Are you getting the full benefit from MBD?

Stephen Werst, Director of Customer Success & Product Strategy

Sigmetrix

Sigmetrix - Global Experts in GD&T and Mechanical Variation

Global Product Data Interoperability Summit | **2019**

- **Over 25 years of Mechanical Variation experience**
- Tolerance Analysis Software Solutions work with CATIA V5-6, Autodesk Inventor NX, PTC Creo, and SOLIDWORKS
  - Analysis models utilize native CAD data files for geometry and PMI
  - OEM provider of 1D stackup and GD&T authoring solutions to PTC Creo and Autodesk Inventor
- Training in ASME GD&T & ISO GPS, Fundamentals of Tolerance Analysis, MBD/MBE, and our software solutions
- Consulting & Integration Services

Customers worldwide supported either directly in North America or through distributors internationally

A few definitions courtesy of Wikipedia with some simplification

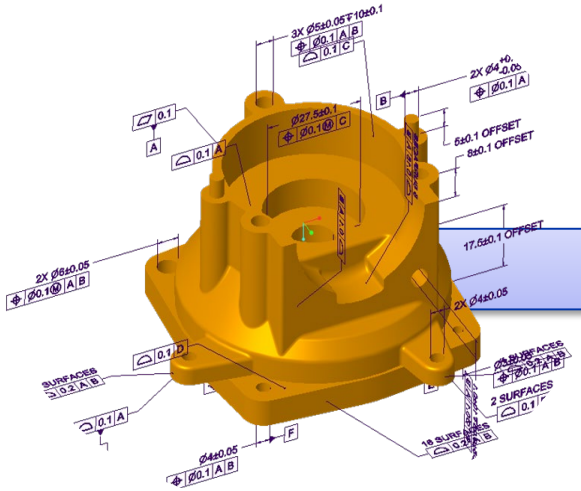
- **Model-based enterprise (MBE)** is a strategy where an annotated digital three-dimensional (3D) model of a product, instead of drawings, serves as the authoritative information source for all activities in that product's lifecycle. There are two prerequisites to implementing MBE:
  1. Creation of necessarily annotated 3D models, known as a Model-based Definition
  2. Transformation of CAD data into forms usable by downstream lifecycle activities (i.e. production)

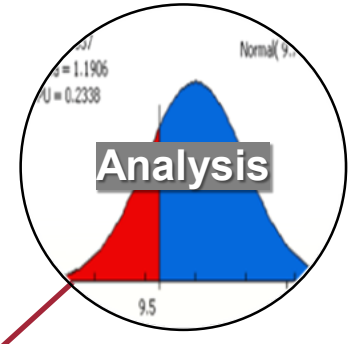
- **Model-based definition (MBD) -** the practice of using 3D models (such as solid models, 3D PMI, and associated metadata) to define product. Types of information included are geometric dimensioning and tolerancing (GD&T), component level materials, assembly level bills of materials, engineering configurations, design intent, etc.

- **Product Manufacturing Information (PMI)** - conveys non-geometric attributes in 3D computer-aided design (CAD) and Collaborative Product Development systems necessary for manufacturing product components and assemblies. PMI may include geometric dimensions and tolerances (GD&T), 3D annotation (text) and dimensions, surface finish, and material specifications.

