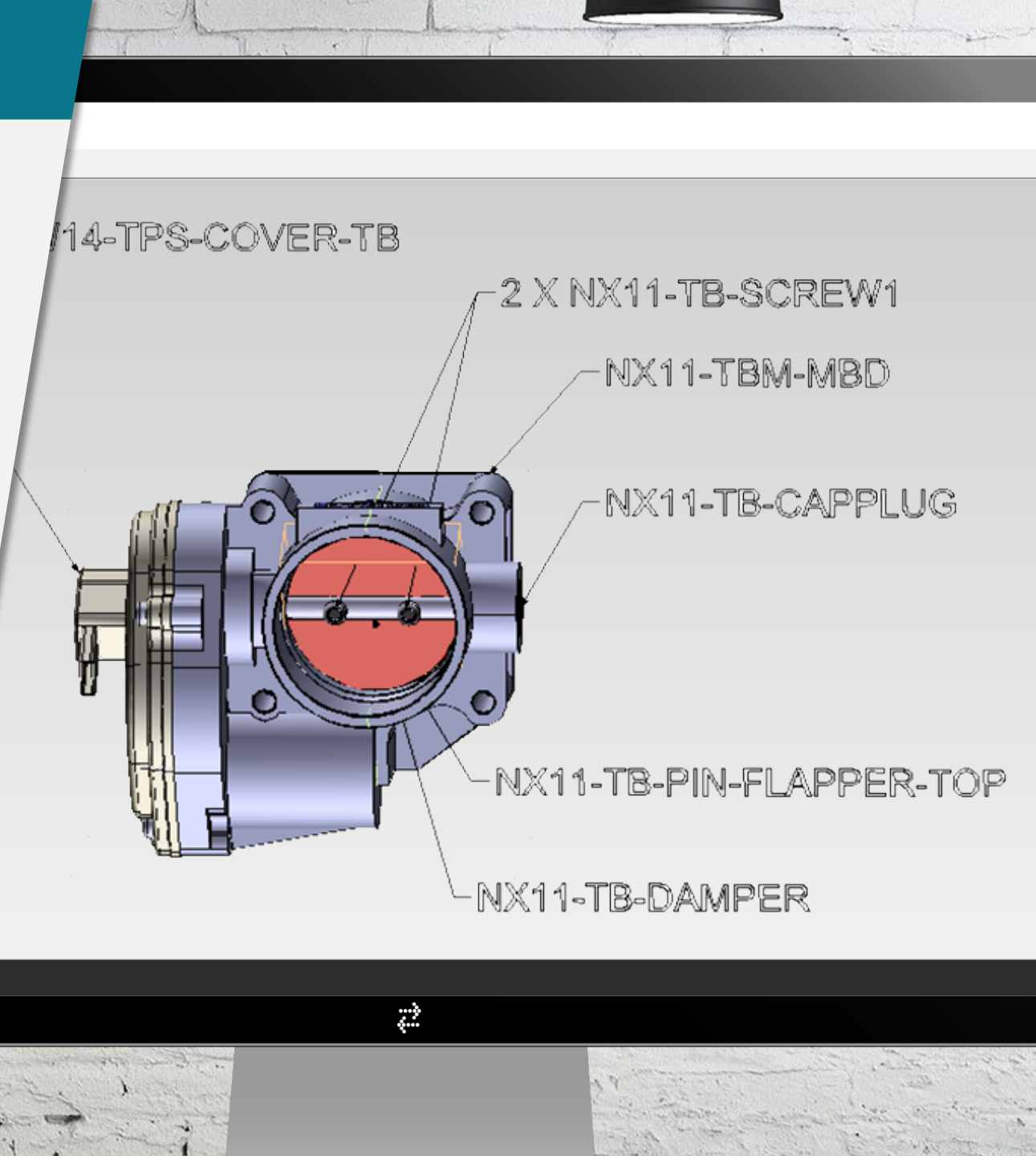
ELYSIUM

MBE Workshop

MBD File Organization

(MBD Schema)



MBD SCHEMA

- An MBD Schema is a documented set of methods and processes that govern how to organize the complete product definition within a native CAD model.

- Subsequently any consumer of the MBD data can use the Organizational Schema to determine how to view the file contents and navigate the documented product definition.
  - Can provide the rules for automated software extraction of the Product Definition for derivative file creation.

A list of <u>your</u> rules for creating the 3D product definition
and also the rules for reading what has been created.

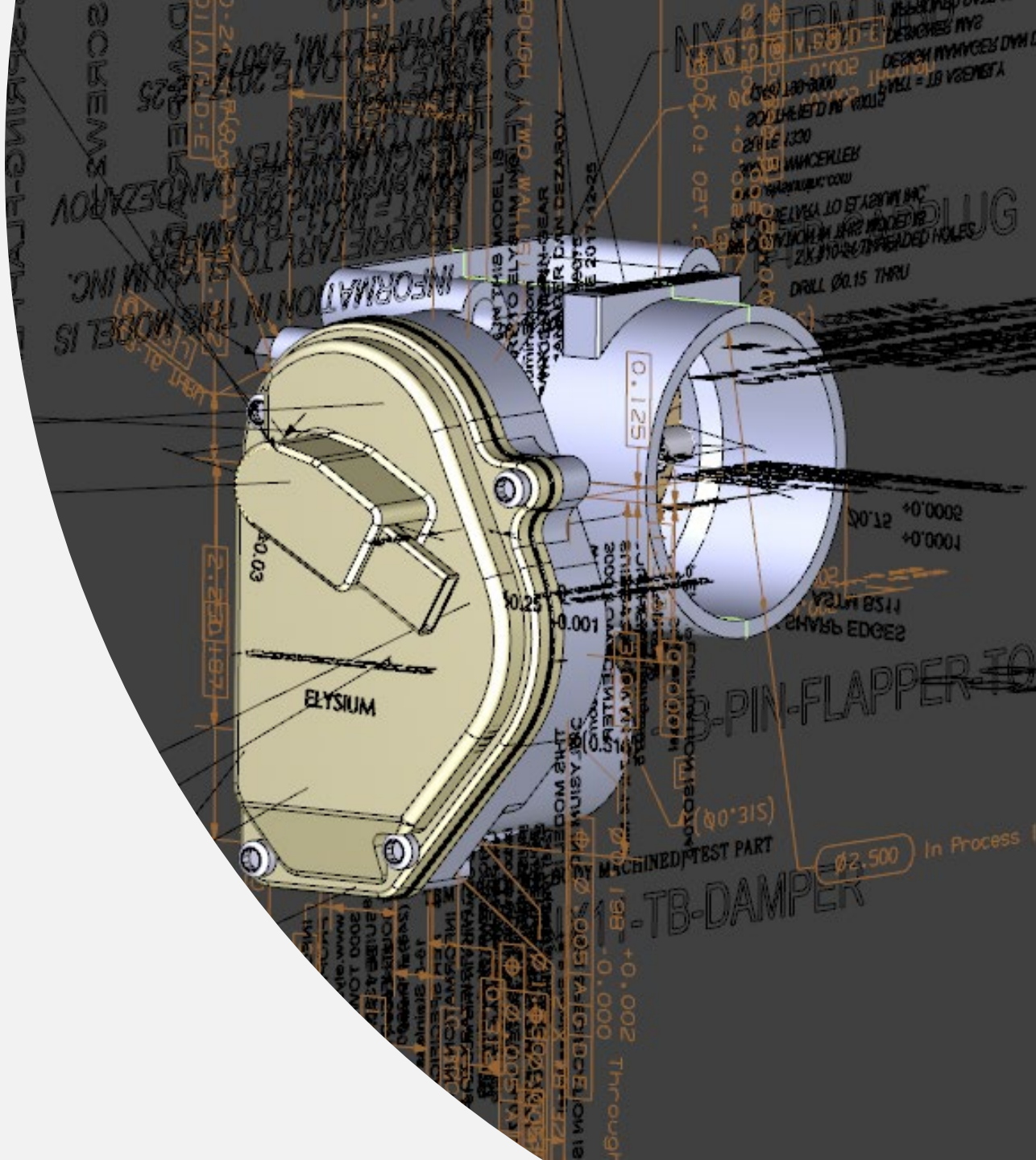
MBD Schema

An MBD Schema Should consist of:

- **View States** (Presentation States as described in (Future) standard ASME Y14.47)
- **PMI**
- **Attributes/Parameters/Properties**
  - Variables used to define product definition Meta-Data (like Material, Approved By,…)

An MBD Schema could include:

