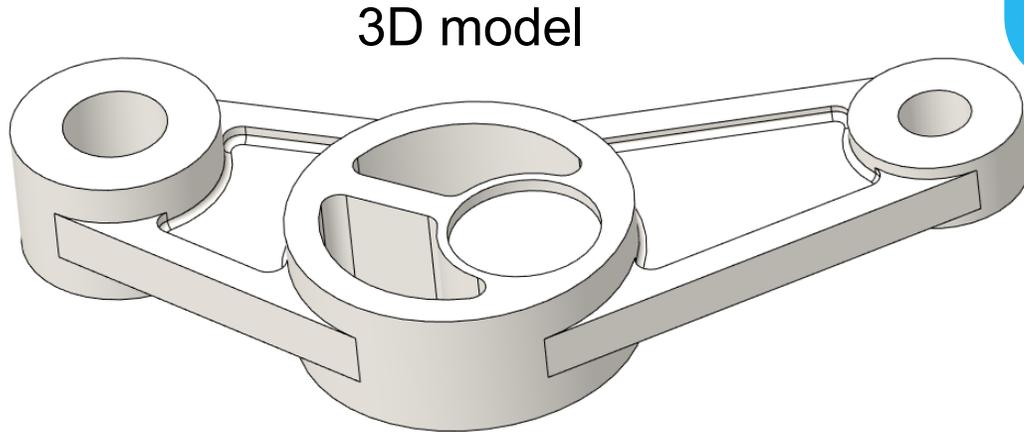


Goal of the presentation

- Giving insight into the relationship between ISO GPS standards and Model-Based Definition.
- Opportunities:
 - Correct machine-readable 3D models enables more automatization.
 - GD&T and dimensions applied to a **fully detailed** 3D model.
 - Align the model annotations with CMM methodology for **accurate** functional specifications.
 - Applying PTC Creo methodology to manage interfaces.
 - Maturity Index and PLM: Understanding Master Data.



Current Status of Two Document Control



Geometry definition –
Two document control



2D Drawing
Not machine readable

- 3D model + 2D Drawing for geometrical and product specification, **both as master data.**
- 2D Drawing:
 - 3D model not always inline with 2D drawing.
 - Not machine readable.
 - WoW suppliers, where do they start from?

R&D

Production

Quality

Annotations: $\phi 21 \pm 0.15$, $\phi 0.1$ A B C, $2x \text{UF}$, 0.2 A B, $\phi 30$, B, $2x$, 0.3 // A, 0.3 // A, $2x$, 0.4 A, 0.2 C Z, A

INTERNAL	LEVEL	DATE	MODEL	DESIGN	APPROVED
PROPERTY	SCALE	PROJECTION	TOLERANCE	DESCRIPTION	
AA	1:2	1			

WEIGHT: kg

DIRECTION: AXC: 100

SCALE: 1:2

PROJECTION: 1

TOLERANCE: ϕ

DESCRIPTION: BELL_CRANK_LEVER-01

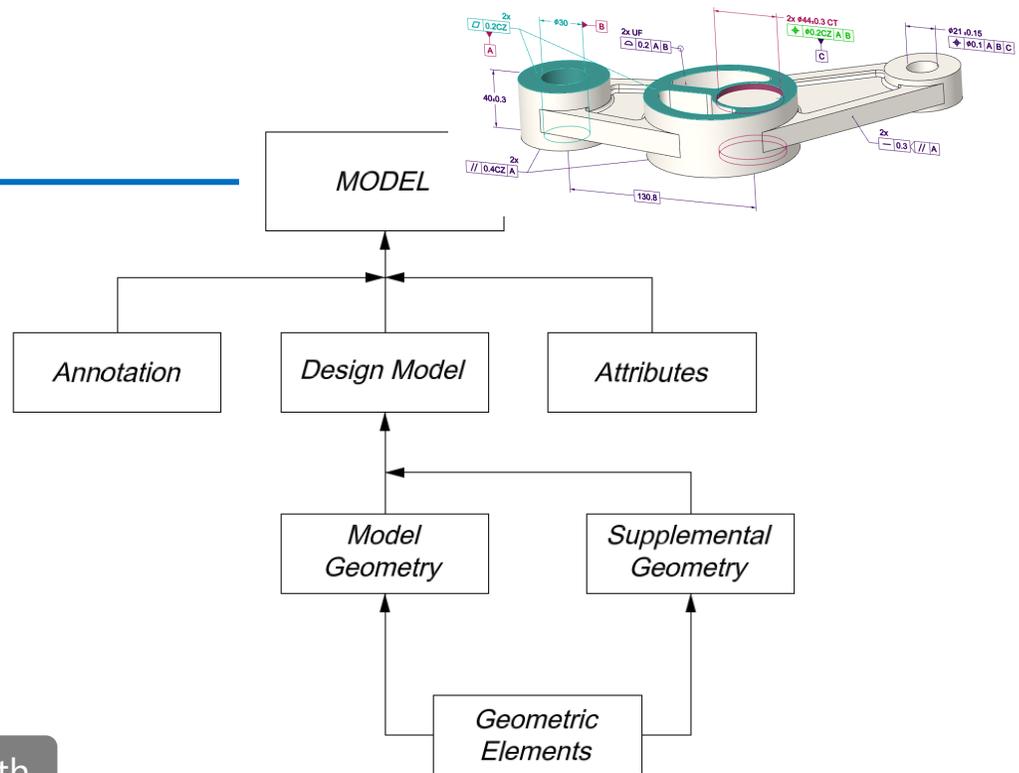
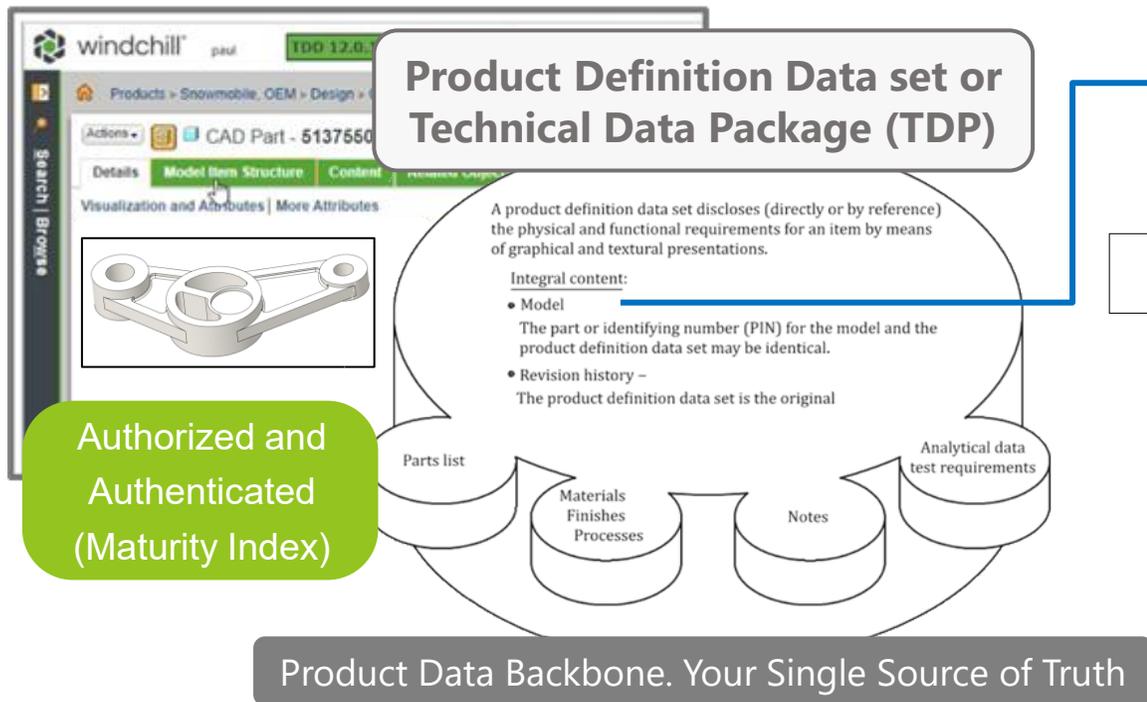
PART NUMBER: BELL_CRANK_LEVER-01

SHEET: 1 of 1

REPLACES: 1

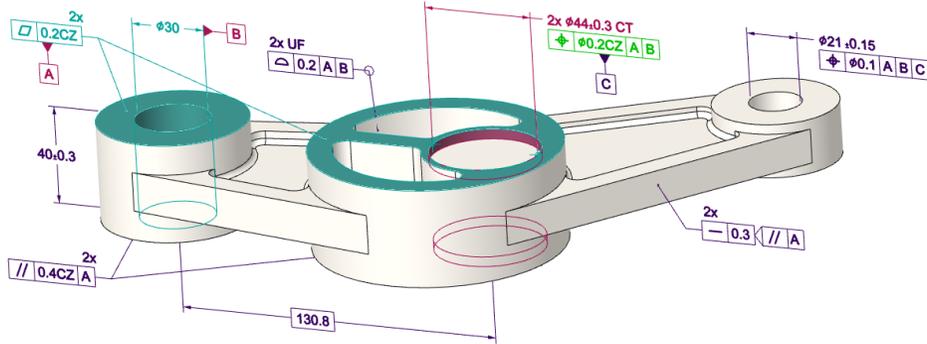
Digital product definition data – ISO 16792

- Specifies requirements for the preparation and revision of digital product definition data, also in ISO named as ‘**data sets**’. PTC uses the term Technical Data Package (**TDP**).
- The data set shall provide complete product definition, a design model, its annotation and related documentation.