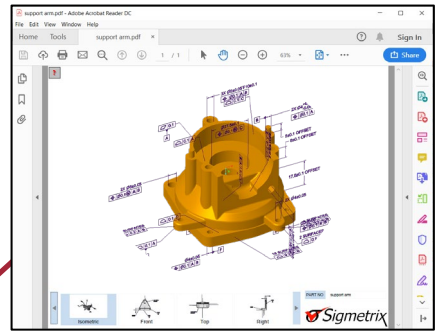
The flow of information in the MBE

- **MBE enables efficient communication throughout the organization**





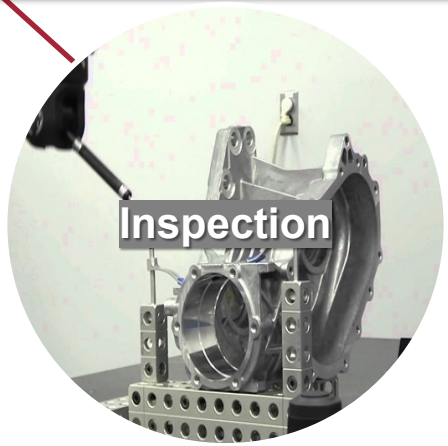
- FEA
- Tolerance Analysis



- Human Readable Formats

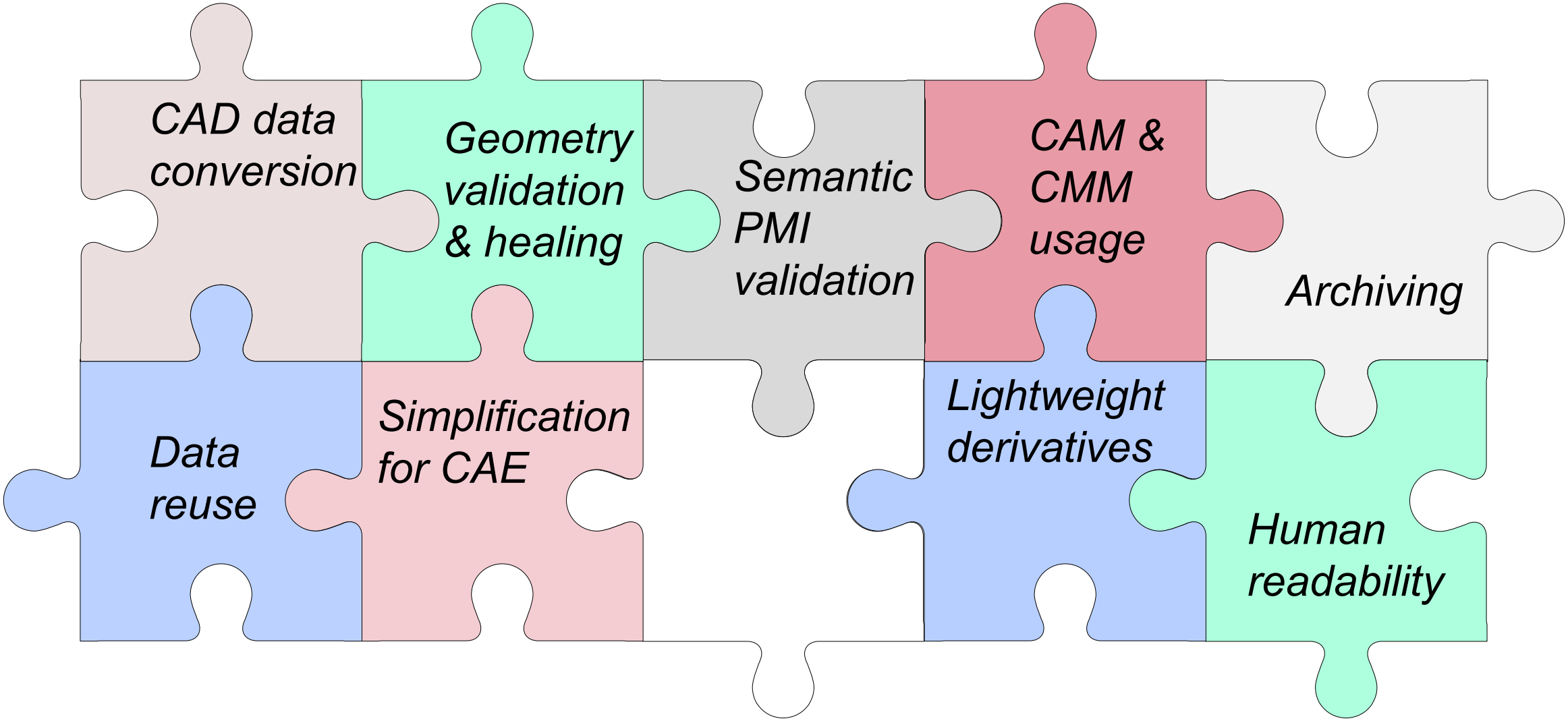
Digital Thread

- CNC Instructions
- Automated Manufacturing Plan



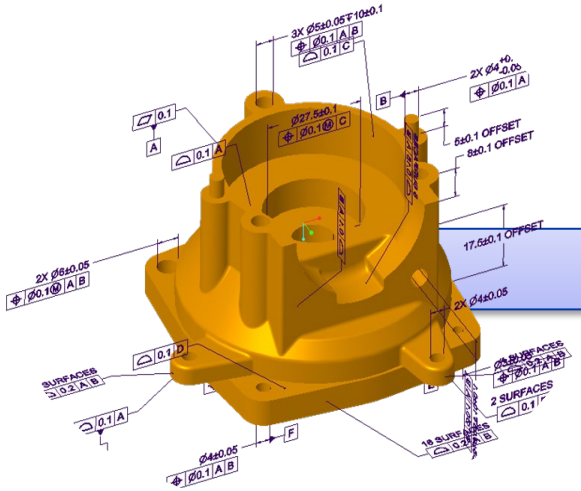
- CMM Instructions
- Closed Loop inspection feedback

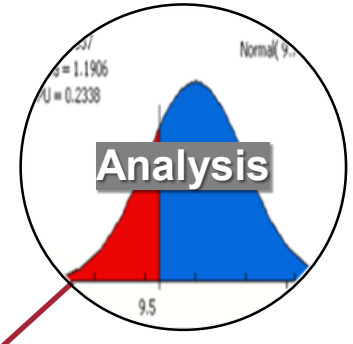
MBD Concerns addressed by various software solutions



The flow of information in the MBE

… but how much potential savings go unrealized if the information is wrong?





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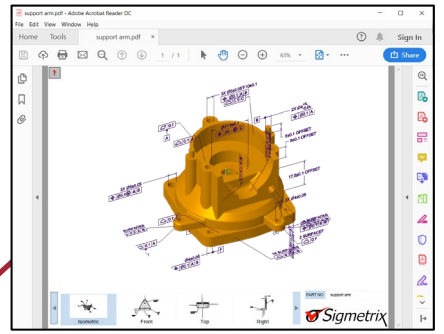

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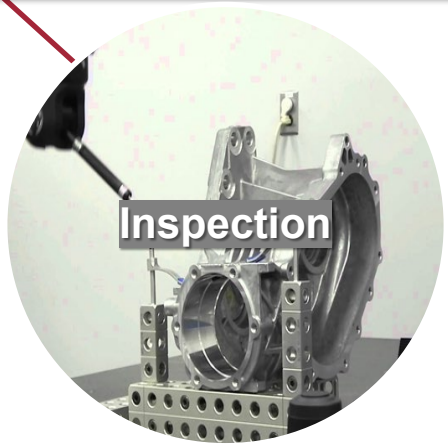

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Dimensional Management MBD Recommendations

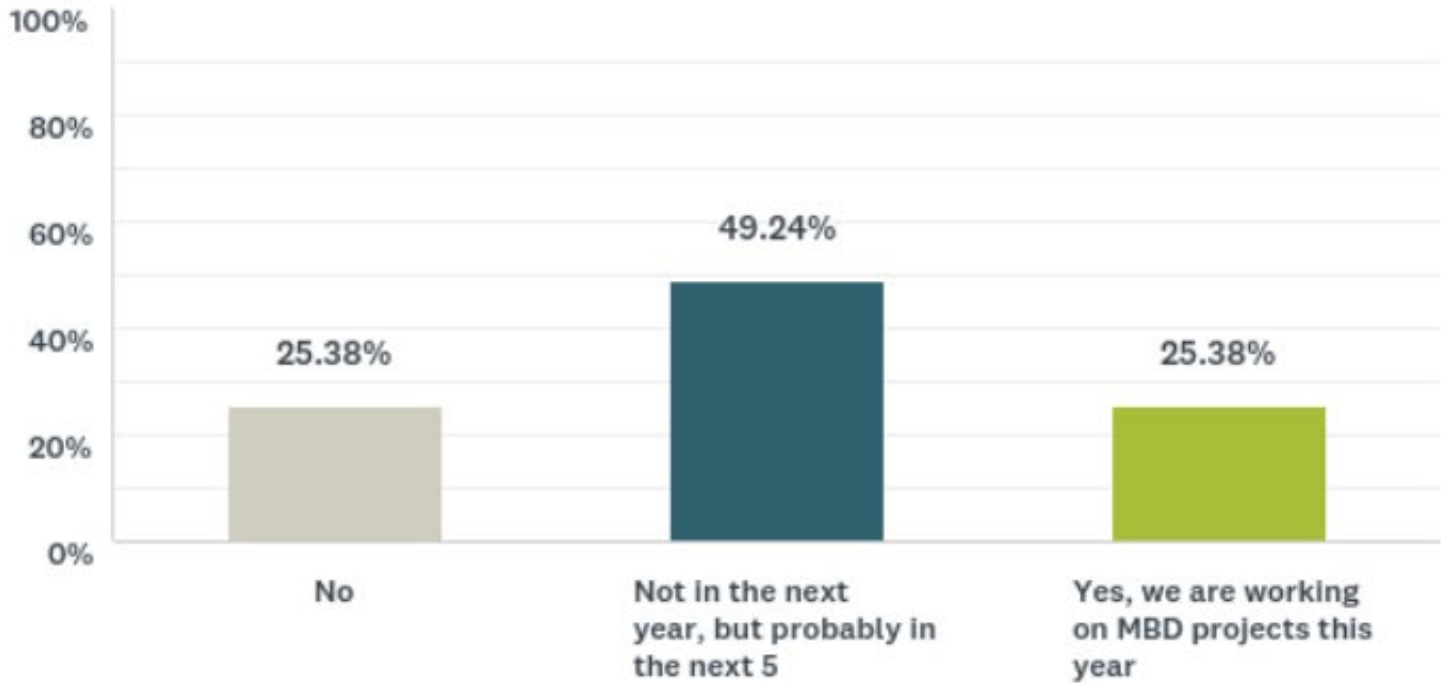
1. **Use tolerance analysis to determine what values should be specified in the dimensional annotations.**

2. **Use Geometric Tolerances (GD&T or GPS internationally) to avoid ambiguity associated with the more common/traditional dimensioning and tolerancing methods.**

3. **Ensure the authors of GD&T/GPS annotations know the language well and have access to tools that help provide "spell-check" and "grammar-check" type of functionality.**