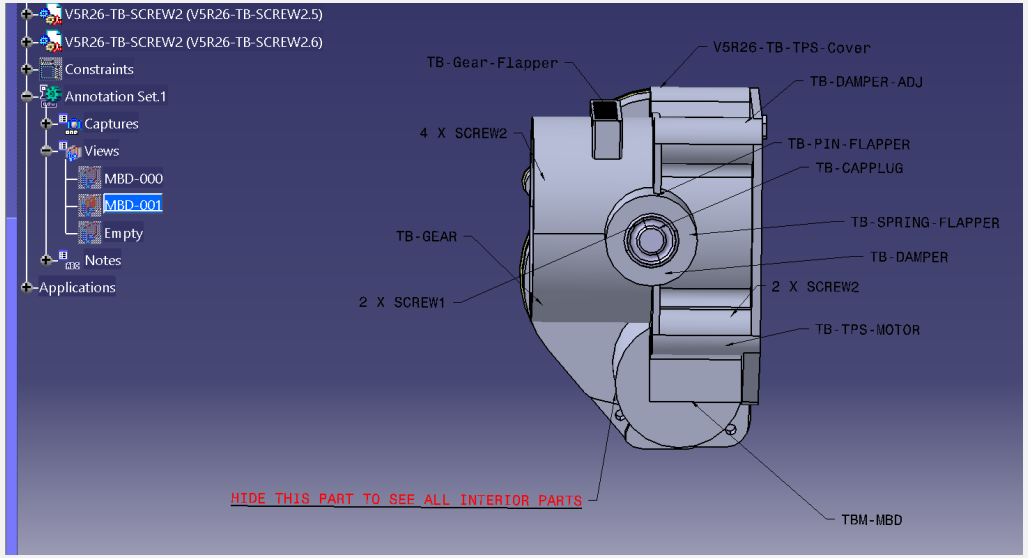
- **Modeling Methods** (Company CAD Standards could be included)



CONTENTS OF AN MBD SCHEMA

- View State naming convention
- How you will define PMI; as Presentation or Representation
- How you will define PMI; as complete or limited
  - If limited is used, what is the method for the determination of ambiguous information? (For Human Visualization in Presentation mode)
- How you will Define if you are using GD&T or Linear dimensioning tolerances, or both? (Both is okay)
- Define where associated data/lists are coming from
- Define contents of Attributes/Parameters/Properties
- Sometimes; Define modeling methods to ensure good reuse of PMI

- For consumer usage: (TDP) (What Derivative Models/files will be created)
  - Native CAD or other solid model types.
  - Archive File type (STEP AP203, AP214, AP242, QIF)
  - Lightweight viewing file (3-DPDF, JT, 3D-XML or others) (Viewing software requirements)



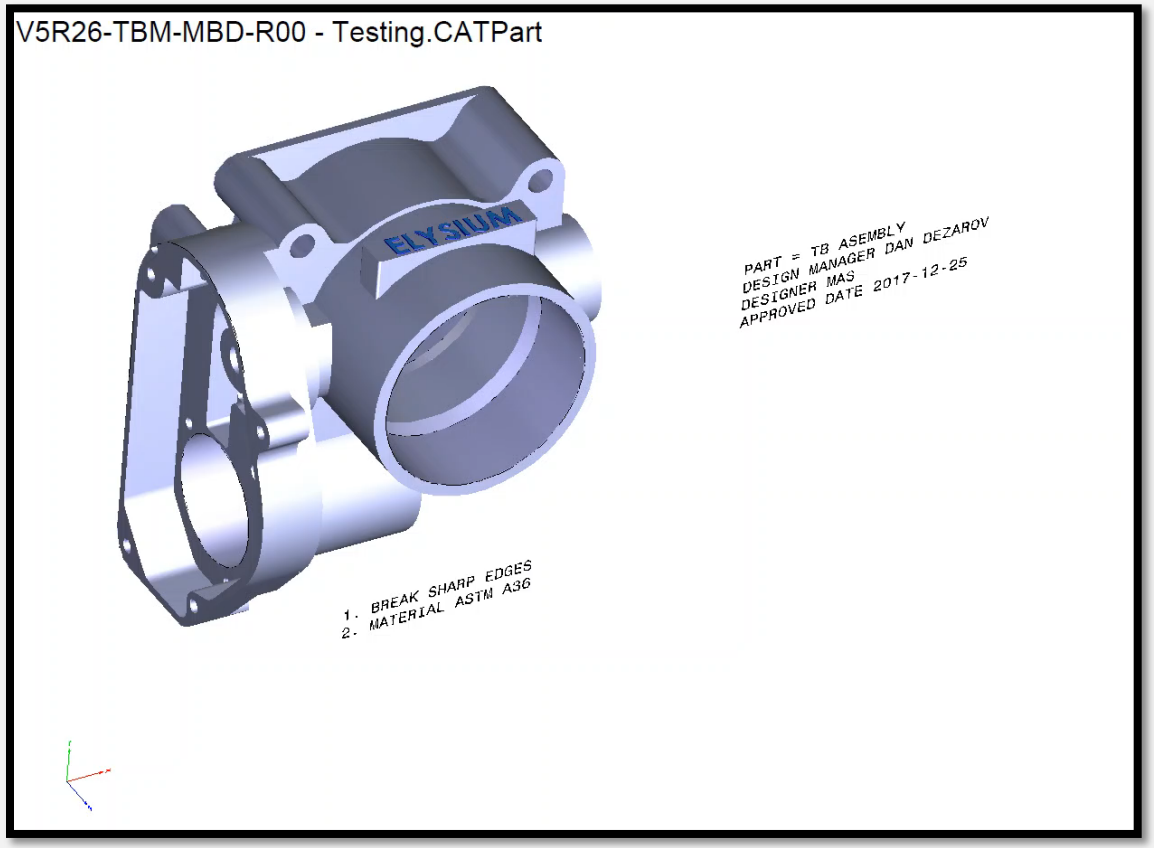
MBD Schema is used by designers and consumers of the data.

VIEW STATES

"View State" in this document is intended to represent the object name of a CAD model "Named View" which is a key component of an MBD Schema.

In this context a View State will hold all the settings (zoom, orientation view point, section, object visibility,…) and objects to show consumers of the technical data.

Multiple View States should provide complete product definition.



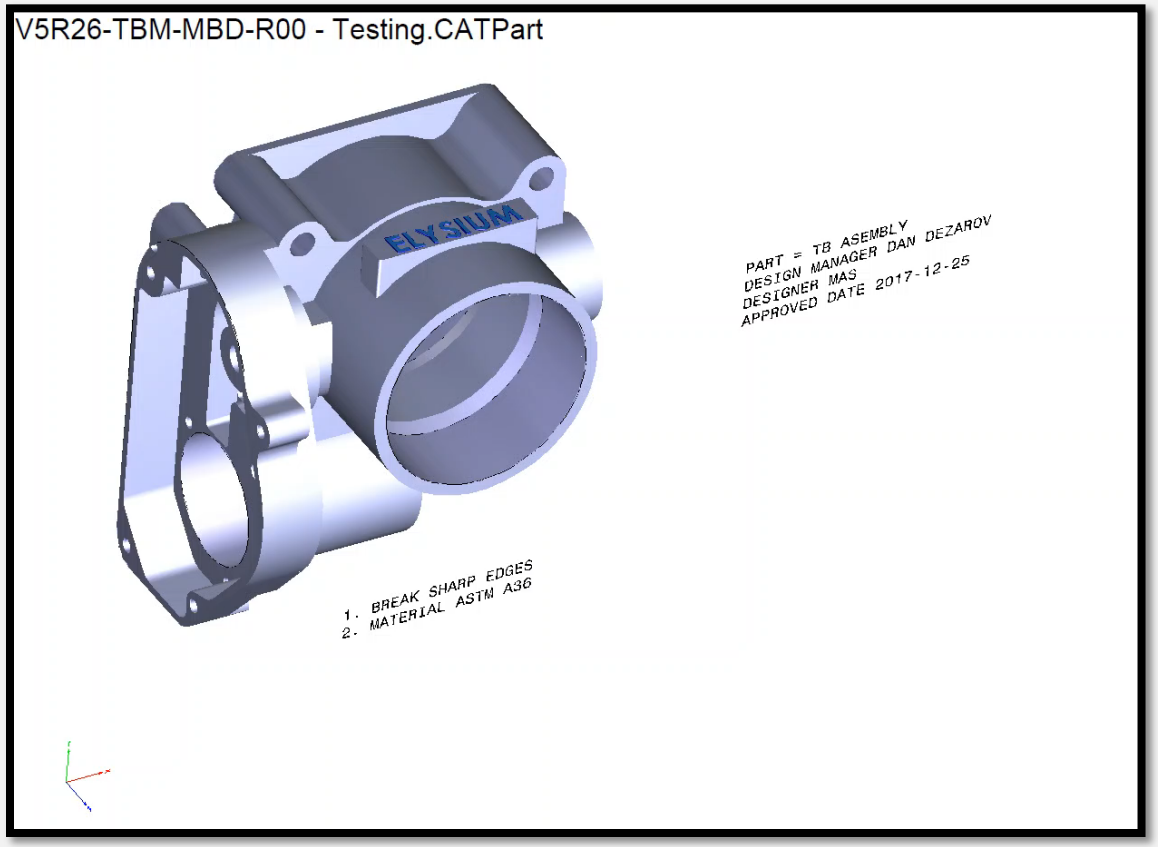
Synonyms:

- Presentation State (Possible future release of ASME Y14.47)
- All State (Creo)
- Model View (NX)
- Capture (CATIA)
- 3D View Captures (SOLIDWORKS MBD)