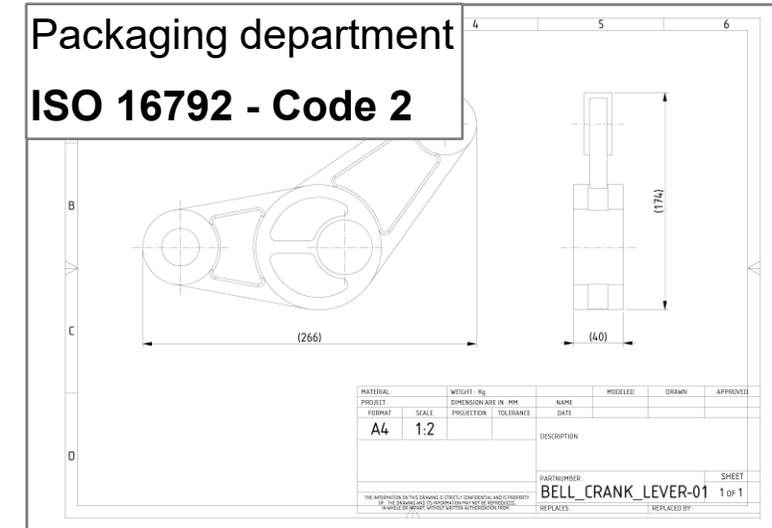


One Document Control

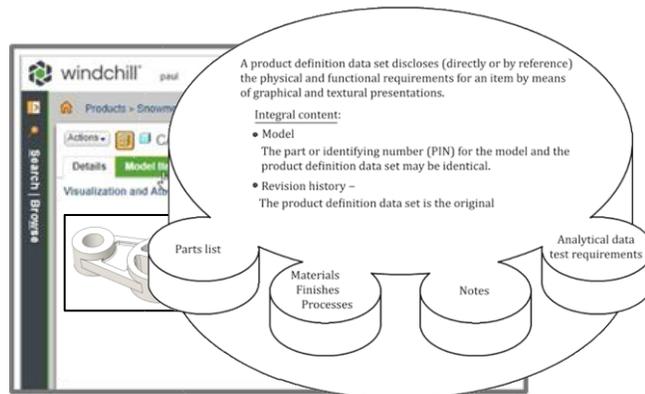
3D annotated model



2D drawing



- 3D model for geometrical specification.
- TDP, data set, for product definition: R&D – Production – Quality (**ISO 16792 - Code 4**).



- ISO 16792 - Classification codes 1-5:**
Designation codes to indicate whether the master data is the drawing, the 3D model or both (see slide 19).

ISO 16792

Code 1

Code 2

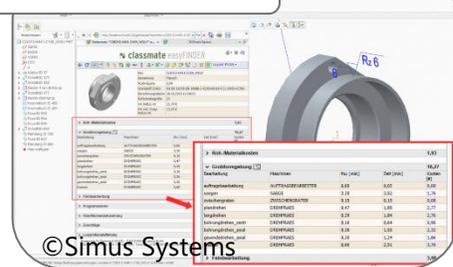
Code 3

Code 4

Code 5

Machine readable PMI enables automatization

Cost calculation



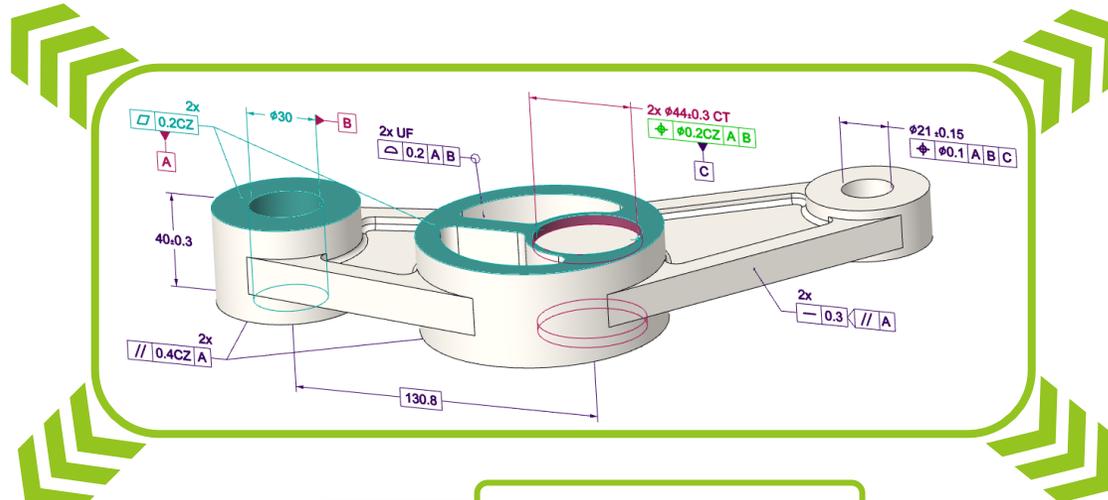
Design validation

- Rule based queries
- Tolerance search
- Wall thickness queries
- Etc.

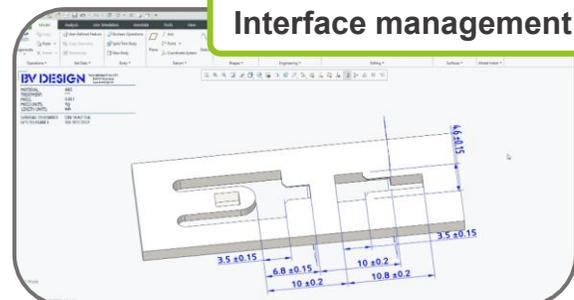
CAM programming



CMM programming



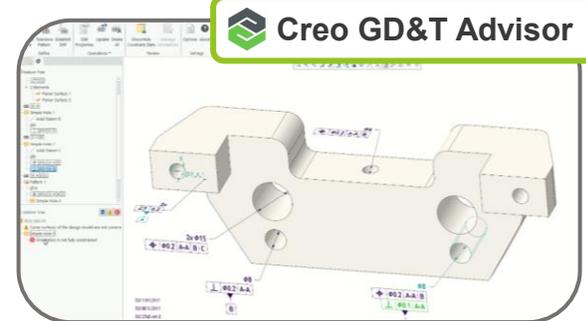
Interface management



Creo EZ Tolerance

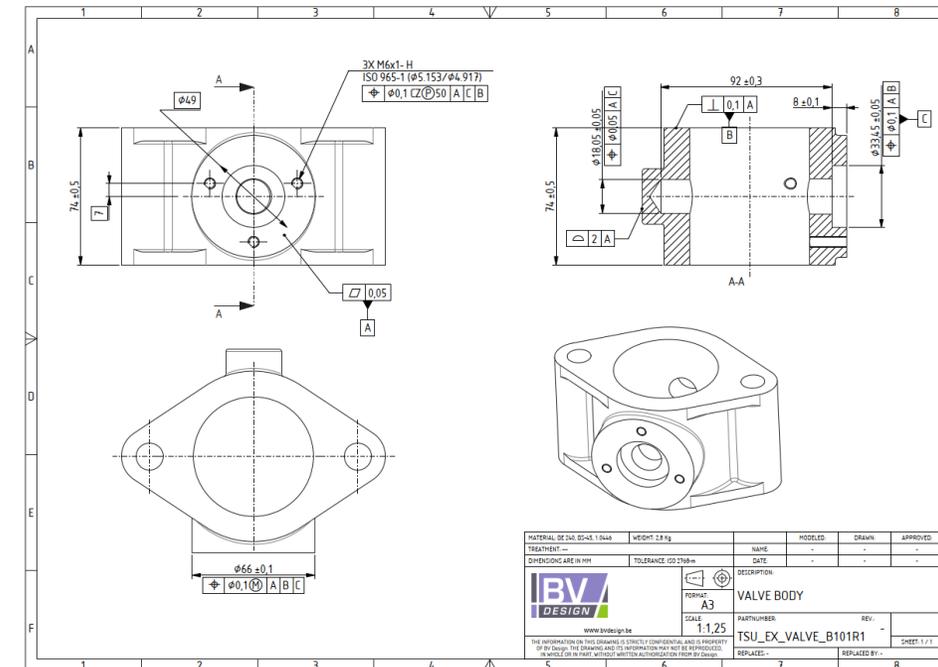
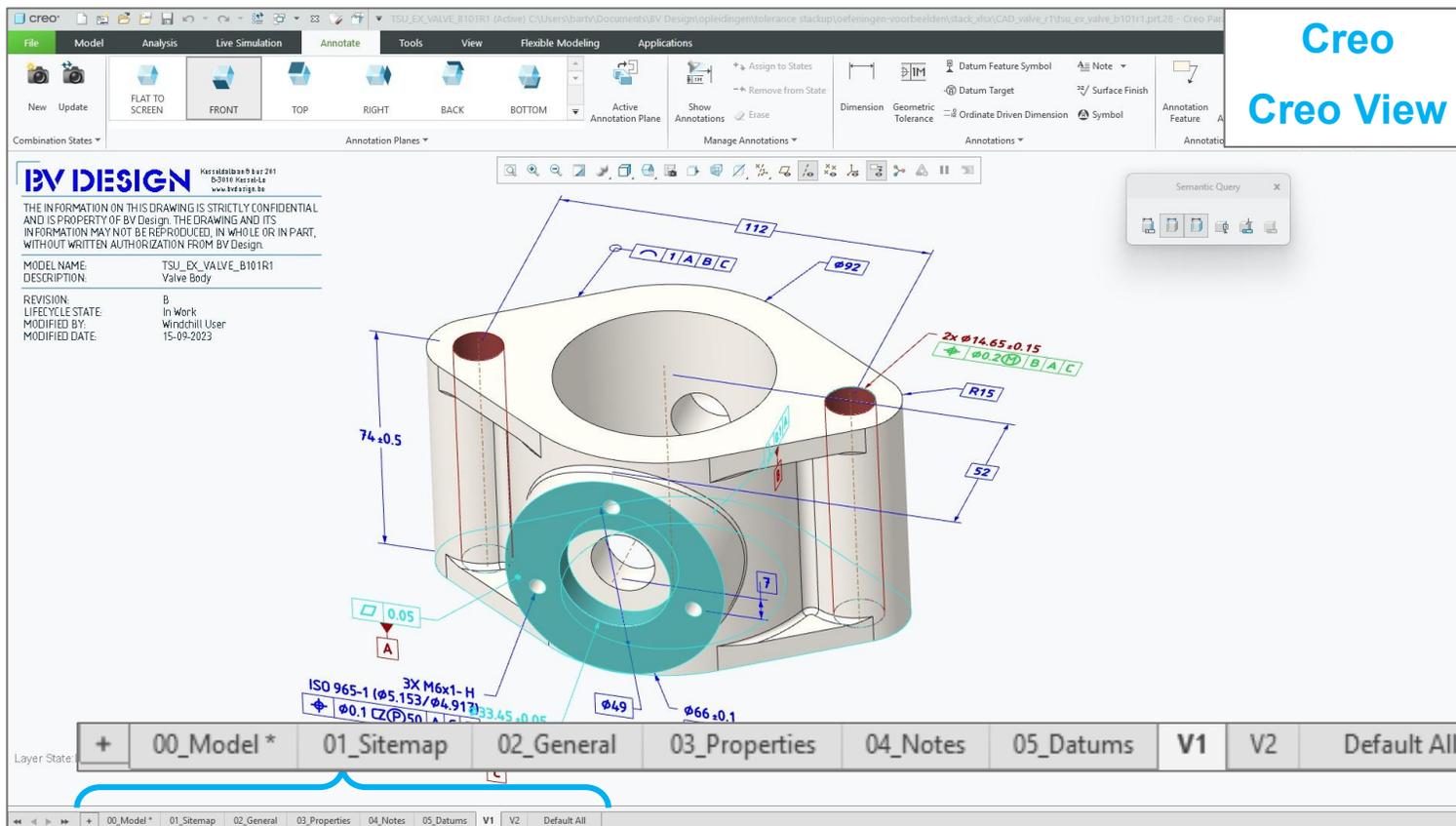