Industry transition to MBD – informal survey results from 376 respondents

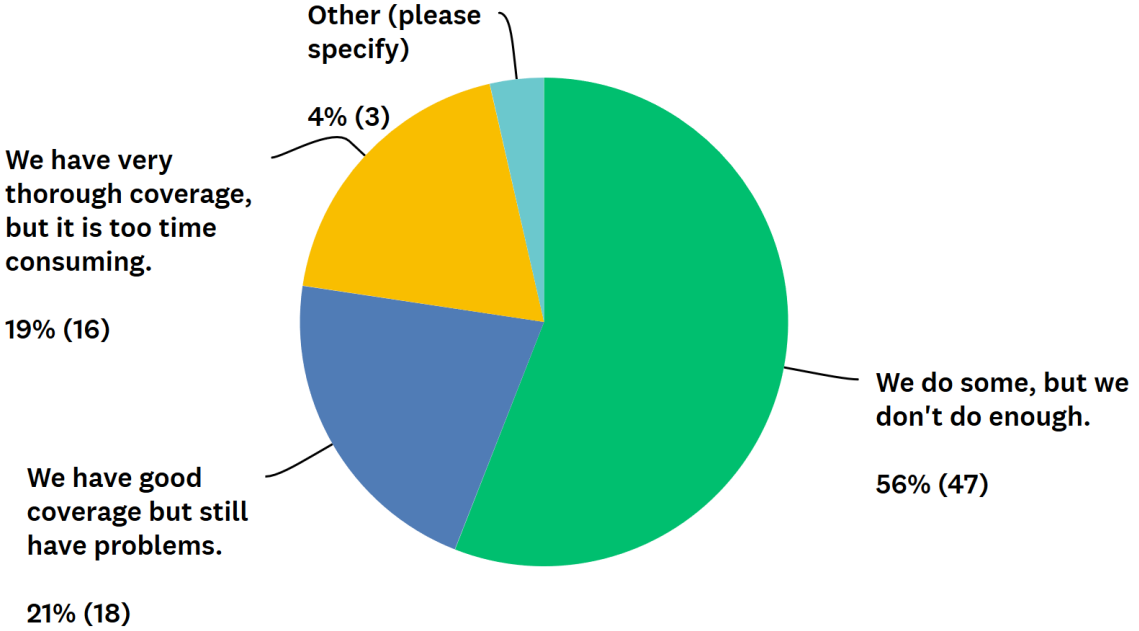
Does your company have any initiatives to move to Model-Based Definitions (where the model is the master instead of the drawing) in the next year? In the next 5?



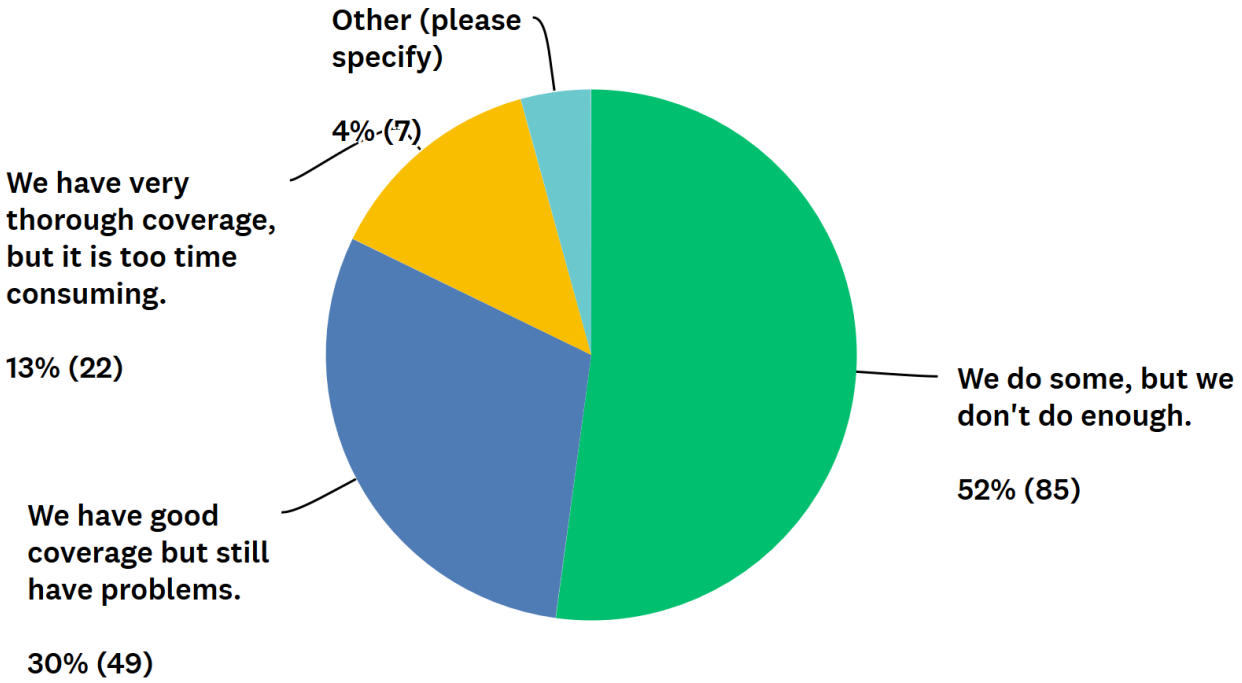
The State of Tolerance Analysis

Which best describes your current tolerance analysis coverage?

MBD in next year



MBD in 2-5 years



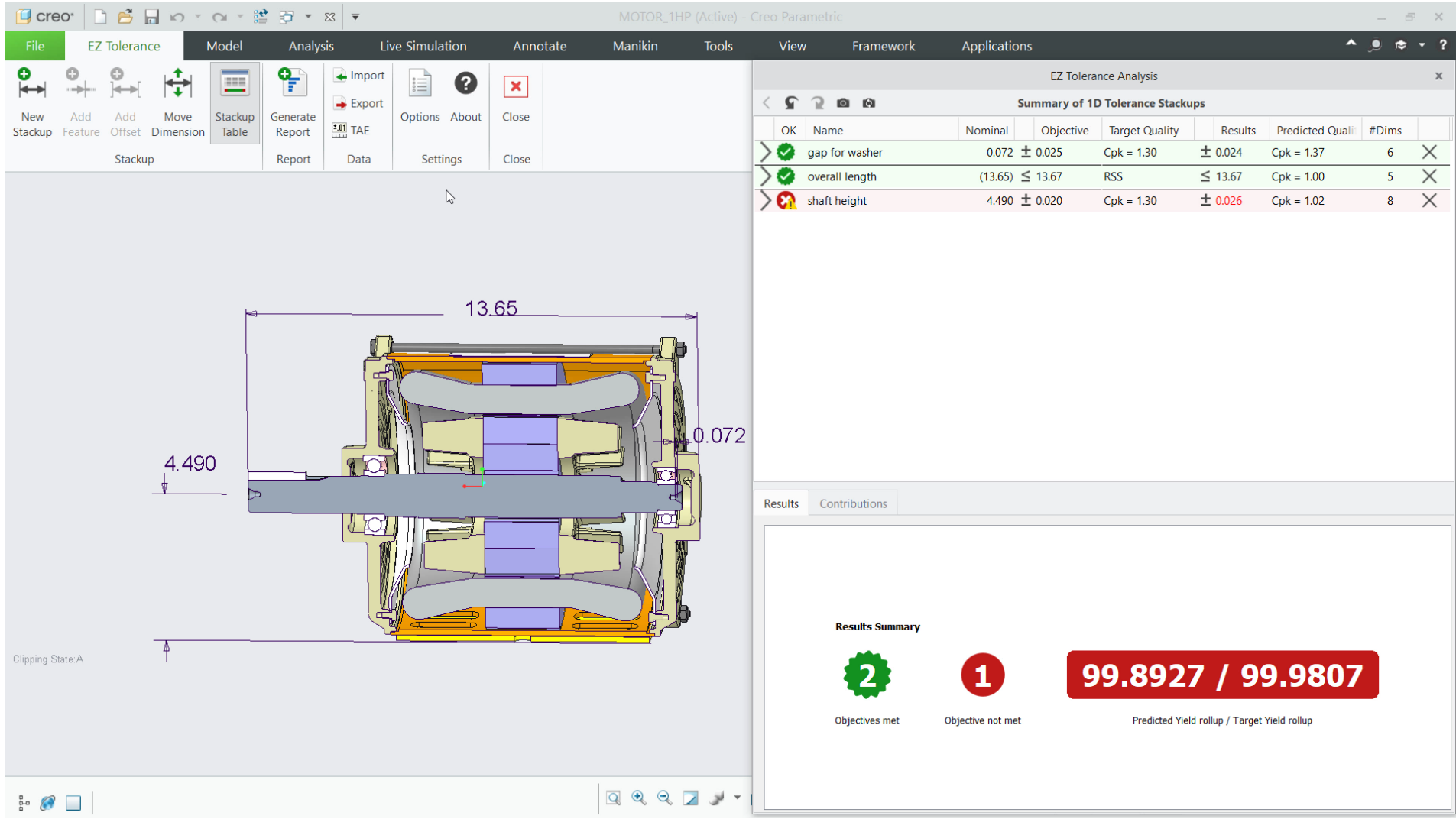
Top reasons cited for investigating tolerances analysis solutions