View States

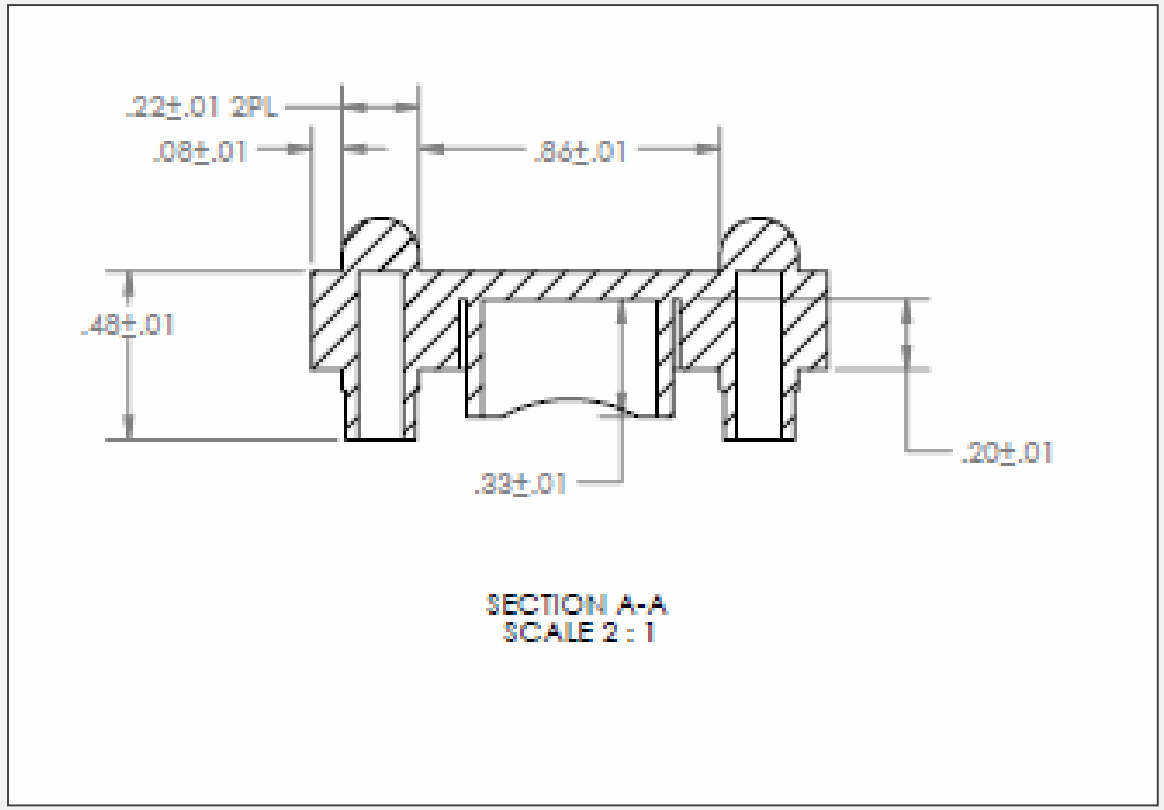
A “View State” is similar to a “Drawing View” but unlike a drawing view a “View State” in a CAD model is dynamic.

As soon as a View State is visible, it can be manipulated (Zoom, Pan, Rotate) with a mouse or other input device.



Drawing View States

- On 2D Drawings, Drawing Views are named in some manner.
- Front, Top, Left. Perhaps on the first sheet (or just one view on some drawings).
- Subsequent views are identified for where the viewpoint is.
  - Section Views
  - Auxiliary Views
  - Detail Views
- When reading 2D drawings, you are reading the “Story” about that product as the designer determined you should, based on the various view types and where they were defined.



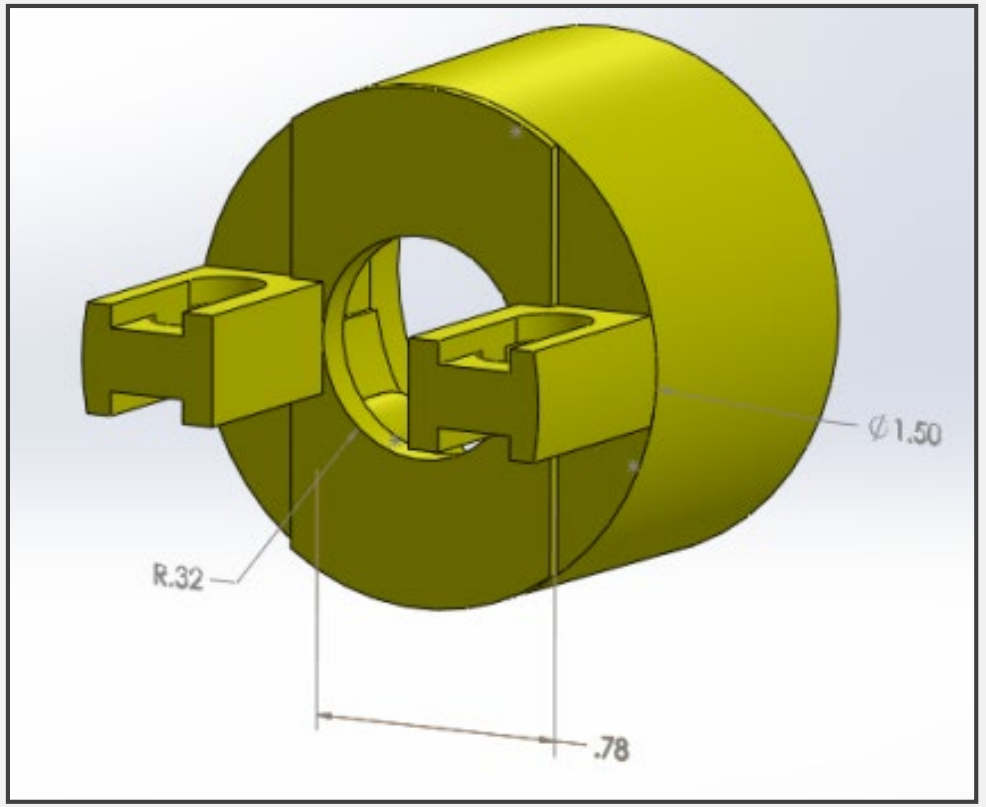
MBD Model View States

"Named View States" consist of the orientation, magnification and position of the solid model as it is viewed in the CAD system.

This is done based on how "You, the Designer" want the visual communication of the product design presented to the consumers of that data. (Similar to Drawings)

In most CAD systems View States can also include:

- Section views
- Exploded views
- Hidden component views
- Configurations



View State Naming Conventions

MBD_xyz?

Xyz_MBD?

XYZ_MBD01_Name?

Name_XYZ_MBD01?

How do you think your MBD views should be identified?

XYZ_001?

001_XYZ?

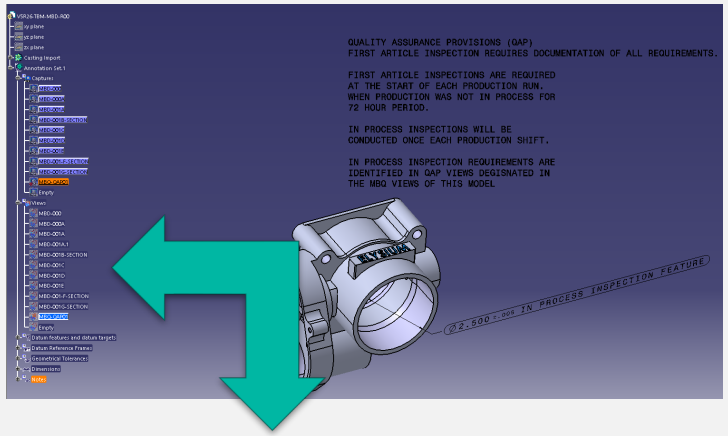
XYZ-mech?

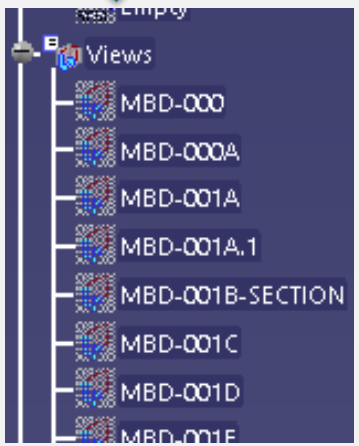
XYZ-elec?

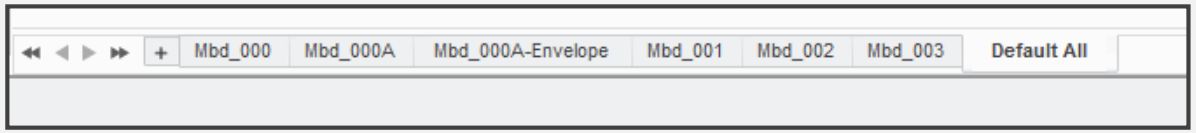
Who doesn't love wingdings?