Creo GD&T Advisor

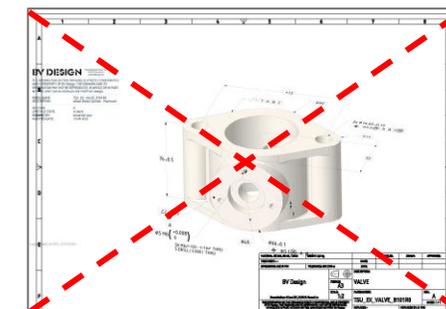


Drawing layout – MBD layout

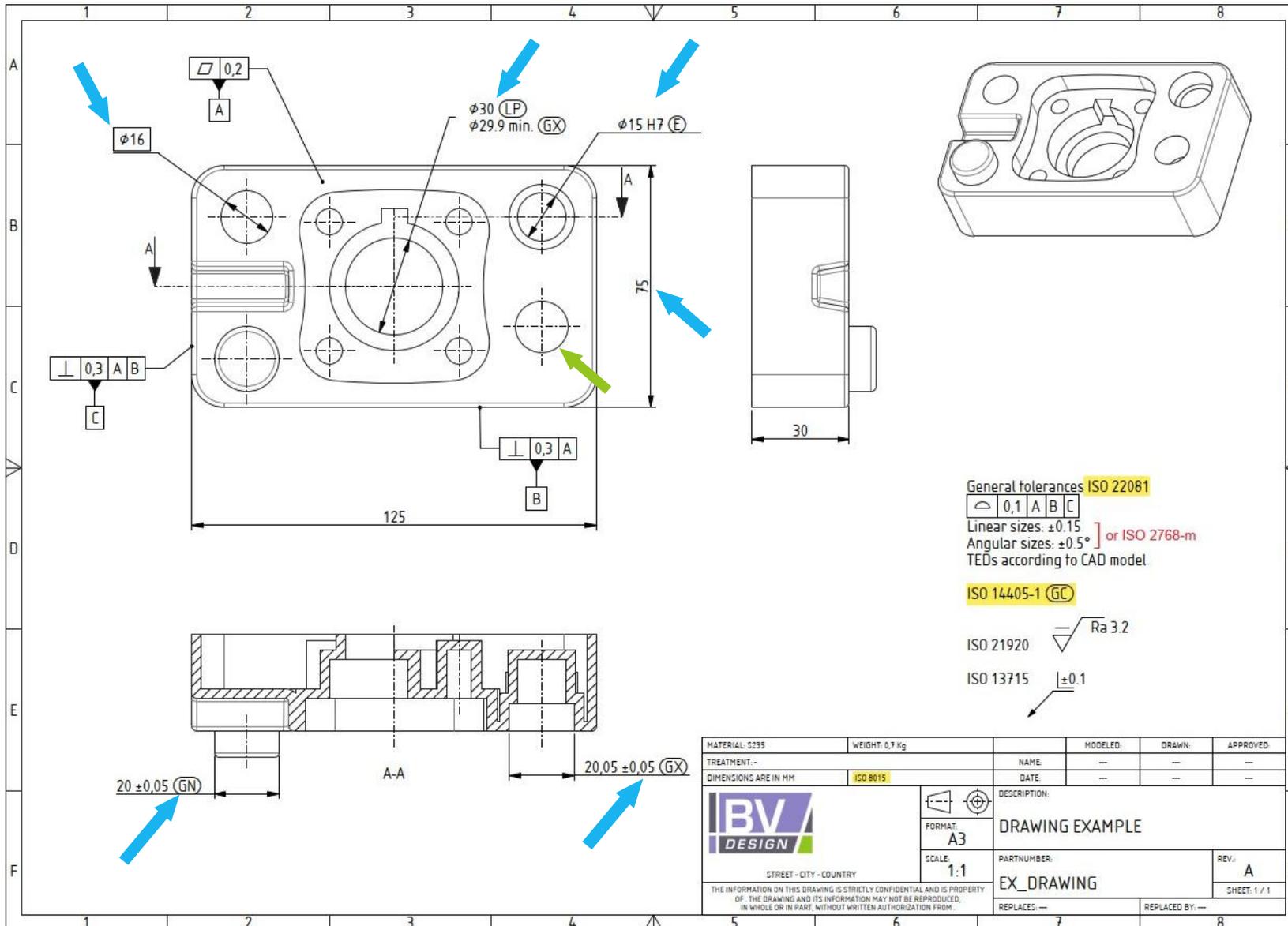
- Creo 'Combined Views' are the 'View states' from the standards.
 - Naming standard: MIL-STD-31000A.
 - Querying linked data and Spin the 3D model.



Useless to automate export to 2D !!!