1. Improved efficiency for performing the analysis – **84%**
2. Reduction in manufacturing problems caused by tolerance issues – **76%**
3. Improved integration of analysis tool(s) and data within CAD models – **70%**
   Note: 80% of respondents use spreadsheets today for their tolerance analysis studies
4. Improved coverage that we are unable to do today because of cost, schedule, etc. – **34%**
5. Reduction in field problems caused by tolerance issues – **34%**
6. Reduction in time required in pre-production phase – **33%**

Tolerance analysis solutions are ready for MBD – 2-minute demo

1D Stackup Analysis

- Quickly define multiple stackups on the CAD geometry
- Analyses automatically update when CAD nominal change
- Dashboard provides on overview of all studies
- Quickly generate reports with loop diagrams

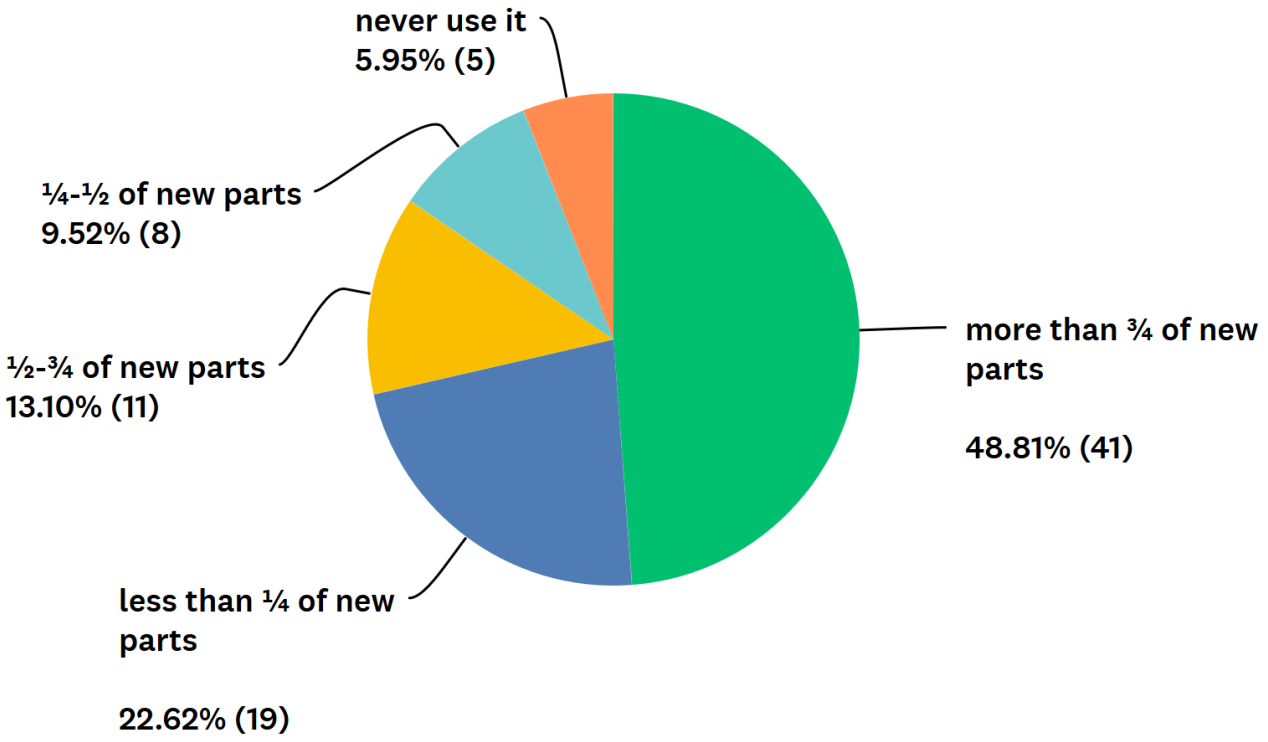


The Importance of GD&T for MBD

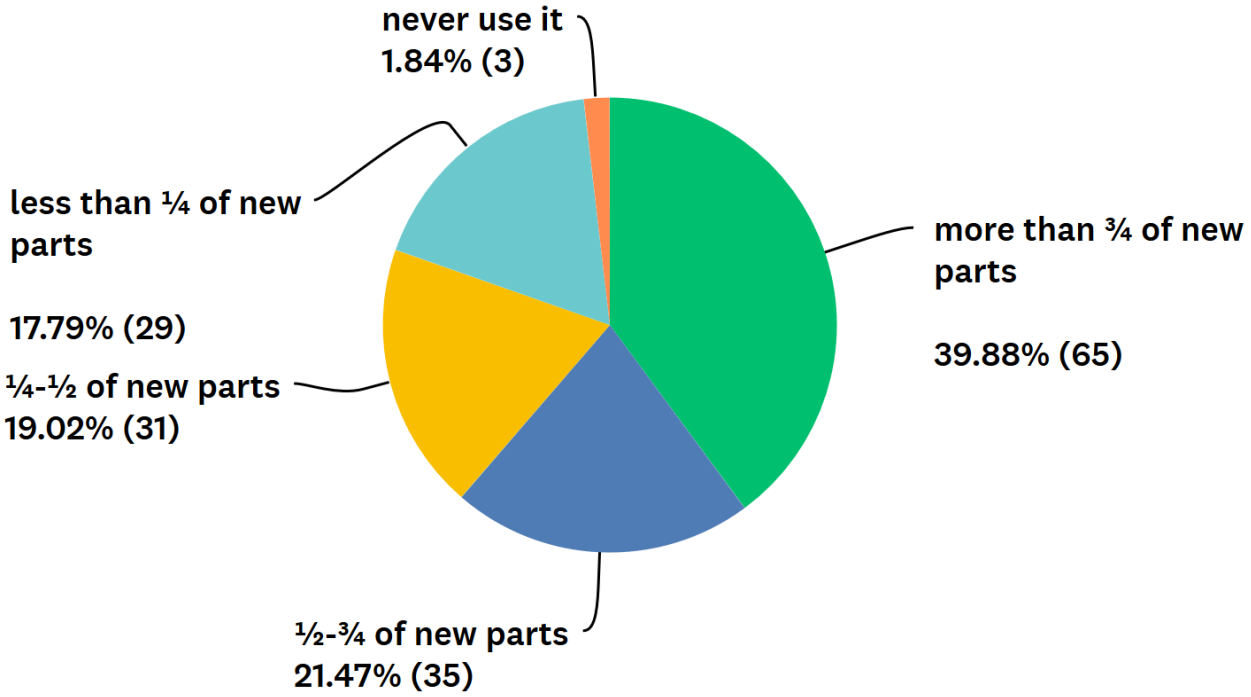
(Hint: it's not about the bonus tolerances)

Which best describers your company's GD&T/GPS usage?