View State Naming Convention

- 2D Drawings use view, section and detail callouts to define viewing order.
- MBD view state names can be used to define the desired viewing order.
- Naming Convention: (Choose one or create your own)
  1. MBD_001, MBD_002, MBD_003...
  2. 001_front, 002_right, 003_top...
  3. 001-mech interface, 002-elect interface...
  4. Substitute MBD for MBM, MBQ, ... (to represent definition, machining or quality)







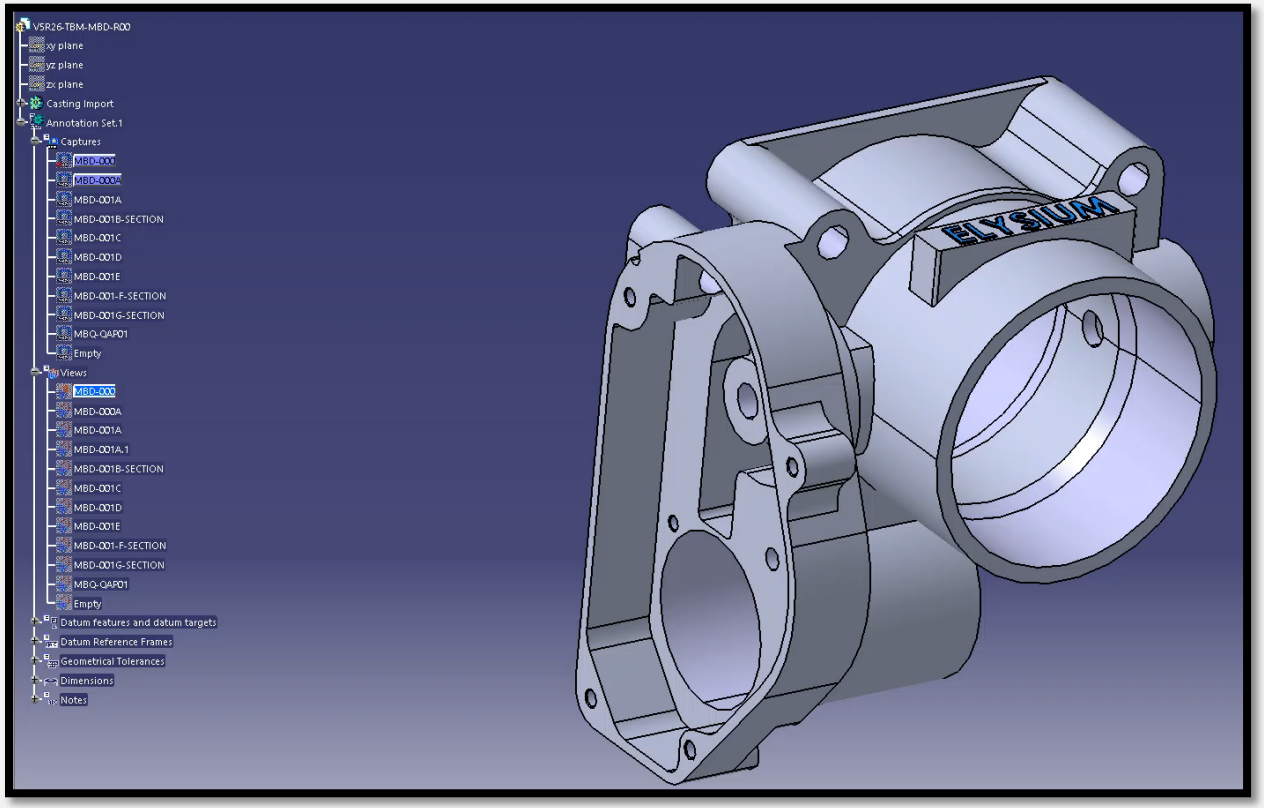
Use Alpha/Numeric sorting rules to define the order you want to present.
(In what order do you want your product definition consumed?)

PMI Settings of View States

Within the organizational structure of the View States PMI can be placed.

In order to place PMI some additional Structure is required.

- Annotation Planes
  - An Annotation plane is a defined plane where an annotation can be placed on it or parallel to it facilitating the reading of the PMI from top to bottom and left to right as English is read.
- View settings
  - Save each view so the initial view point is as the designer wants to tell the story.
  - The consumer can always rotate the view for more clarity as desired.
  - Views can be defined and saved as Orthogonal or Axonometric views it is the designer's choice



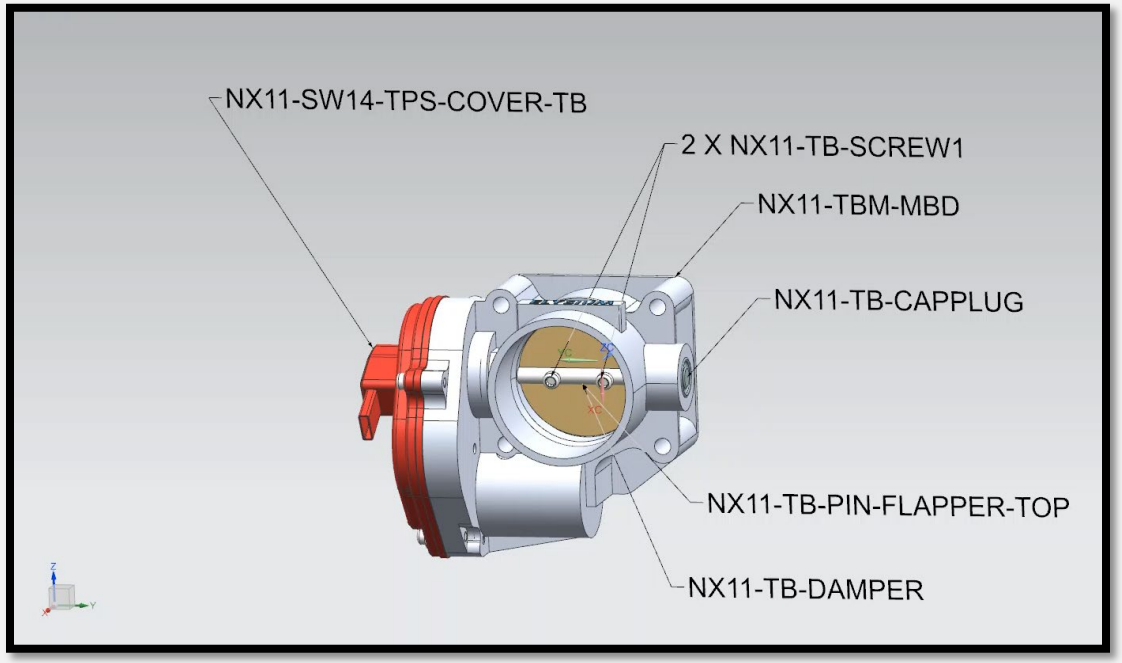
PMI Settings of View States

Annotation Planes:

- Annotations can be locked to that plane or depending on CAD system and settings could be dynamic and flip as the CAD model is rotated.

- ASME 14.41 specifies the ability for text to flip “To Ease reading”. This function can be turned off in most CAD systems where it is possible.

- A reason for not allowing this functionality is because a user might get their CAD file set to have everything visible per their needs, but the PMI might have been established with the model rotated so the positional settings for the PMI is backwards relative to the natural annotation plane reading direction. When using translation tools this flipping of text might not be accounted for and the translated model might show the text out of reading direction. **Not All CAD systems allow the flipping of text as the model is rotated.**



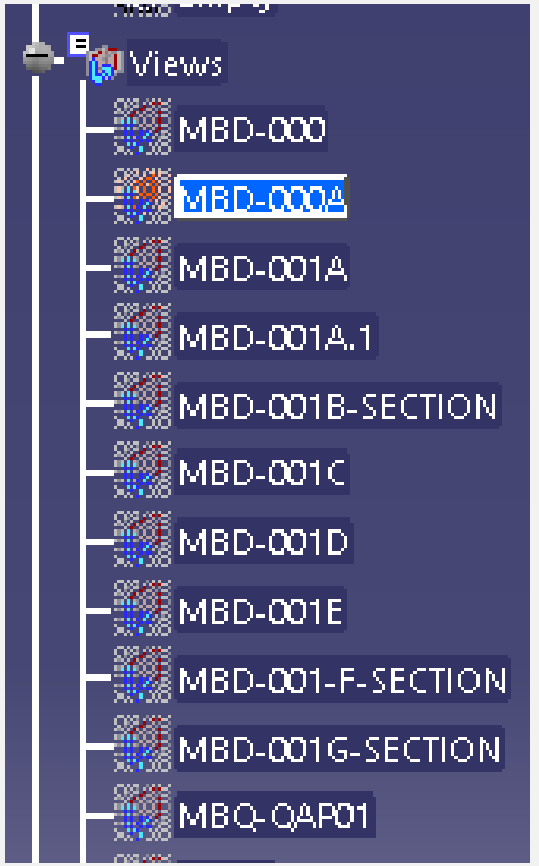
A best practice might be to turn off the text flipping functionality as PMI is created and View States are saved. After the PMI is completely defined, the text flip functionality should work without adverse downstream issues.

Prefix Suggestions for View States

Prefix acronyms (Some possibilities to consider)

- MBD Model Based Definition
- MBQ Model Based Quality (QAPs)
- MBI Model Based Inspection (Key and Critical)
- MBF MODEL Based Fabrication
- MBSE Model Based System Engineering
- ... (many more, its your decision)

A highly suggested quasi-requirement is to use Alpha Numerical naming convention so sorting on View Names will allow the definition of desired read sequence automated extraction of View States for inclusion into derivative file formats.