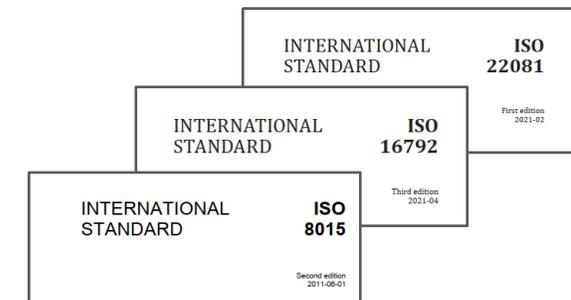


ISO GPS - CMM Template

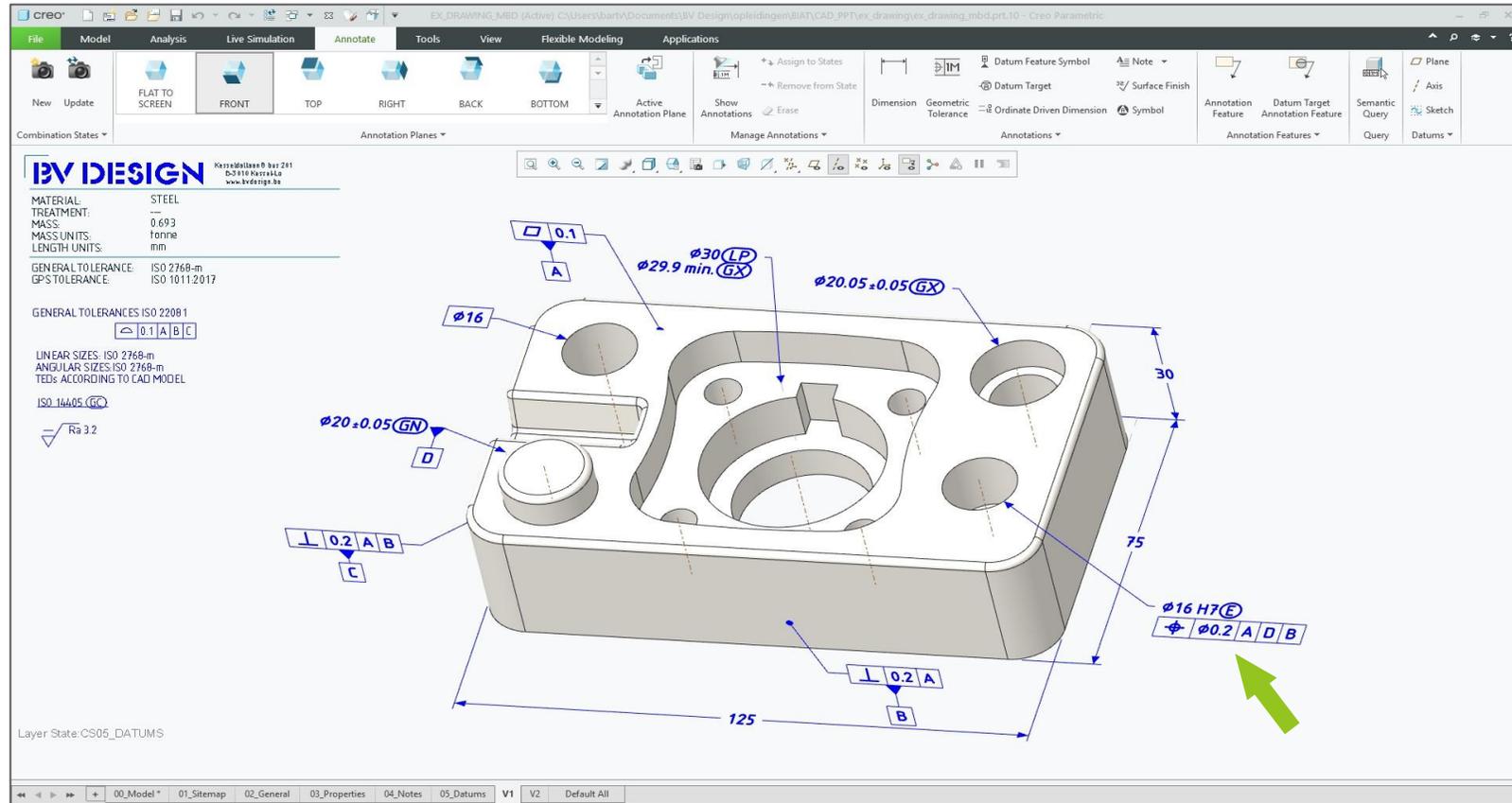
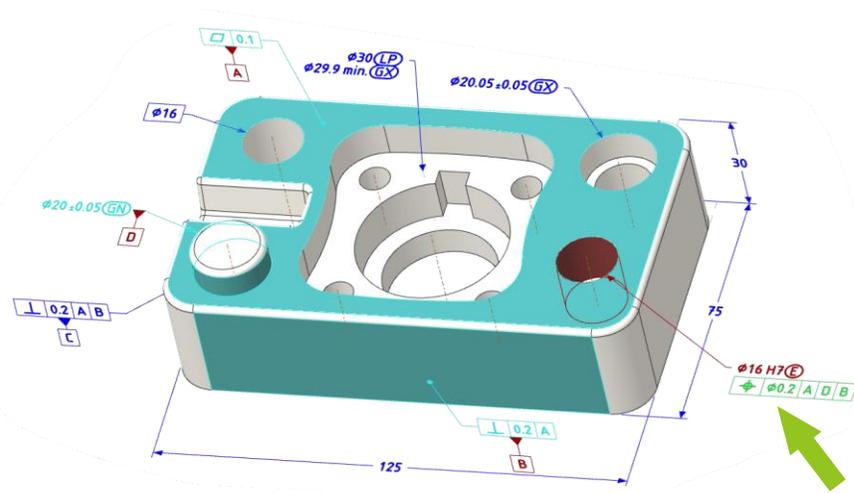
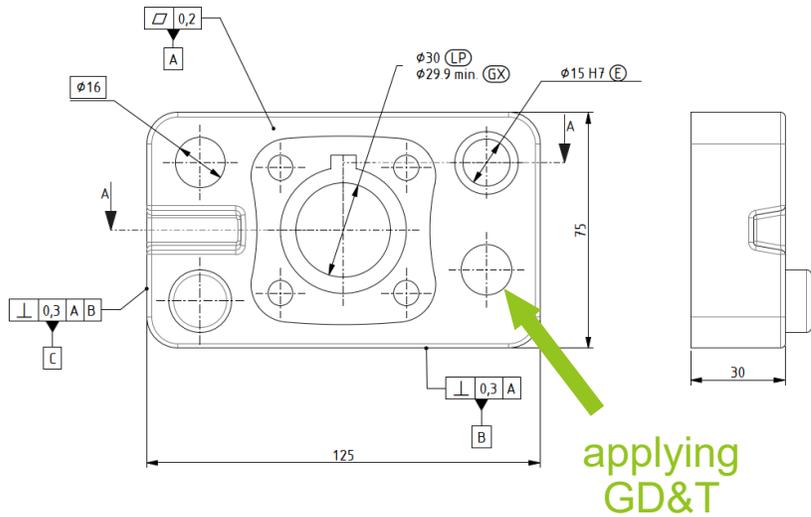


The main driver for this GPS template setup, CMM:

- Engineers seek better understanding of measurements relative to actual parts and specs.
- GD&T can provide a functional, unambiguous definition for interpreting CMM point cloud data.
- On-machine measurement (OMM)
- ISO 8015 default assumes 'caliper' measurement.



ISO GPS - CMM Template MBD video demo



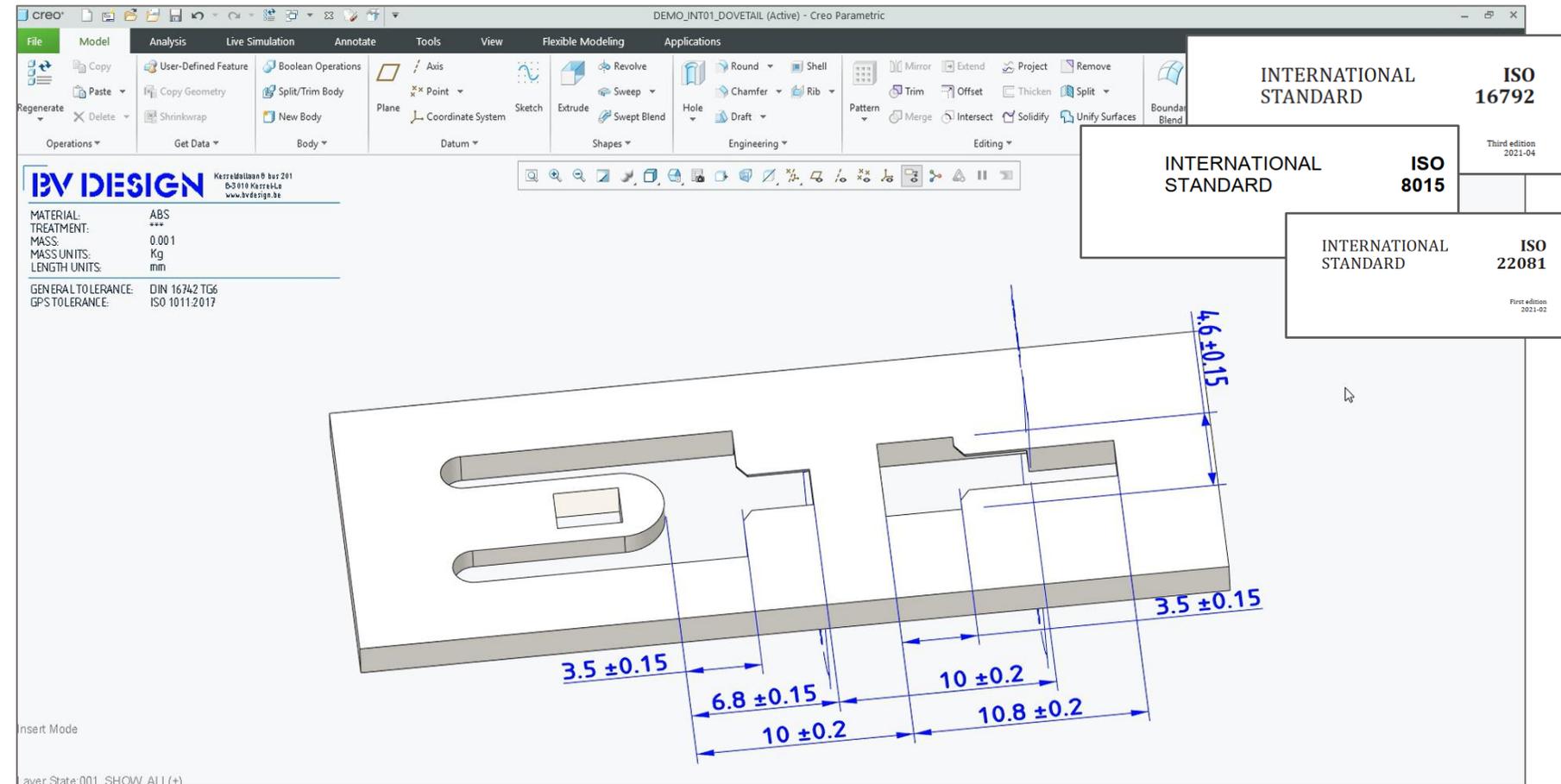
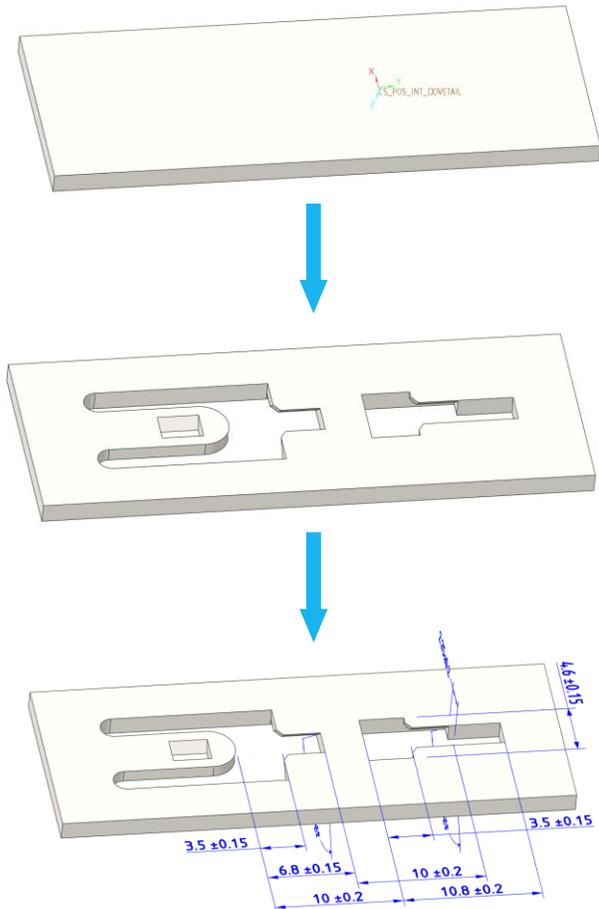
Benefits:

- Applying GD&T in 2D requires visualizing and interpreting tolerances in a 3D context.
- Applying GD&T directly in 3D provides a **clearer understanding** of how tolerance zones relate to the actual model.