MBD in next year

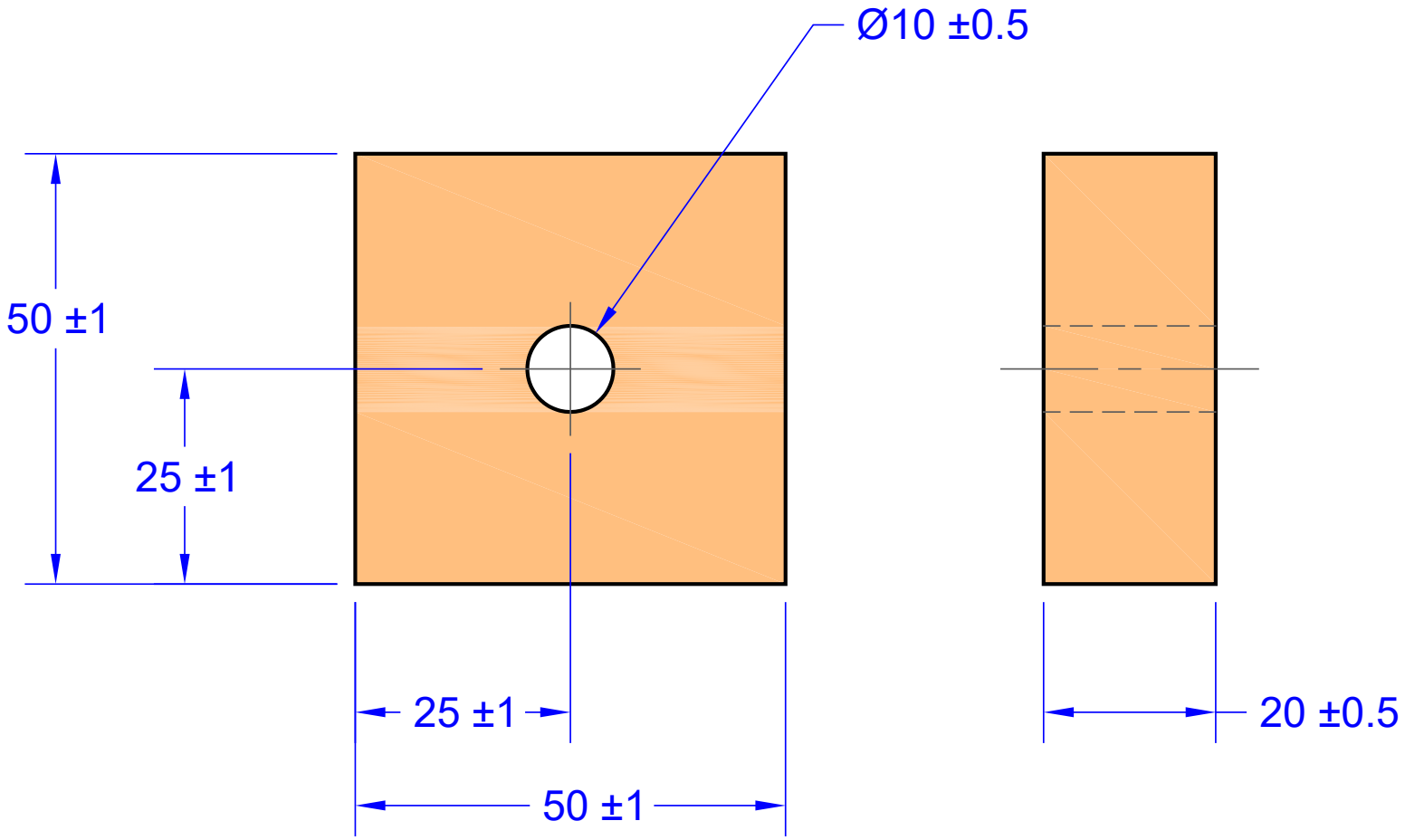


MBD in 2-5 years



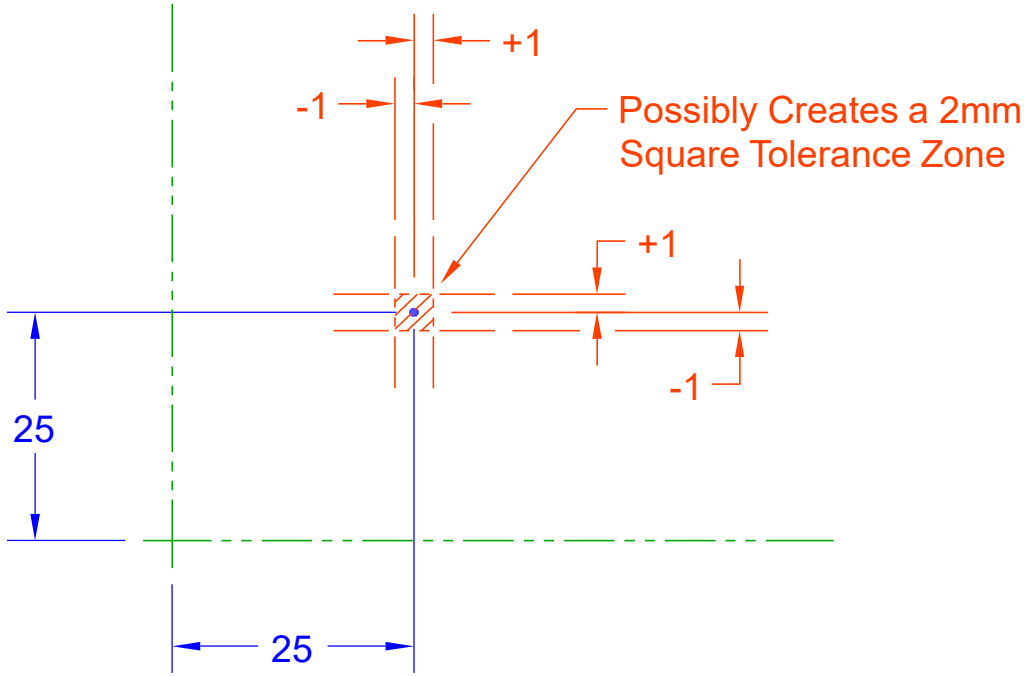
Dimensions with +/- Tolerance are Ambiguous

What do the dimensions on this drawing mean?