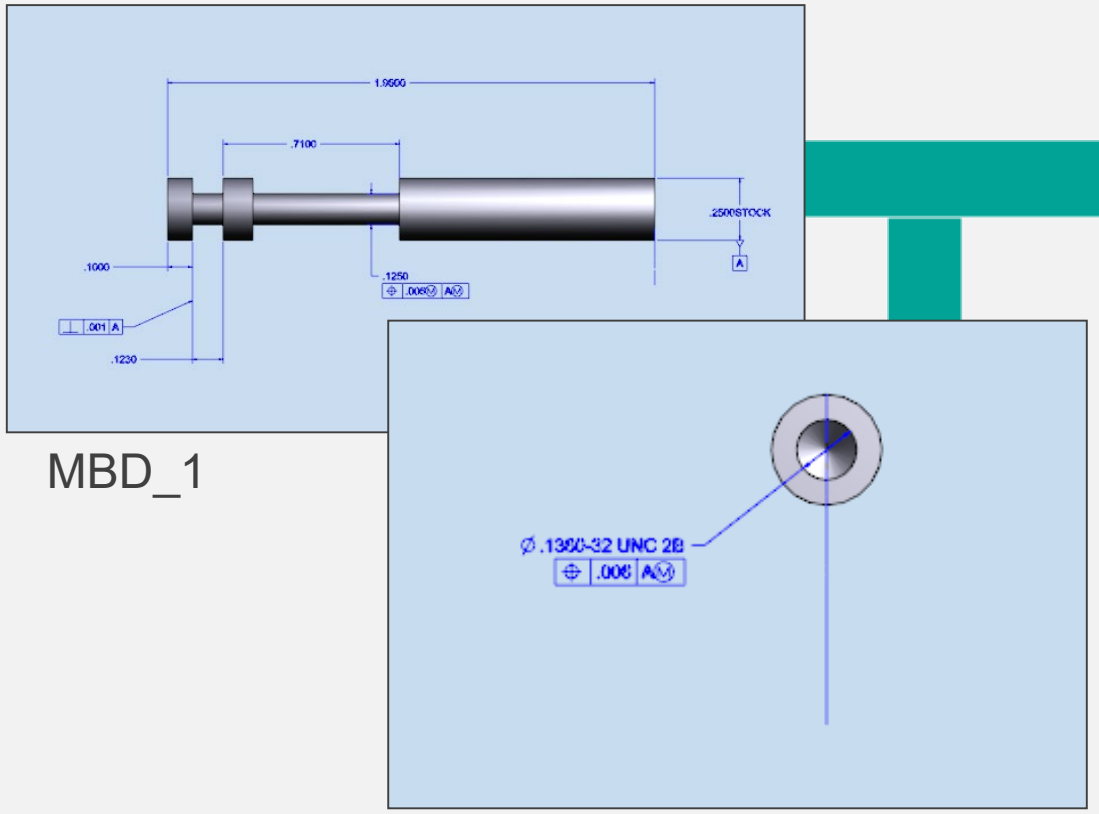


Consider, MBQ Views could be split off to be separate QAPs for government use or Critical Key Characteristic or inspection methods/frequency for commercial use.

Orthogonal or Axonometric View States

Two Orthogonal views or one Axonometric view could be used to show the same thing.

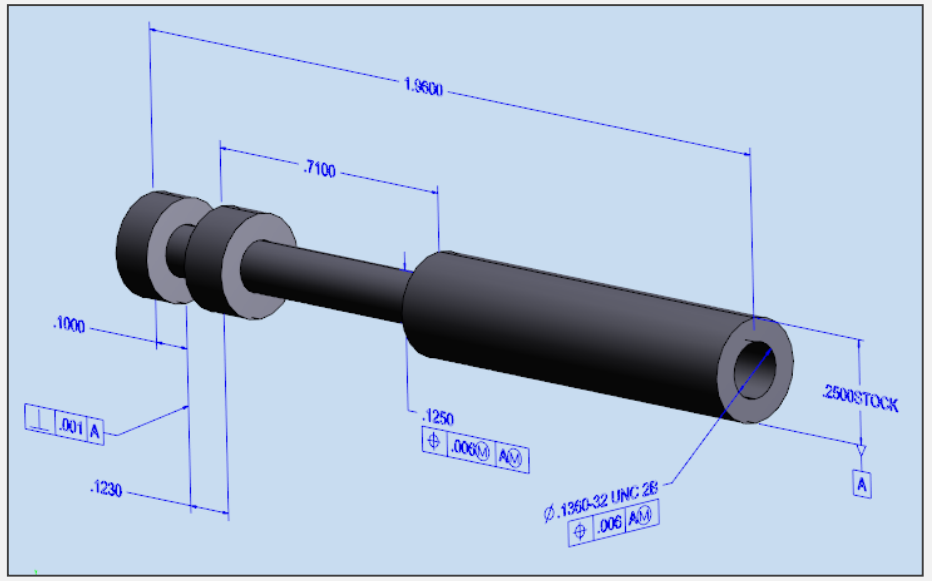
Orthogonal



MBD_1

MBD_2

Axonometric



MBD_1

View States - Metadata, Proprietary information display

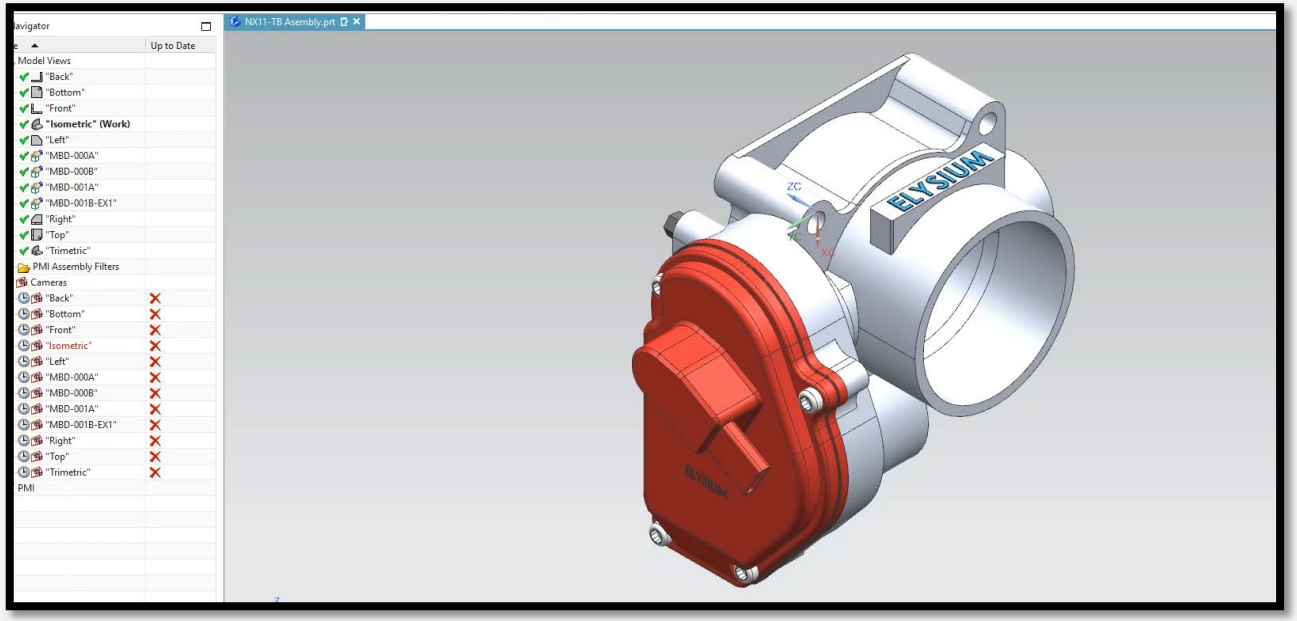
Flat or Parallel to screen annotation planes can be used for Proprietary or other note display.
Flat or Parallel to screen notes can be used with dynamic model and PMI display to enhance the consumer experience.

PLACE Your Propriatary NOTE Here

CONTENTS OF THIS FILE ARE COMPANY PRIVATE
AND CONTROLLED BY INTERNATIONAL COPYRIGHT LAWS
IT IS NOT PERMITTED TO VIEW CONTENTS OF THIS FILE UNLESS YOU ARE AUTHORIZED

IF YOU HAVE RECEIVED THIS FILE BY MISTAKE PLEASE CONTACT:
INFORMATION OFFICER
XYZ COMPANY
GREENFIELD ROAD
DETROIT MI.

MBD-000-Propriearty



Proprietary or Legal notes can be saved to be the default view as CAD and various derivative files are opened. This is suggested practice.