Interface management – video demo

Creo Methodology Interfaces:

An interface is defined by matching male and female geometries.



Benefits:

- **Standardized geometry and tolerance scheme** across all parts with the same interface.
- Managed in PLM as a trusted source (version-controlled, **traceable**, etc.)

Creo GD&T Advisor – video demo

The screenshot displays the Creo GD&T Advisor interface. At the top, a specification bar shows 'Name: Simple Hole 2', 'Scheme: Toleranced Size', and 'Datum Feature' options. The main area is divided into three panes: 'Feature tree' on the left, 'Advisor tree' on the bottom left, and a large 3D model on the right. The 3D model shows a mechanical part with several holes and surfaces, each annotated with GD&T symbols such as $\phi 0.2$, $\phi 8$, $\phi 15$, and $\phi 0.1$, along with datum labels A, B, and C. The 'Feature tree' lists features like 'Simple Hole 1', 'Simple Hole 2', and 'Pattern 1'. The 'Advisor tree' shows a warning: 'Some surfaces of the design model are not constrained' and 'Orientation is not fully constrained'. A 'Constraint State Legend' at the bottom left indicates 'Fully constrained' (green), 'Partially constrained' (yellow), 'Unconstrained' (grey), and 'Constrained by Surface Profile in note' (blue). The bottom right of the 3D model area lists standards: 'ISO 1101:2017', 'ISO 8015:2011', and 'ISO 2768-mK-E'. A 'Specification' label is positioned above the 3D model.

Feature tree

Advisor tree

Specification

ISO 1101:2017
ISO 8015:2011
ISO 2768-mK-E

ALL DIMENSIONS SPECIFIED IN MILLIMETERS

Benefits:

- Intuitive application of the GD&T standard, enabling machine readability.
- **Automated guidance** during part tolerancing.

Creo GD&T Advisor DOF

Feature Tree

- 0.2
- A
- Pattern 1
 - Prismatic Datum B
 - Ø16
 - Ø0.2 A
 - Simple Hole 2
 - Simple Hole 3
 - A B-B
 - Simple Hole 4
 - Ø36
 - Ø0.2 A B-B
- Extruded Group 1
 - 0.2 A B-B
- 4 Elements
 - Planar Surface 2
 - Planar Surface 3

Advisor Tree

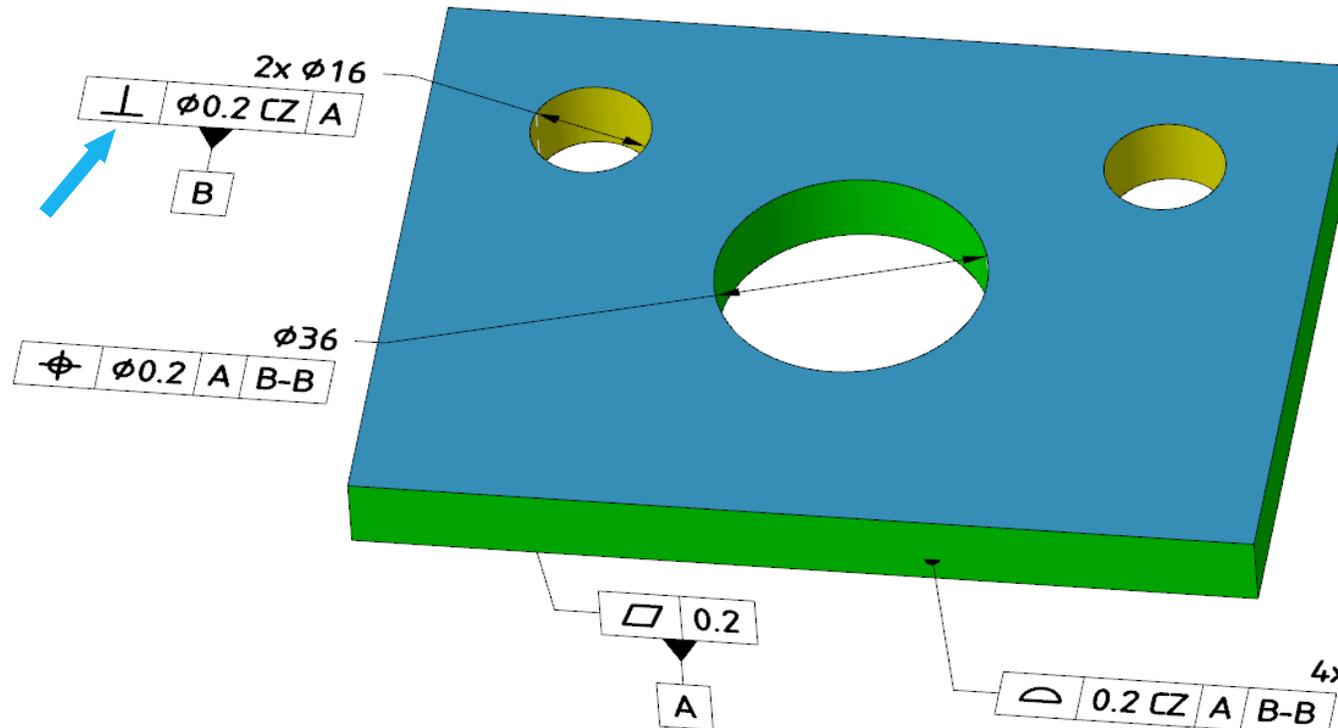
- FIG_SYL05_DATUM-COMMON
 - Pattern 1
 - Size is not fully constrained

Constraint State Legend

- Fully constrained
- Partially constrained
- Unconstrained
- Constrained by Surface Profile in note

NOTES:
1. UNLESS OTHERWISE SPECIFIED, 0.2 A B-B APPLIES TO ALL SURFACES

Tolerance Feature	Tolerance Pattern	Establish DRF	Edit Properties	Update	Delete All	Show/Hide Constraint State	Unvalidated Annotations List	Options	About	Close
Define		Operations			Review		Settings		Close	



ISO 1101:2017
ISO 8015:2011
ISO 2768-mK
ISO 16792:2021
ALL DIMENSIONS SPECIFIED IN MILLIMETERS

Size is Not Fully Constrained

Not all aspects of size have been constrained by the controls that have been applied to the feature. For patterns, this message may indicate that the spacing of the pattern has not been constrained.

Creo GD&T Advisor DOF

Feature Tree

- 0.2
- A
- Pattern 1
 - Prismatic Datum B
 - Ø16
 - Ø0.2 A
 - Simple Hole 2
 - Simple Hole 3
- A B-B
- Simple Hole 4
 - Ø36
 - Ø0.2 A B-B
- Extruded Group 1
 - 0.2 A B-B
 - 4 Elements
 - Planar Surface 2
 - Planar Surface 2

Advisor Tree

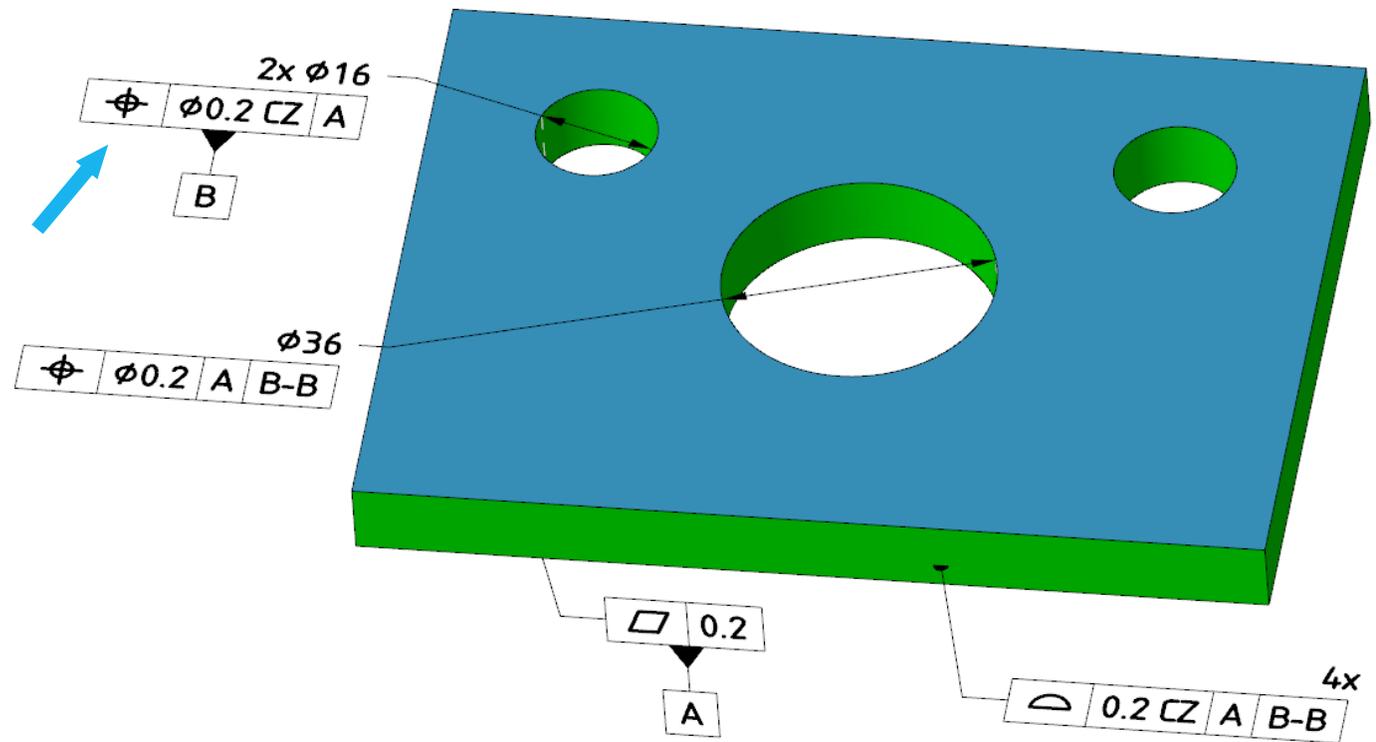
FIG_SYL05_DATUM-COMMON

Constraint State Legend

- Fully constrained
- Partially constrained
- Unconstrained
- Constrained by Surface Profile in note