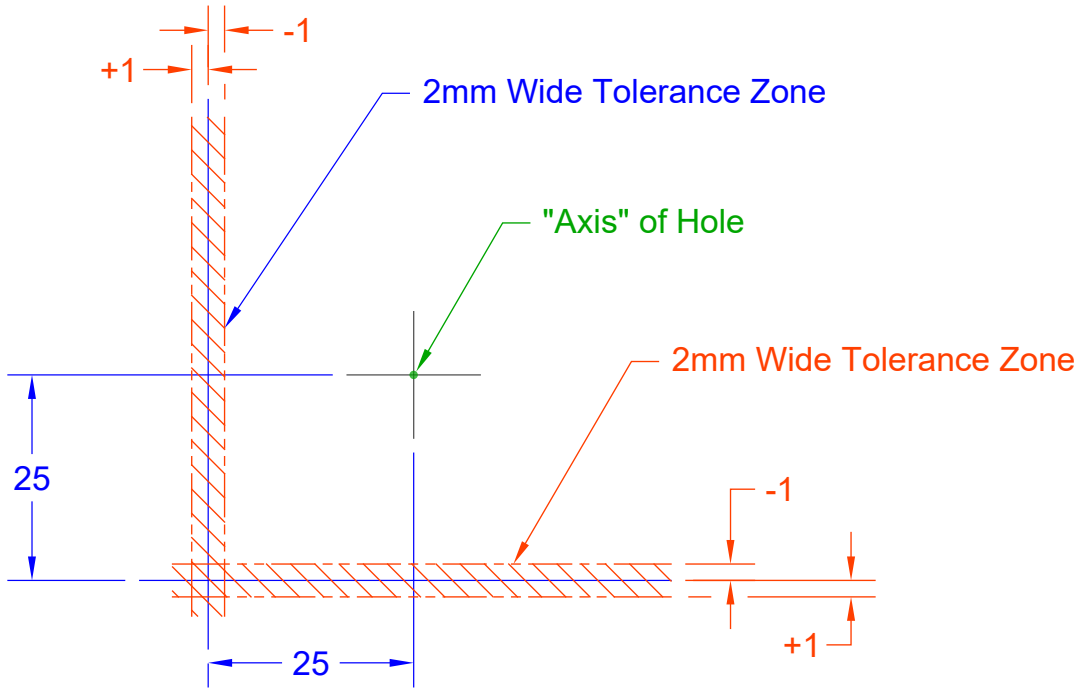


Dimensions with +/- Tolerance are Ambiguous

Is the hole being controlled to the sides?

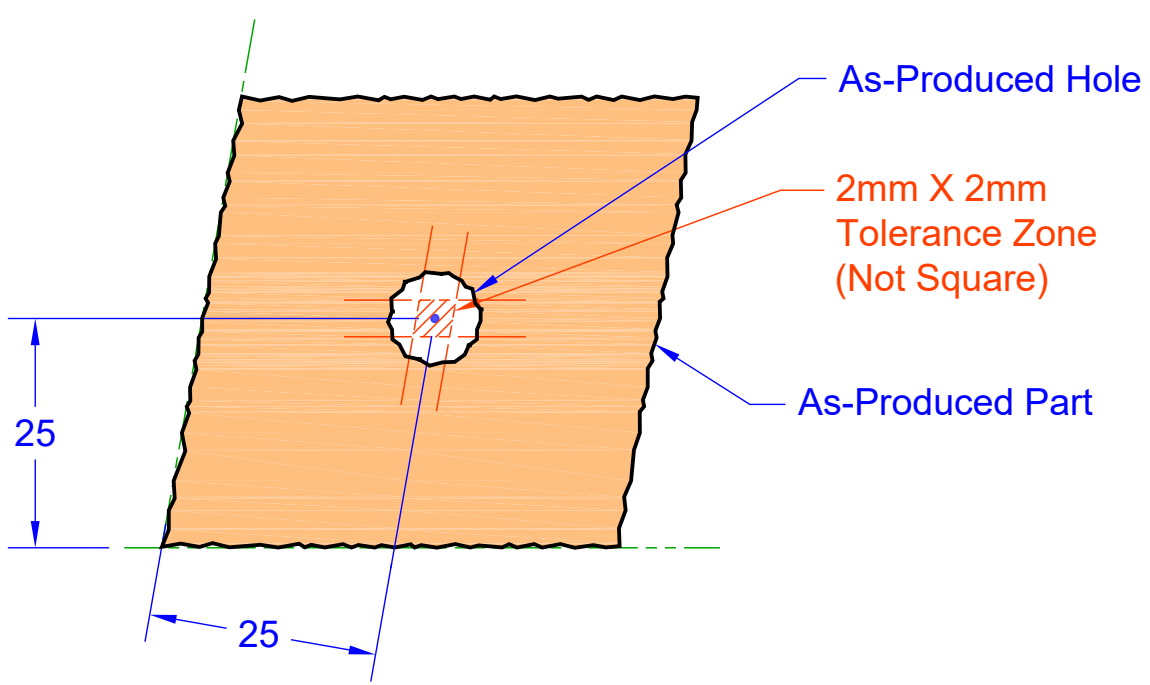


Are the sides being controlled to the hole?



“Real-world” variation adds additional complexity

How does inspection determine the measurement direction on the actual parts?



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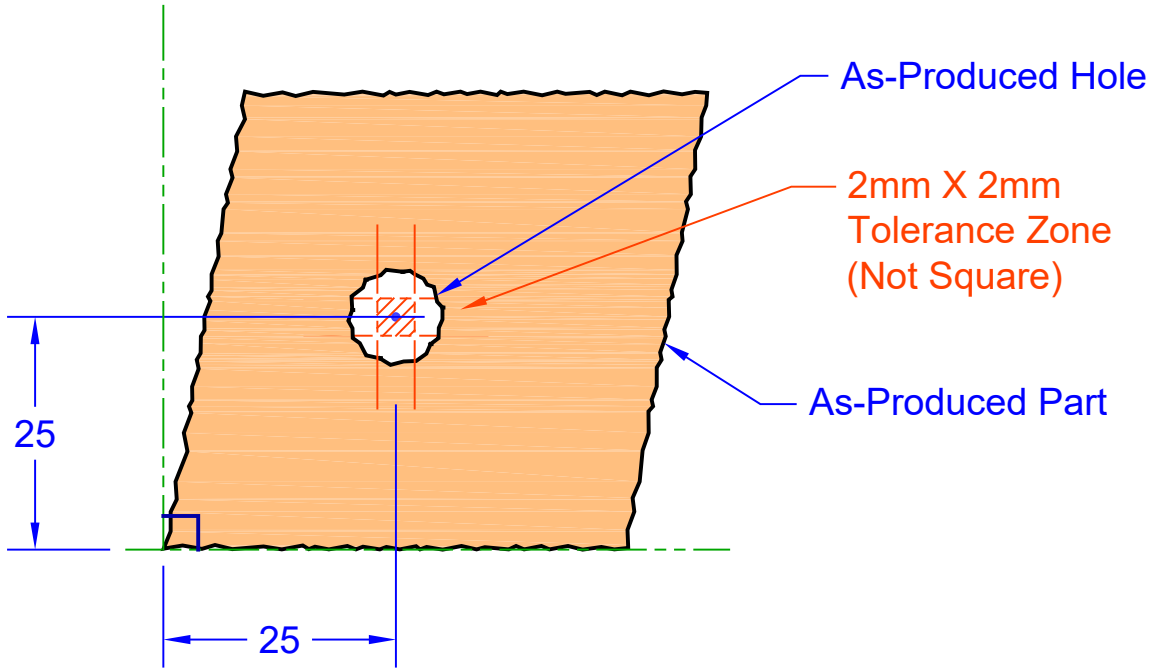
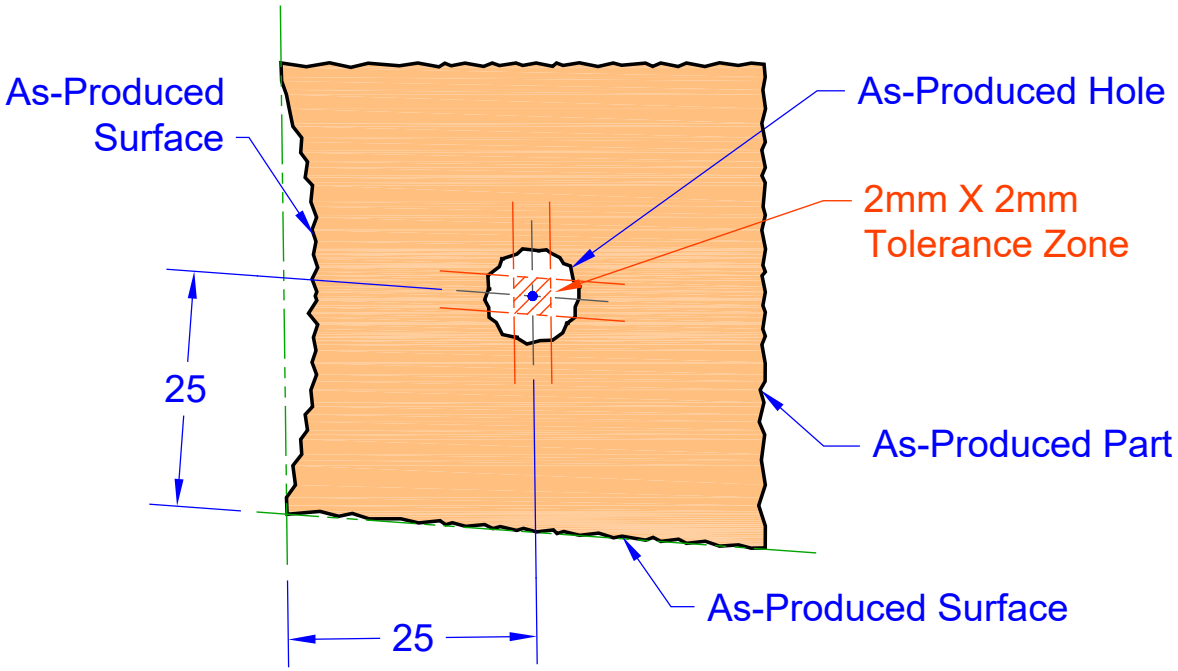