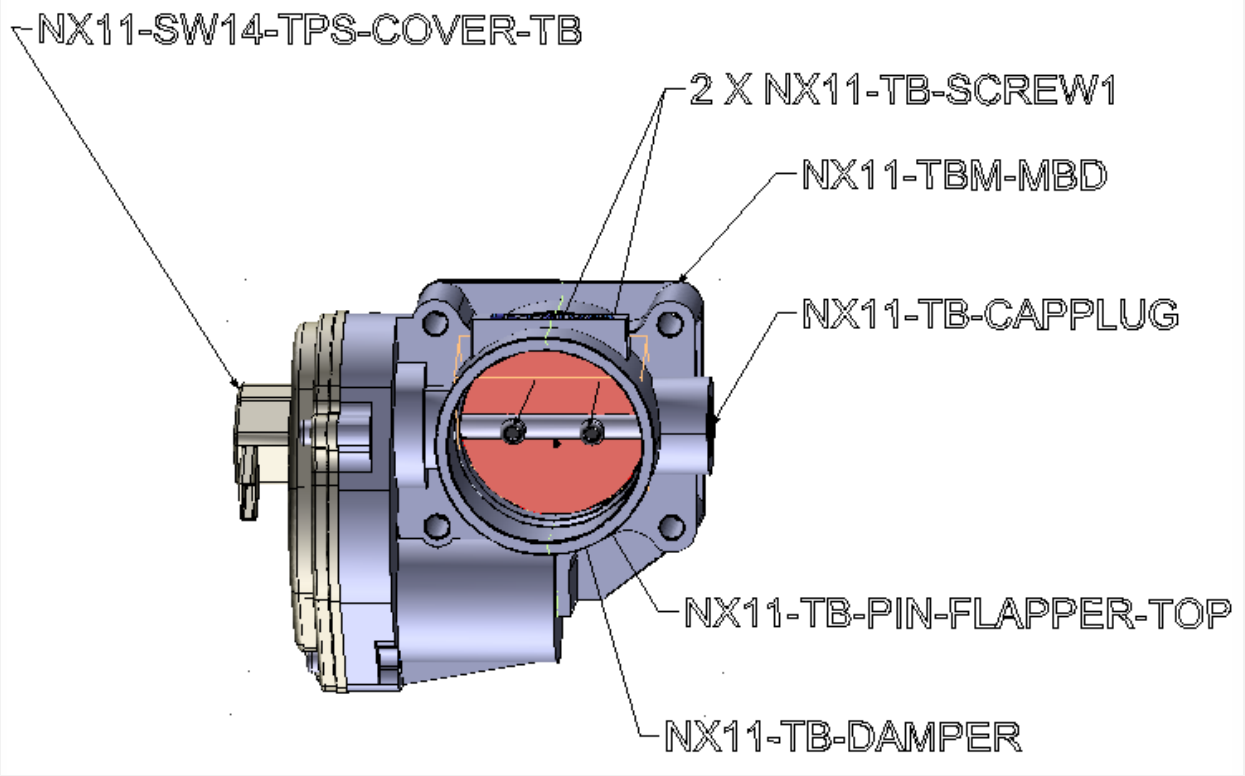
CONTENTS OF A MBD SCHEMA

How you will define PMI; as Presentation or Representation?

Presentation PMI is purely for human consumption.

The reason for it being “Presentation”

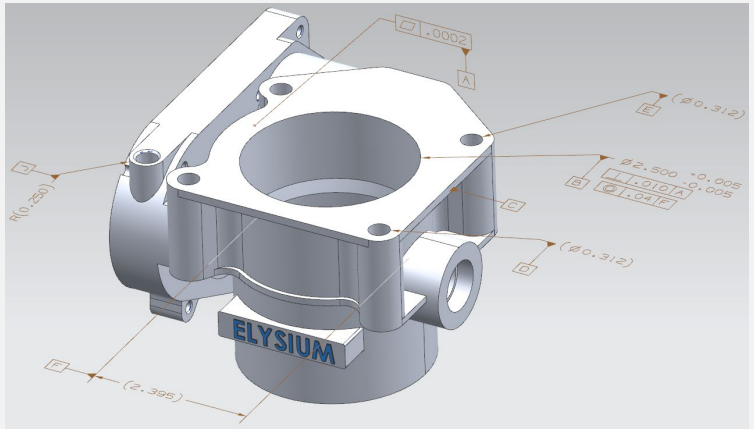
- Might be due to being made of polylines instead of alpha numerical characters.
- Might be alpha numeric characters which is understandable to humans who read it but not be understandable to computer systems in its meaning.
- The CAD system did not create it with semantic meaning.
- In the CAD system it cannot be edited with a dialog box , a freeform text editor might be needed.



CONTENTS OF A MBD SCHEMA

How you will define PMI; as Presentation or Representation?

- Representation PMI is for automatic/programmatic consumption.
- The reason for it being “Representation”
  - It consists of alpha numerical characters added by selections in a dialog box.
  - No freeform text editor input.
  - The contents of what is said is understandable in its meaning.
  - The CAD system needed to have created it with semantic meaning.
  - In the CAD system it can be edited with a dialog box , not a freeform text editor.



In the context of CAD MBD models, there are two meanings of Semantic (Related To). Both meanings are required to be fully semantic.

1. The PMI Entity is physically related to the geometry that it is describing. (Ex. A hole callout is tied to the geometric representation of that hole) both visually and behind the scenes in the CAD system.
2. The definition of what is said in the annotation can be understood to represent a process or QA requirement. (It should be created by a CAD system dialog box and editable by that same method).

If Representation PMI is done right it will serve Presentation needs as well.

Contents of a MBD Schema

How you will define PMI; as Complete or Limited Annotation sets?

Complete Product Definition

- There will be no ambiguity in the resulting model data set.
- This is the same as a “Level 3” drawing
  - Every aspect required to create the physical product needs to be clearly defined within the model and easily extracted for use.
- Must be careful to avoid the “furball”
  - Intentional views can be created to section out specific sets of information. These views can provide representative data, presentation data, or both.

Limited Annotations

- If limited is used, what is the method for the determination of ambiguous information?
- ASME Y14.41 supports the limited method to a degree. (7. Model Values and Dimensions)
  - For GD&T, Model dimensions not shown are considered to be basic dimensions.
- If you already do 2D this way
  - There are less new processes to define as MBD is implemented.
  - You already have limited methods defined in the 2D world.
- It might be harder to automate processes that utilize limited annotations.
  - There might be more human reasoning required to complete processes that rely on less embedded information.

CONTENTS OF A MBD SCHEMA

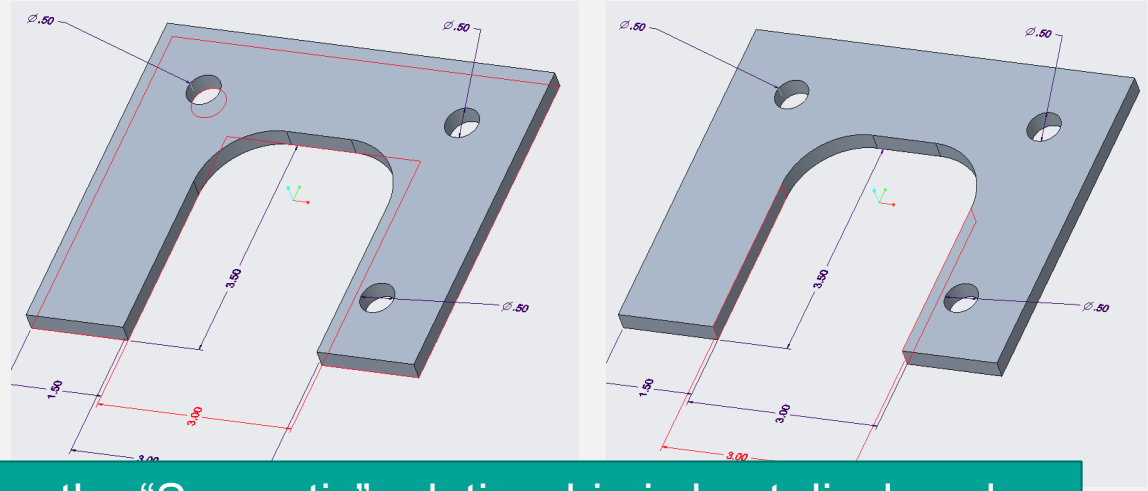
How you will define PMI annotations; as Driven or Driving?

- **Driven Dimensions**
  - Usually using the PMI creation menu within the CAD system to add individual PMI entities.
  - This type of dimension is driven from the model.
- **Driving Dimensions**
  - This type of dimension is reusing the geometry creation dimensions as shown in 3D space.
  - Dimensions from the base sketch, extrusion, hole size from sketches or geometry creation, shown in 3D space.

Shown to right:

First picture shows Driving dimension shown from sketch, entire sketch highlights.

Second picture shows Driven dimension from PMI creation menu, highlighted surfaces.



Recommendation: Use the method where the “Semantic” relationship is best displayed.

CONTENTS OF A MBD SCHEMA

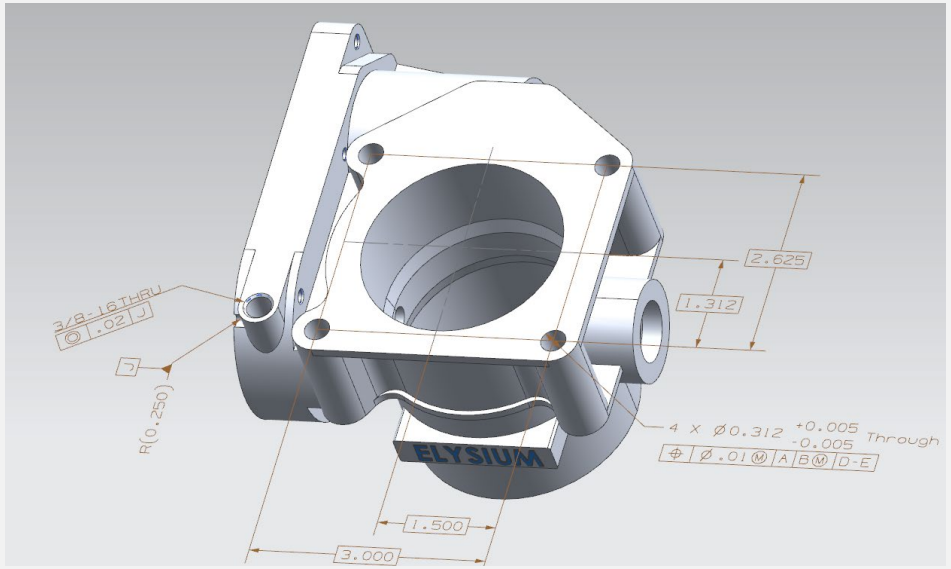
GD&T / Linear

- GD&T or Linear Dimensioning Tolerances, or both?