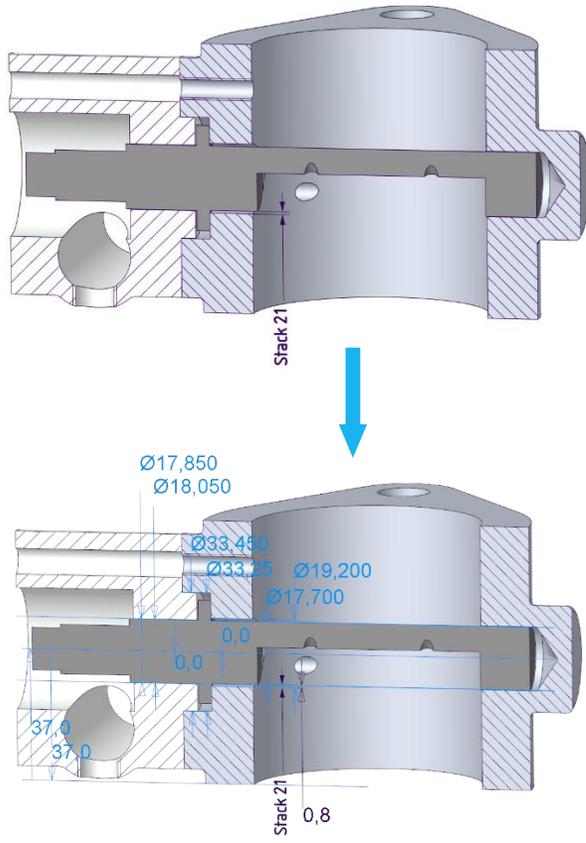
NOTES:
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Tolerance Feature	Tolerance Pattern	Establish DRF	Edit Properties	Update	Delete All	Show/Hide Constraint State	Unvalidated Annotations List	Options	About	Close
Define		Operations			Review		Settings		Close	



ISO 1101:2017
ISO 8015:2011
ISO 2768-mK
ISO 16792:2021
ALL DIMENSIONS SPECIFIED IN MILLIMETERS

Creo EZ Tolerance – video demo



Name	Sens	Nominal	Tolerance	Cp
TSU_EX_VALVE_B101R0				Default (1,0)
Hole10	+1/2	Ø19,200	±0,200 mm	Part (1,0)
Dimension13	-1	37,0	+0,00/-0,00	Part (1,0)
Additional tolerance Dim	+1	0	+0,200/-0,000	
B				
Dimension14	+1	37,0	+0,10/-0,10	Part (1,0)
Additional tolerance Dim	+1	0	±0,050	
C				
Asm shift C-Shaft12	+1	0	±0,100 mm	
TSU_EX_VALVE_B102R0				Default (1,0)
Shaft12	-1/2	Ø33,25	±0,05 mm	Part (1,0)
Dimension15	-1	0,0	±0,1 mm	Part (1,0)
D				
Asm shift D-A	+1	0	±0,100 mm	
TSU_EX_VALVE_B104R0				Default (1,0)
A				
Dimension16	+1	0,0	+0,00/-0,00	Part (1,0)
Additional tolerance Dim	+1	0	+0,100/-0,000	
Shaft11	-1/2	Ø17,700	±0,100 mm	Part (1,0)
Stackup2		0,8	±0,3 mm	Σ = 7,00
Objectives		0,8	±0,5 mm	Σ = 3,00

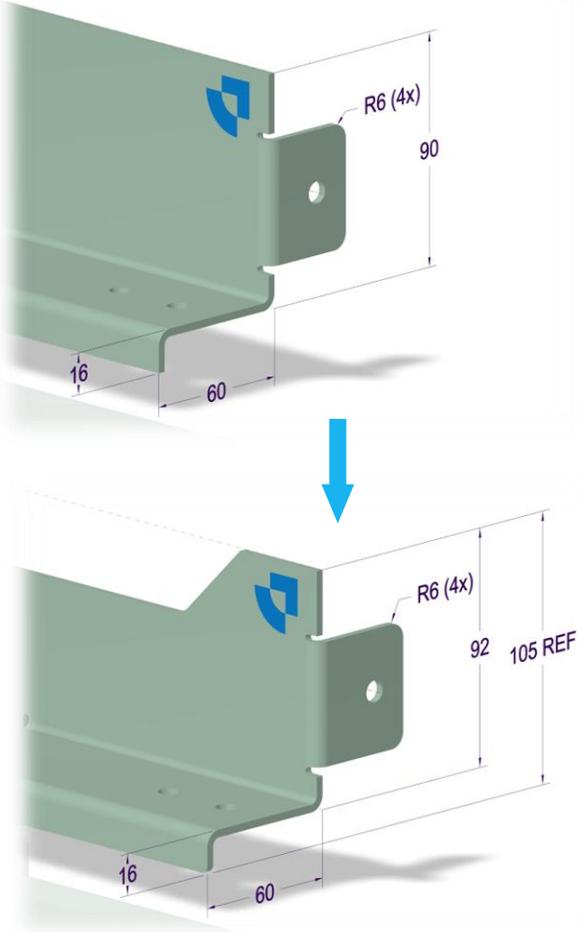
Results Contributions

target quantity: $\bar{x} = 0,8$
 Predicted Quality: $\bar{x} = 7,00$
 : Cpk = 1,55
 : Yield = 100,00
 : DPMO = 0,00
 Mean: 0,8 mm
 Standard Deviation: 0,1 mm

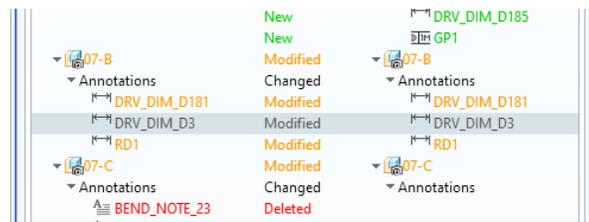
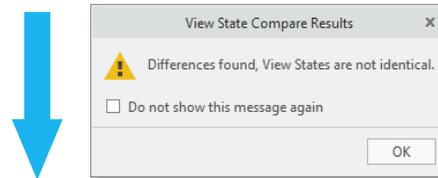
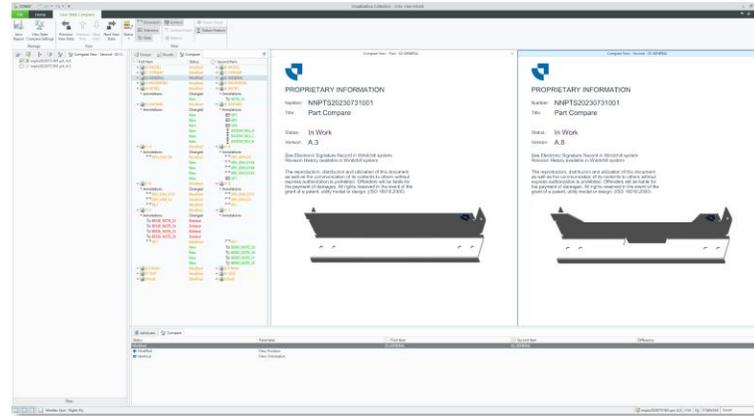
Benefits:

- This tool has the potential to be utilized as early as the prototype phase of a design.
- Its ability to **quickly provide insights** into a design's tolerance sensitivity.

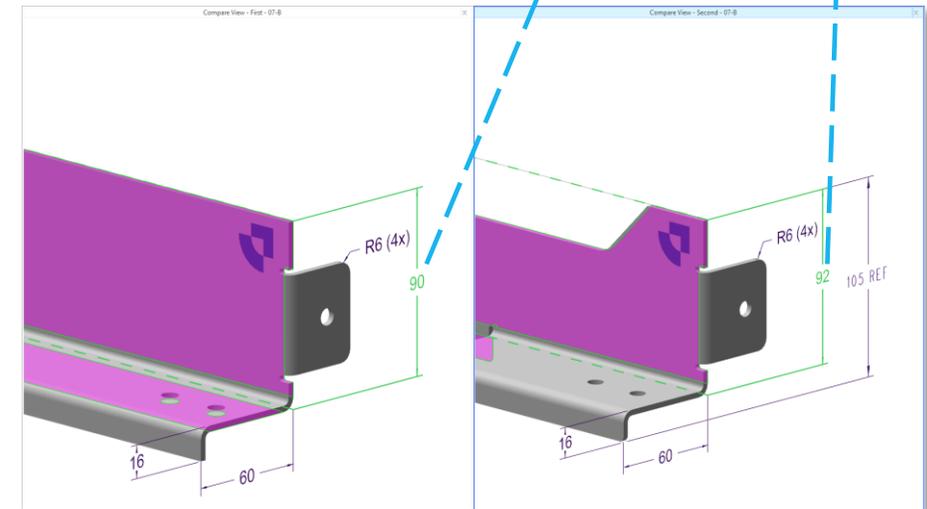
Vizualize Changes ©innoptus



Creo Parametric



Status	Parameter	First Item	Second Item
Modified	Visibility	DRV_DIM_D3	DRV_DIM_D3
Identical	Bounding Box	Shown	Shown
Identical	References		
Modified	PTC_DIM_NOMINAL_VAL (Model Annotation Properties)	90.000000 (mm)	92.000000 (mm)