“Real-world” variation adds additional complexity

How does inspection determine the measurement origin on the actual parts?



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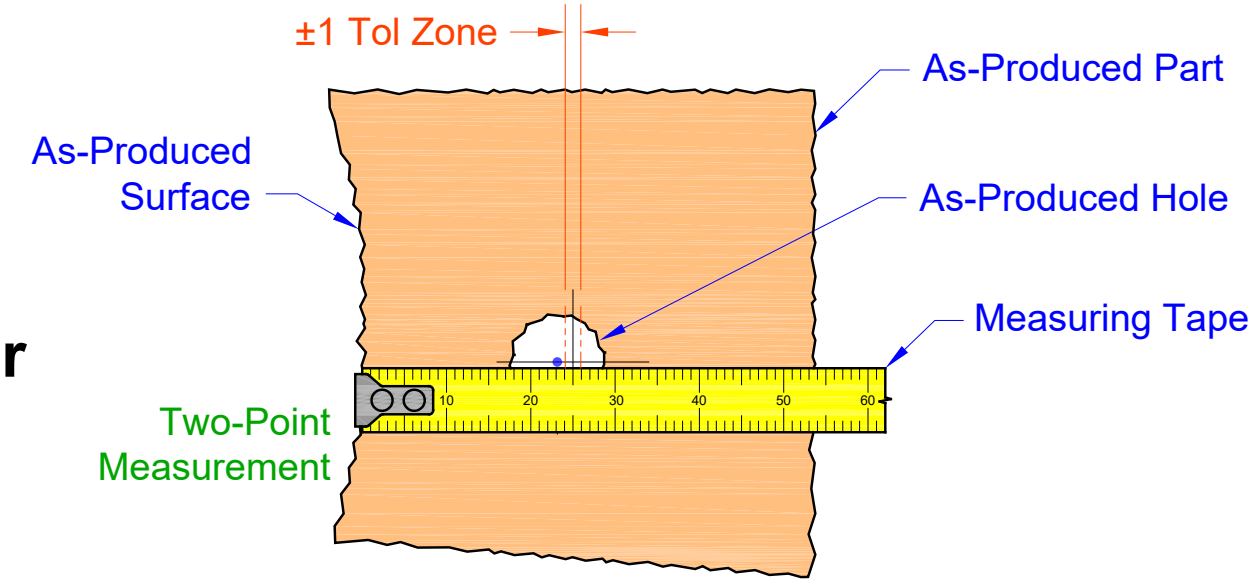
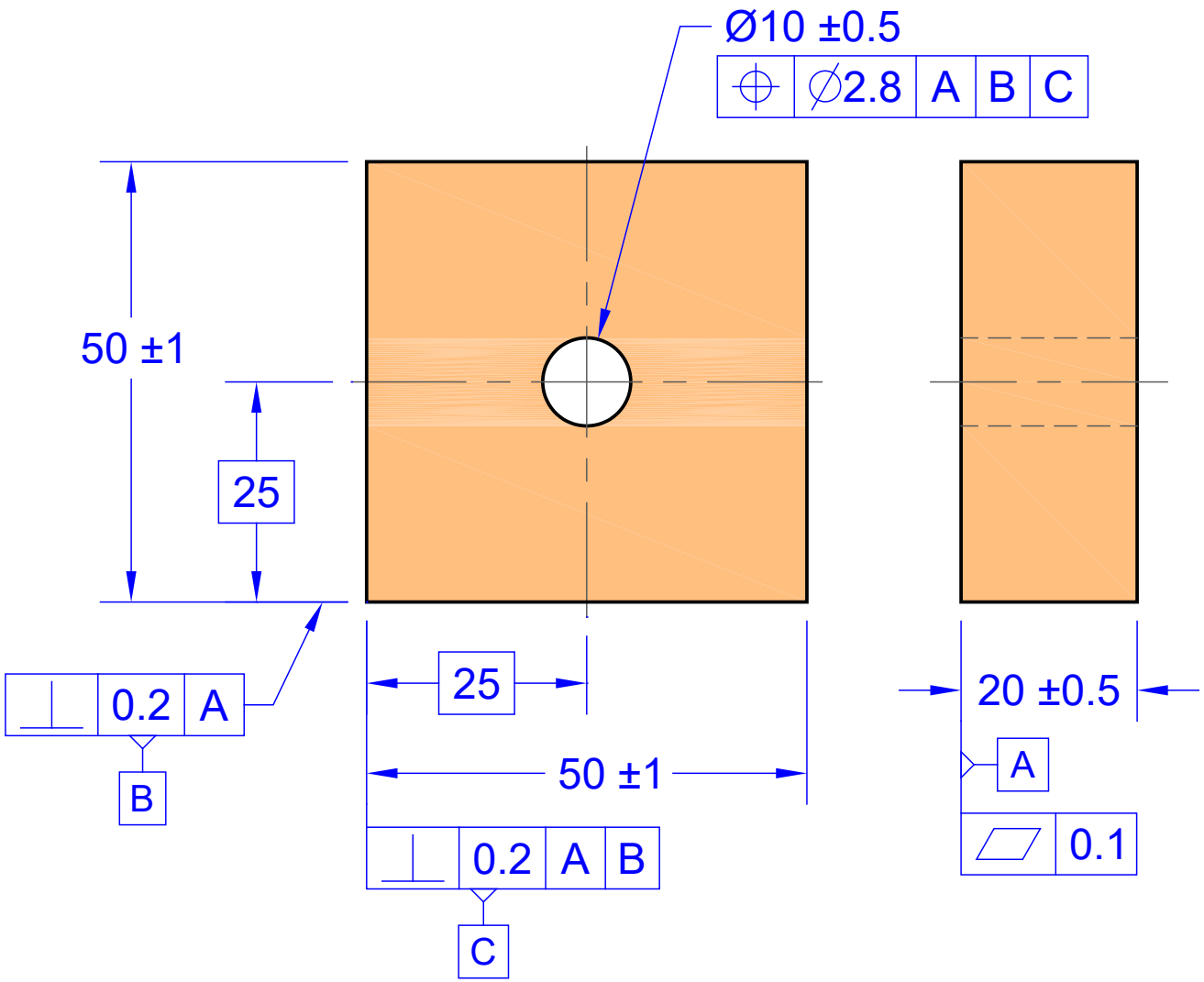