- Use whatever method you are best able to use across your enterprise.
- The simple fact you are going to use MBD will begin to improve your cost.

- GD&T has associated savings all by itself.
  - GD&T or not should be a discussion separate from MBD
  - When GD&T is used in conjunction with MBD more possibilities emerge.
    - Increased savings within the manufacturing environment**
    - Increased savings within the Quality Control environment **

** When properly applied and used.



There are ways to improperly use GD&T so that cost is higher;
Use an expert to oversee the design and subsequent interpretation of GD&T.

CONTENTS OF A MBD SCHEMA

Associated Data/Lists

BOM Level	Part Number	Part Name	Revision	Quantity	Unit of Measure	Procurement Type	Reference Designators	BOM Notes
0	20-0001	EveryRoad GPS, Shippable, US Model 300	B		each	MTS		Complete packaged unit
1	20-0002	EveryRoad GPS Car Navigation Unit - Model 300	B	1	each	MTS		Product Only - no packaging
2	20-0003	EveryRoad, Front Bezel Assembly	A	1	each	OTS		
3	40-0011	LCD	A	1	each	OTS		
3	50-0012	EveryRoad, Front Bezel	B	1	each	MTS		
3	50-0080	Gasket, Screen, 3.5in	A	1	each	MTS		
2	20-0004	EveryRoad, Rear Assembly	B	1	each	MTS		
3	20-0015	EveryRoad, PCBA, Model 300	B	1	each	MTS		
4	40-0035	EveryRoad, Circuit Board	A	1	each	MTS		
4	40-0038	GPS Micro controller	A	1	each	OTS	U2	
4	40-0039	USB Connector	A	1	each	OTS	J4	
4	40-0041	0.1uF Ceramic Chip Capacitor	A	5	each	OTS	C15, C6, C10-12	
4	40-0042	10k Resistor	A	8	each	OTS	R1, R5, R11, R12, R14, R16, R23, R24	
4	40-0043	1k Resistor	A	4	each	OTS	R25, R38, R31, R32	
4	40-0044	1.0uF Ceramic Capacitor, 1206	A	1	each	OTS	C3	
4	40-0045	Low-dropout 5.0V 100mA Voltage Regulator	A	1	each	OTS	VR1	
4	40-0046	100ohm Resistor	A	1	each	OTS	R44	
4	40-0047	51k Resistor	A	1	each	OTS	R4	
4	40-0048	470k Resistor	A	2	each	OTS	R8, R13	
4	40-0049	500mW NPN Transistor	A	2	each	OTS	Q5, Q9	
4	40-0050	Small-signal PNP Transistor	A	2	each	OTS	Q2, Q4	
4	40-0051	470 ohm Resistor	A	1	each	OTS	R15	
4	40-0052	Tantalum Capacitor 10uF@16V,B pkg	A	1	each	OTS	C9	
4	40-0053	Tantalum Capacitor 4.7uF@4V,A pkg	A	3	each	OTS	C1, C4, C8	
4	40-0054	Voltage Detector CMOS 4.3V SOT23	A	1	each	OTS	VD1	
4	40-0055	220k Resistor	A	1	each	OTS	R40	
4	40-0056	1M Resistor	A	2	each	OTS	R2, R9	
4	40-0057	0.01uF Ceramic Chip Capacitor, 0603	A	2	each	OTS	C5, C7	
4	40-0058	47 ohm Resistor	A	2	each	OTS	R3, R17	
4	40-0059	Small-single NPN Transistor	A	2	each	OTS	Q1, Q8	
4	40-0061	N-Chn Enhan-Md MOSFET	A	1	each	OTS	Q6	
4	40-0062	3k Resistor	A	1	each	OTS	R29	
4	40-0063	Exclusive Or Gate single	A	1	each	OTS	U1	
4	40-0064	Speaker w/drive circuit 3-15volts	A	1	each	OTS	P1	
4	40-0066	Signal Diode	A	2	each	OTS	D8, D10	
4	40-0067	2M Resistor	A	2	each	OTS	R7, R30	
4	40-0068	P-Chan MOSFET SOT-223	A	1	each	OTS	Q12	
4	40-0069	HE 2 Channel solid state relay (B form)	A	1	each	OTS	RY1	
4	40-0070	Schottky Diode, 320mV@1mA	A	2	each	OTS	D1,D2	
4	40-0071	Millmax 0666 Socket for 0.020 pins	A	2	each	OTS	J1 ,J3	
4	40-0072	2.7k Resistor	A	2	each	OTS	R41, R42	
4	40-0073	4.0 MHz Fixed oscillator	A	1	each	OTS	X1	
4	40-0074	Miniature Pushbutton Switch, Right Angle	A	1	each	OTS	SW1	
4	40-0075	Single Logic Level P-Channel FET	A	1	each	OTS	Q3	
4	40-0076	Red/Green SM LED	A	1	each	OTS	LD1	
4	40-0077	Molex 4-pin 0.079 RA Header	A	1	each	OTS	J2	
4	40-0078	IR 40Khz Integrated Receiver Siemen	A	2	each	OTS	IR1, IR3	
3	50-0016	EveryRoad, Rear Panel	B	1	each	MTS		
3	50-0089	Screw, M2 x 5, ST, PH, Torx	A	4	each	OTS		Torx Drive Screw
2	50-0010	Screw, M3 x 6, ST, PH, Torx	A	4	each	OTS		
2	50-0018	EveryRoad Model 300 Safety Label	A	1	each	MTS		Label has US and EU safety marks
1	20-0005	Package Documentation	A	1	each	OTS		
2	90-0006	Manual - Model 300/500	B	1	each	MTS		
2	90-0007	Warranty Card	A	1	each	OTS		
1	30-0085	Packaging	A	1	each	MTS		
2	50-0087	EveryRoad Model 300 US Boxed Product Label	A	1	each	MTS		Barcode label
2	50-0088	Box with EveryRoad Logo, 5 in x 5 in x 5 in	B	1	each	MTS		Box logo
1	40-0009	Power Supply, US	A	1	each	OTS		
1	40-0081	USB A/A Cable, Black	A	1	each	OTS		
1	40-0084	USB to Car Power Adapter	A	1	each	OTS		To be included in both the EU and US models
1	50-0083	Hook & Loop (Velcro), Black, 2" wide	A	2	inch	OTS		To be applied to GPS by customer

- Define where associated data/lists are coming from
  - What format is the data in?
  - How is the listed information stored? (CSV, XML, etc.)
- Standards (ASME, AIA, ASTM, ...)
  - What standards are in use?
  - How are you defining your data?
- Company Standards or Best Practices
  - Does your company have standards/best practices in place?
    - If yes, do all engineers abide by these practices?
    - If no, would the adoption of standards or a set of best practices improve the overall flow of information?
- BOM Lists
- Others

These associated data and lists should be secured by some IT method.
PLM, ERP, MPM, MES systems can do this as can File Management (DM/CM)

CONTENTS OF A MBD SCHEMA

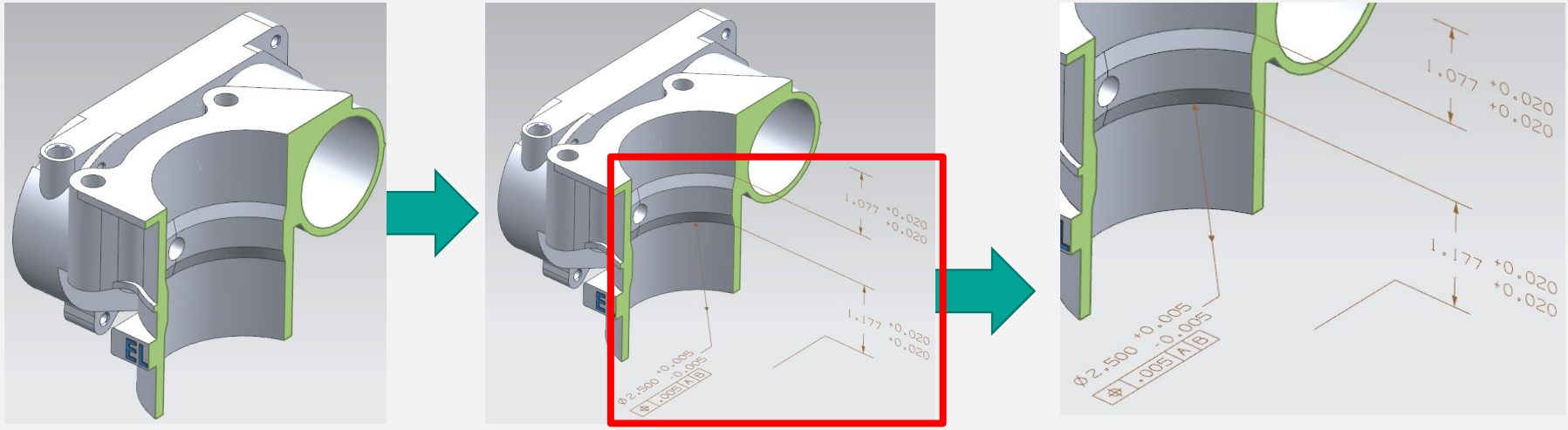
Attributes/Parameters/Properties

- Define contents of Attributes/Parameters/Properties (Meta Data)
- Every CAD Software System has the ability to store variable information and to reuse that information at different phases of CAD model use.
- For the purpose of this description those variables are stored within either:
  - Attributes
  - Parameters
  - Properties
- Define contents of Attributes/Parameters/Properties (Ex.)
  - material_used = Enter Material Name as text
  - material_spec = Enter material specification as text
- These text entries should be based on some standard or best practice so that it is always the same “Representation” for future automation needs. Drop down lists are a great way of accomplishing this. Secured start part templates is another.