Creo View MCAD

MBE Maturity index

PTC Virtual Event 

From Novice to Expert: Exploring the MBD/MBE Maturity Matrix



Wednesday, September 17, 2025

Europe: 14:00 CEST
Americas: 12:00 PM EDT/ 9:00 AM PDT

[Register Now](#)

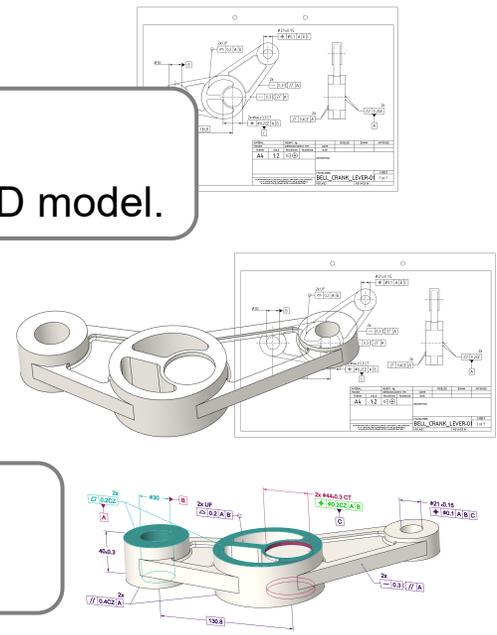
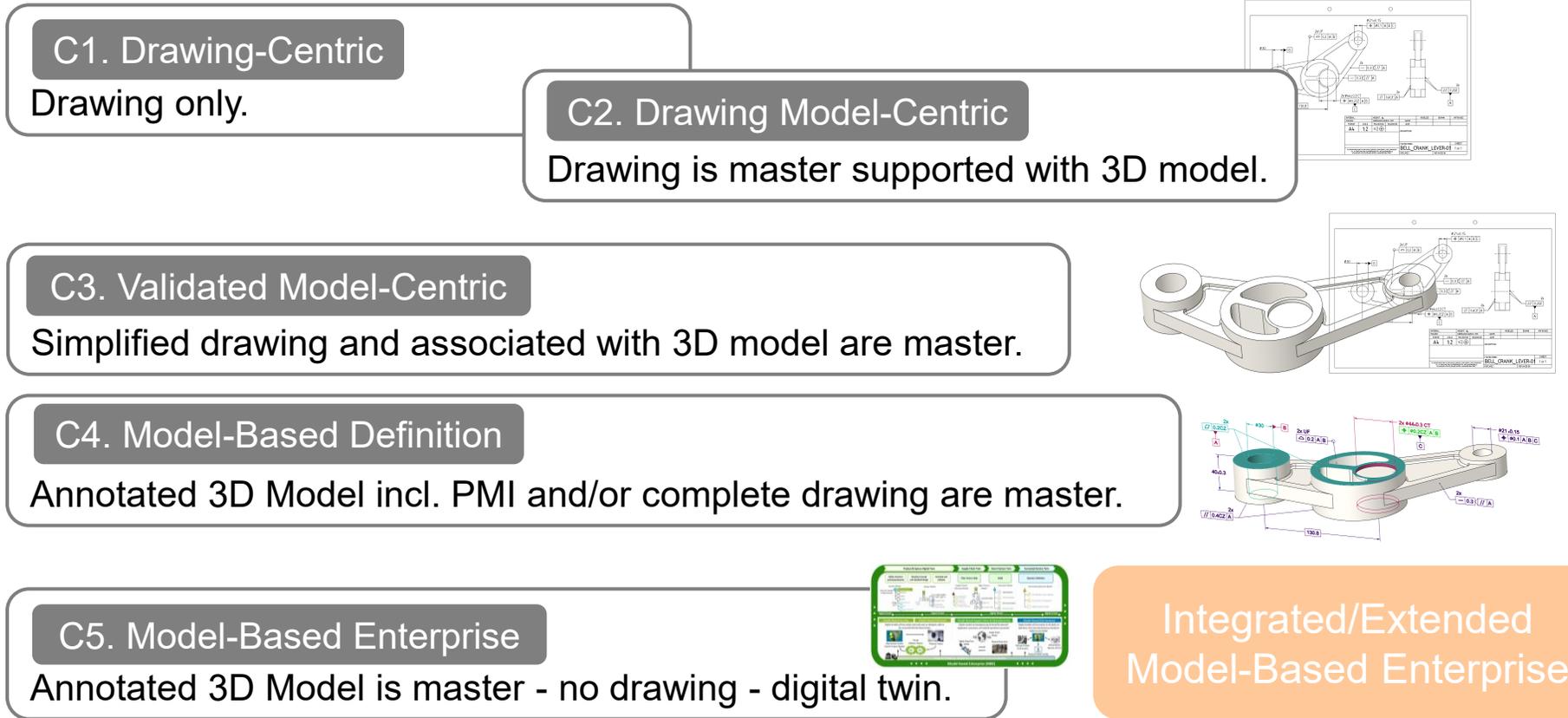


In this webinar you'll learn:

- How to assess your current MBD/MBE maturity level
- What investments and capabilities are required to move up the curve
- The tangible business value of a model-based approach
- Next steps to take in your digital transformation

MBE Maturity index

- Sandia National Laboratories - NSE MBE Maturity Index Issue C. A tool to gauge the readiness of an enterprise/supplier to effectively use MBD.
 - <https://www.sandia.gov/mbit-mbe/2025/04/11/nsc-mbe-maturity-index-issue-c/>



ISO 16792	Maturity Index
Code 1	Level 0
Code 2	Level 1
Code 3	Level 2
Code 4	Level 3
Code 5	Level 4
NA	Level 5
	Level 6

Integrated/Extended Model-Based Enterprise

MBE Maturity index

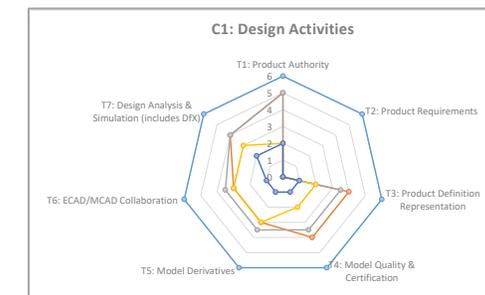
Framework used to assess an organization's - incl. suppliers - progress in adopting and implementing Model-Based Engineering (MBE) practices.

Assessment Identifier (AID):	Organization under assessment (OUA):	Description of Environment:	Assessor:	Assessment Date:	Target Date/Event:								
NSE MBE Maturity Index Rev: NO-VBA BVD01													
Maturity Level Name/# Categories (e.g., C1) Topics (e.g., T3) Facets (e.g., F2)	Description: How the organization ... Transition: As maturity increases, the organization's ...	Drawing-Centric	Drawing Model-Centric	Validated Model-Centric	Formalized Model-Based Definition	Trusted Model-Based Definition	Integrated Model-Based Enterprise	Extended Model-Based Enterprise	Weight Factor for Topic/Facet (0,2,5,8,10)	AS-IS Level			TO-BE Level
		L0	L1	L2	L3	L4	L5	L6		Capability: Tools are Available?	Readiness: Processes are Ready?	Adoption: People are Using?	Target Adoption
C1: Design Activities	Activities involved in designing a product. Product definition becomes a trusted model-based definition dataset.	2D Drawings used for all activities	2D Drawings derived from models	2D Drawings and other derivatives from validated 3D model	Semantic PMI included within 3D model	Certified, Authorized MBD	MBD dataset made useable for all lifecycle activities within enterprise	Product definition system model made useable for all lifecycle activities	4	4,0	3,0	2,0	5,0
T1: Product Authority									4	4,0	3,0	2,0	5,0
F1: Authorized Definition	Identifies the authorized product definition (i.e. legal definition). MBD data collection becomes the product authority.	Paper 2D drawing with support documents	Electronic 2D drawing with support documents	2D drawing from 3D model with support documents and support model	3D drawing (e.g. 3D Interactive Viewable) from MBD model with support documents and support model	MBD model with support drawing and support documents	MBD dataset containing all authorized product definition artifacts	Product definition system model communicating all authorized product definition artifacts along with their relationships.	4	4	3	2	5

■ MBE Category, functional areas to be assessed:

	Capability	Readiness	Adoption	Target
C1: Design Activities	0.0	0.0	0.0	0.0
C2: Product Data Management Activities	0.0	0.0	0.0	0.0
C3: Manufacturing Activities	0.0	0.0	0.0	0.0
C4: Quality Activities	0.0	0.0	0.0	0.0
C5: Enterprise Enabling Activities	0.0	0.0	0.0	0.0