Contents of a MBD Schema

Company Best Practice CAD Standards

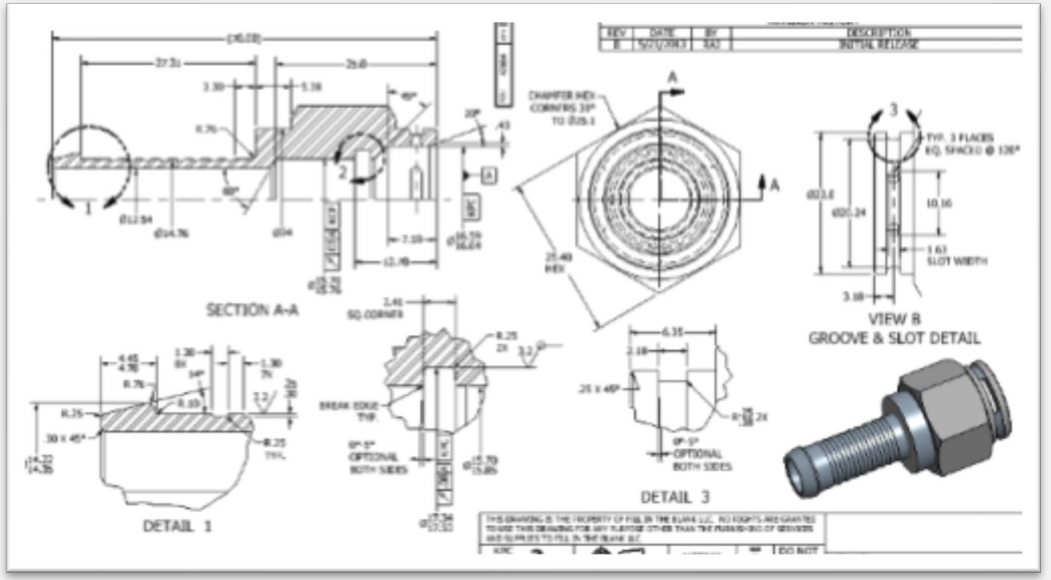
- Sometimes the definition of modeling methods is needed to ensure good reuse of PMI.
- Most companies have Company specific “Modeling Standards”.
- Some of these requirements also serve the ability to create good Model Based Definition.
  - Variables/Meta Data being defined in Attributes/Parameters/Properties as previously described.
- Things like using Layers, Representation States/Configurations might affect the reuse of data.



Sometimes we might wonder, “Does the MBD Schema drive our CAD Best Practices or vise versa”?

MBD Schema – Other Considerations

- "Shown On"
  - A drawing for each part? (Each part has a model, shouldn't each model have its own MBD?)
  - Is the product definition for each part shown on its own model or somewhere else?
  - Most of the time product definition for parts are/should be **shown on** their own model.
  - Sometimes product definition for parts are "Shown On" the next higher assembly. (At least in some drawings.)
- This is a debatable practice in both 2D drawings and MBD models.
  - Sometimes done this way to reduce the quantity (cost) of drawings required (Design engineering practice)
  - Sometimes manufacturing engineers need to create additional drawings to accommodate the practice.
    - This is less efficient, costs more to the overall program.
    - Needs to be done when component parts are acquired one place and assembled at another place.



MBD Schemas in some CAD systems can be configured to accommodate this. (But should we?)

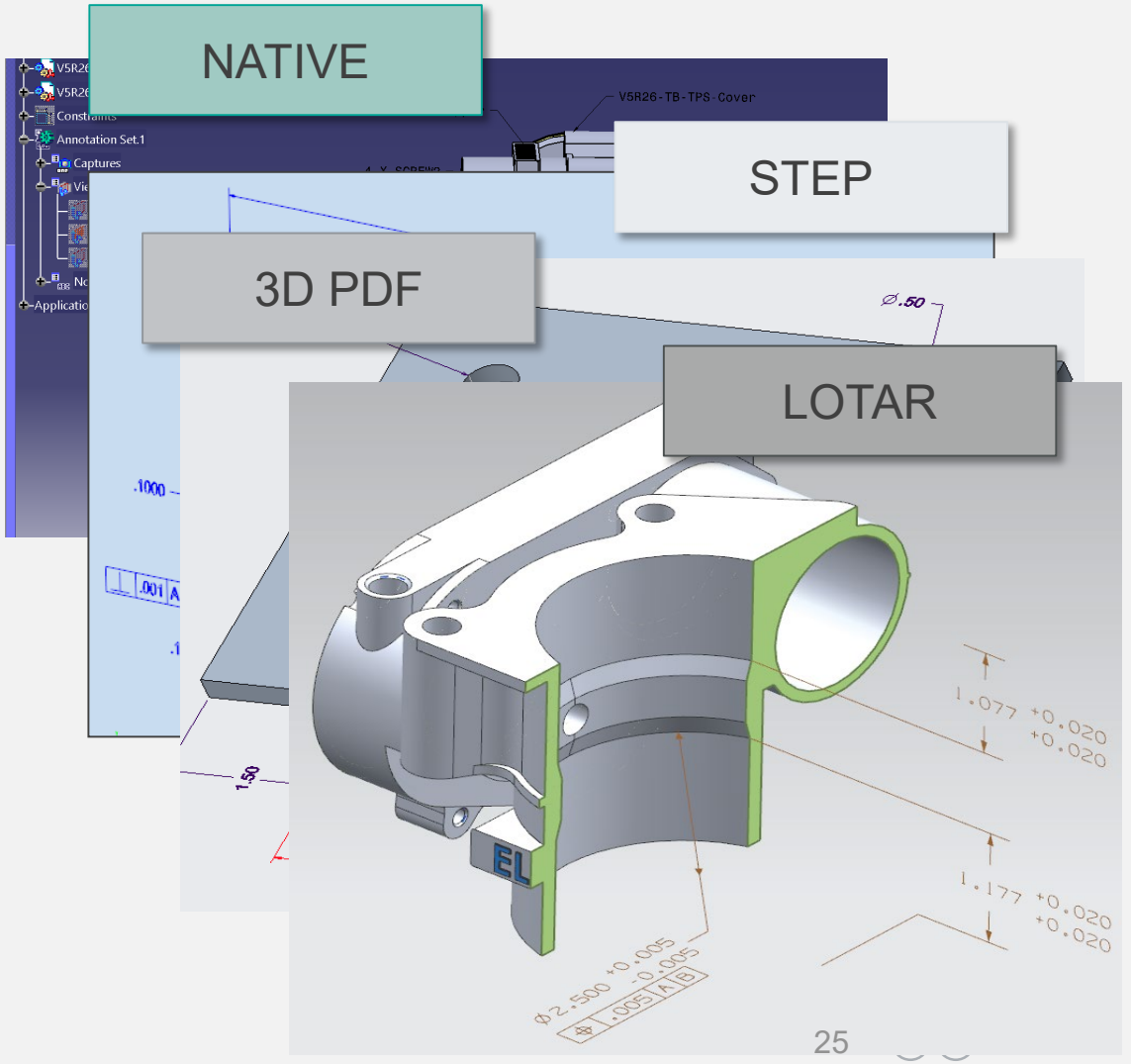
MBD Schema – Other Considerations

A description of intended derivative types and the method for their creation.

- Sometimes, this matters for how an MBD model is defined.

For consumer usage: (TDP) (Derivative Models)

- Native CAD or other solid model types.
- Archive File type
  - STEP AP203
  - STEP AP214
  - STEP AP242
  - QIF
- Lightweight viewing file (Viewing software requirements should be defined)
  - 3D PDF
  - JT
  - 3D XML



Derivative Models

Drawing Files

- Can still be used in MBD, **usually by exception** (fill gaps)

STEP (Long term data archiving and native file translation)

- AP203e2 allows 3D annotation (polyline) representation. Visual Presentation.
- AP242 allows Semantic PMI representation.

QIF Quality Information Framework

- Contains Geometry as well as Semantic PMI for Quality process planning and execution
- Not sure about translation issues

3D PDF

- Currently, most popular method for lightweight viewing.
- Product definition – Export the views that are required for product definition the way you do in drawings.
- Process definition – Export the views and motion sequences to describe how to manufacture the product.
- Sometimes there are some translation issues

HTML 5 (somewhat new and unsure of translation issues)

- Should be similar to 3D PDF

Native viewing files (JT, Creo View, 3D XML, e-Drawings)

- So called native viewing formats still require a translation, sometimes more errors than STEP or PDF

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