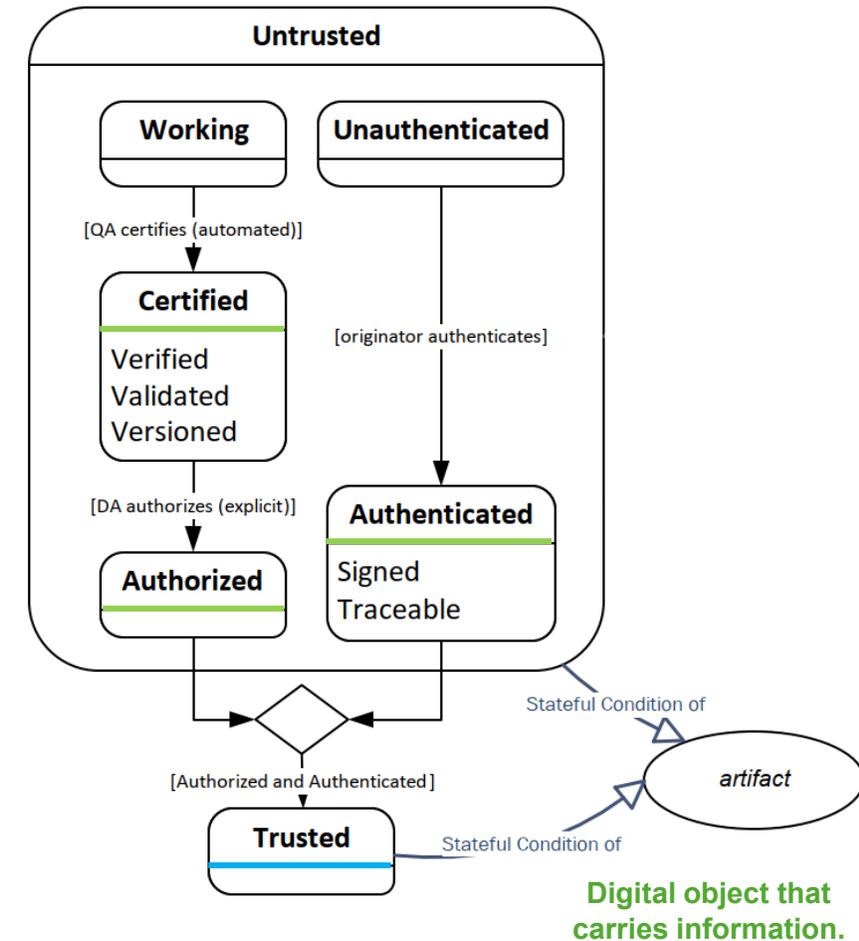
AS-IS Level			TO-BE Level
Capability: Tools are Available?	Readiness: Processes are Ready?	Adoption: People are Using?	Target Adoption



MBE Maturity index

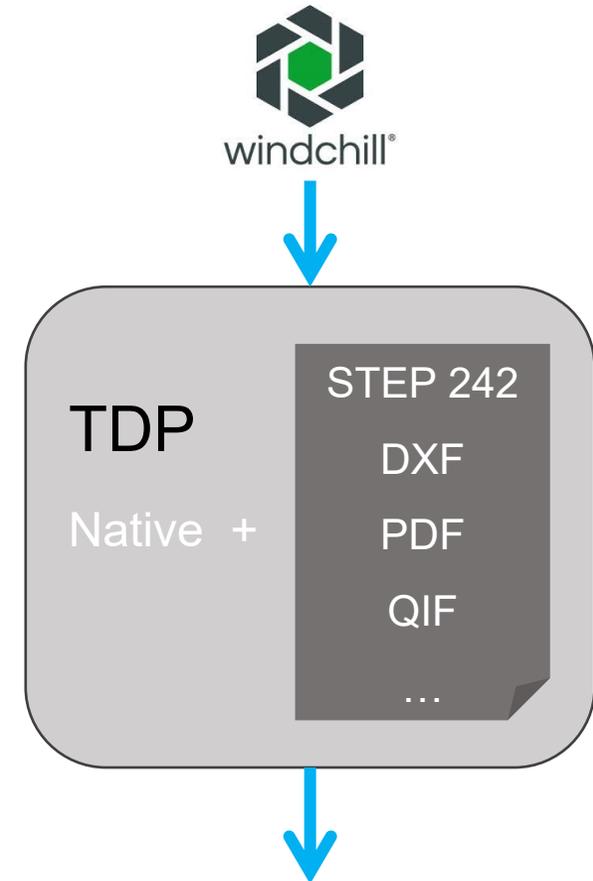
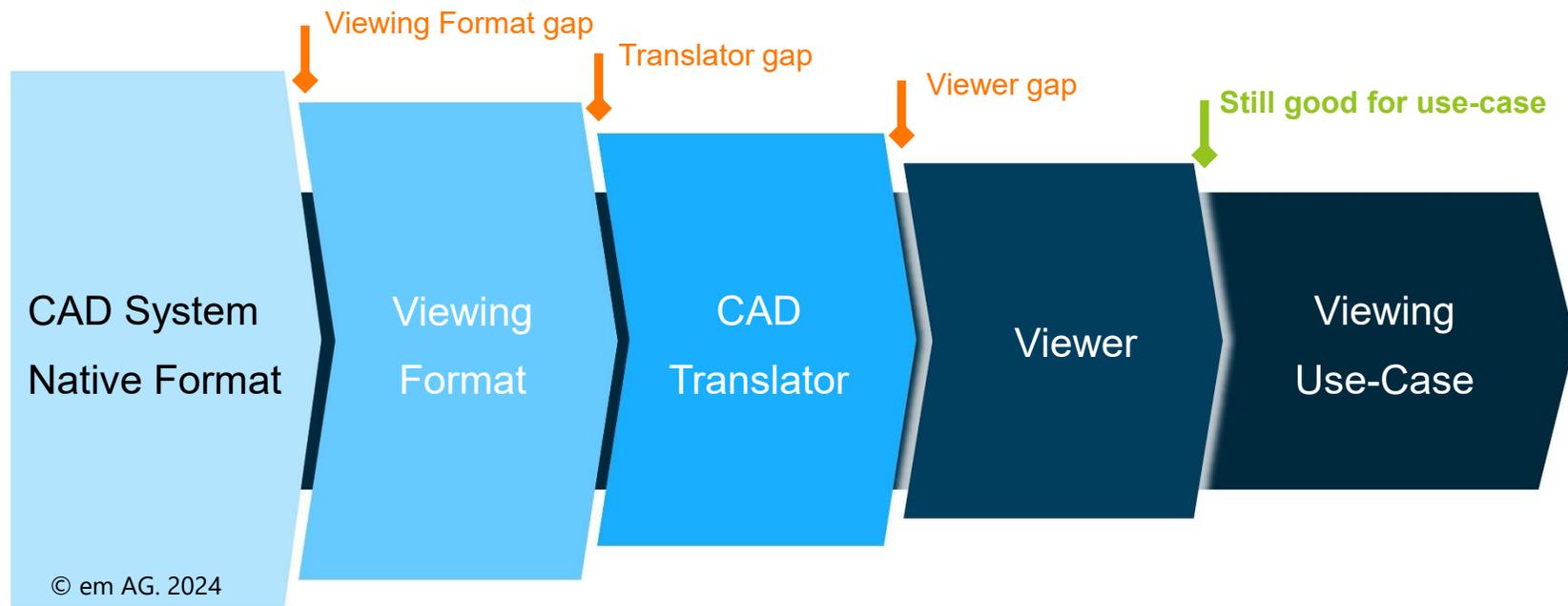
Trust Framework, embedded in the index:

- A 2D drawing often feels like the master and binding source, but that's a false perception.
- The trust framework refers to the level of confidence placed in the digital models and data sets used throughout the product lifecycle.
 - Certified: Guaranteed to conform to protocols.
 - Authorized: Approved by an authority for use in a lifecycle activity.
 - Authenticated: Proven to be genuine as issued by its originator.



Translation Gaps

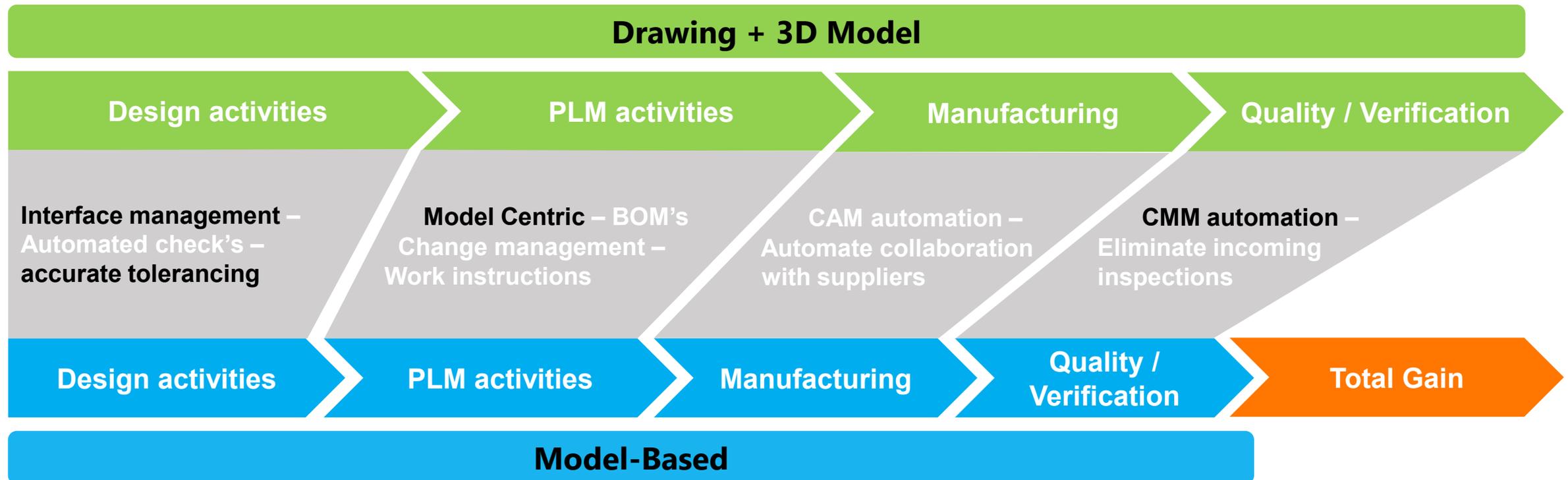
- Supplier portal PLM system
 - Automatic file generation.
 - Native files can contain company specific attributes.
- We can grow toward MBD without waiting for 100% format translation.



- CMM
- CAM
- Sheet metal
- Web/HTML
- Human readable
- ...

Conclusion: Measure the gains – Quick wins

- Use the Maturity Index to analyze current versus new methods.
- Calculate ROI.



Thank you !!!