GD&T removes ambiguity



- The hole is being controlled relative to a coordinate system defined by three datum features labeled A, B, and C. This is DRF A|B|C.
- The axis of the hole must fall within a cylindrical tolerances zone having a diameter of 2.8 mm and located 25 mm from both datums B and C as defined by DRF A|B|C

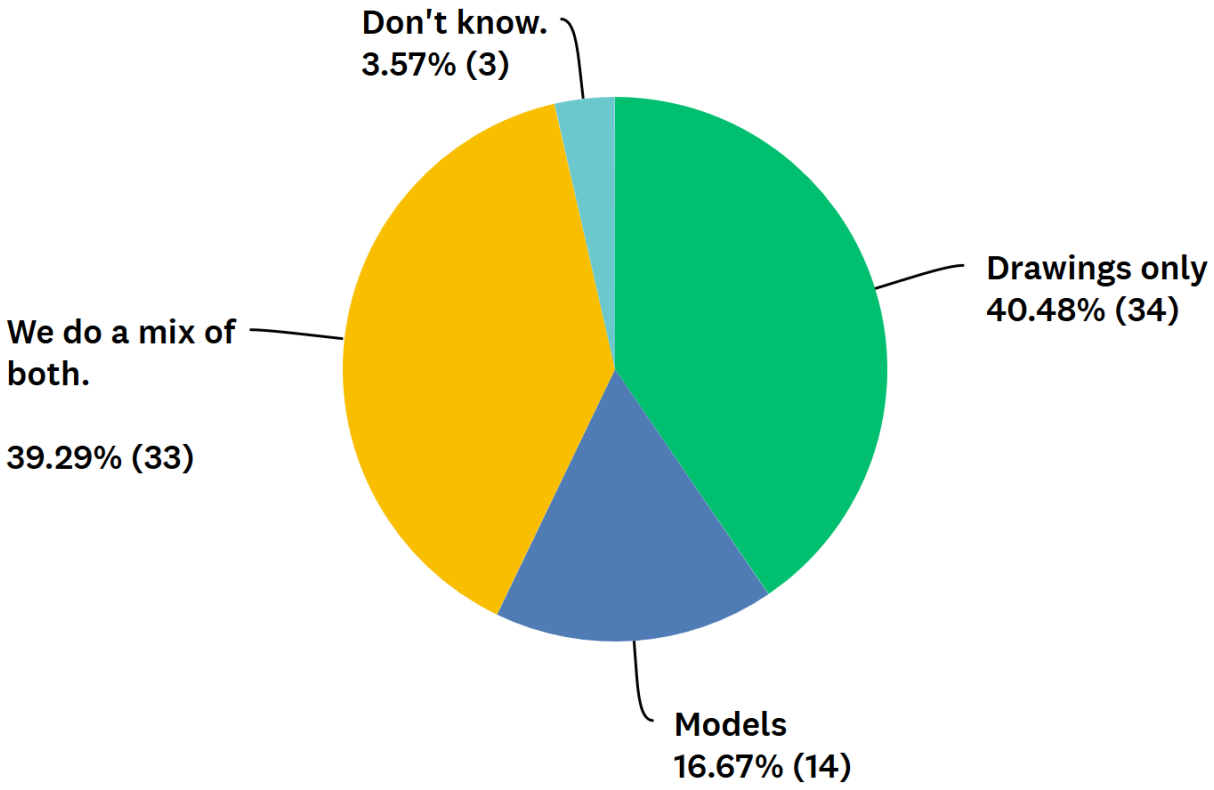
GD&T is a language

- To “speak” it properly requires:
  - Education
  - Application
  - Practice
- For authors, don’t feel obligated to use all things covered in the standards. A subset of the standard will carry you far.
- Like any language, no two people will speak it identically.
  - It is possible to converge on similar definitions with standard processes.

The State of GD&T Authoring

Where are tolerances first defined?

MBD in next year



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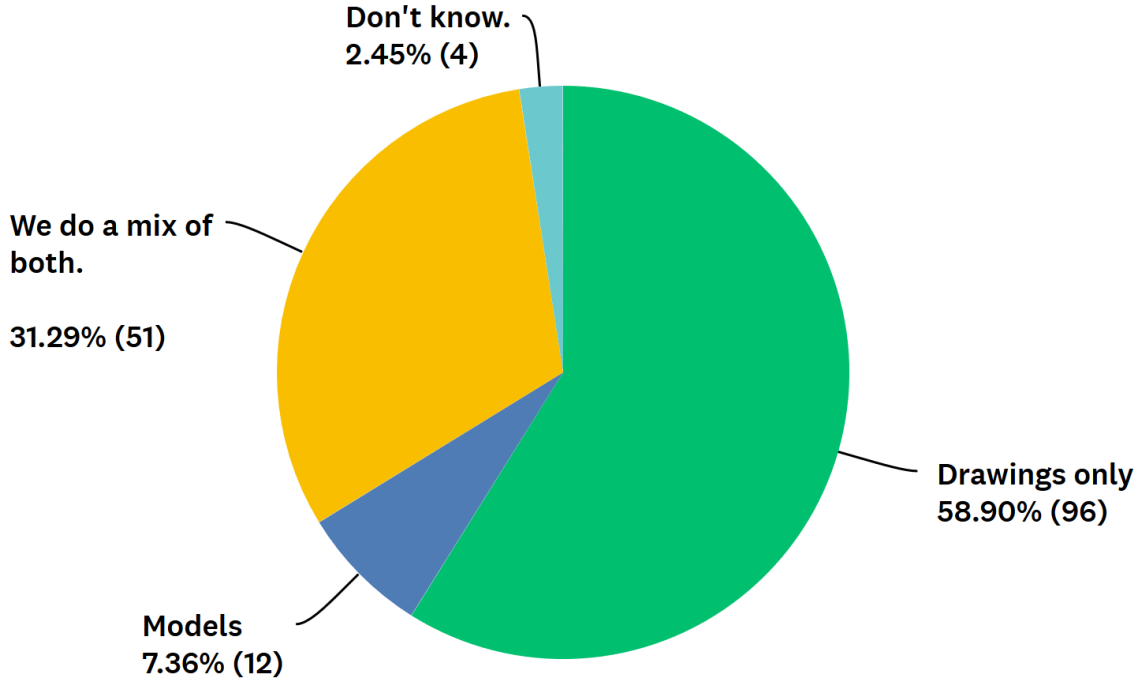
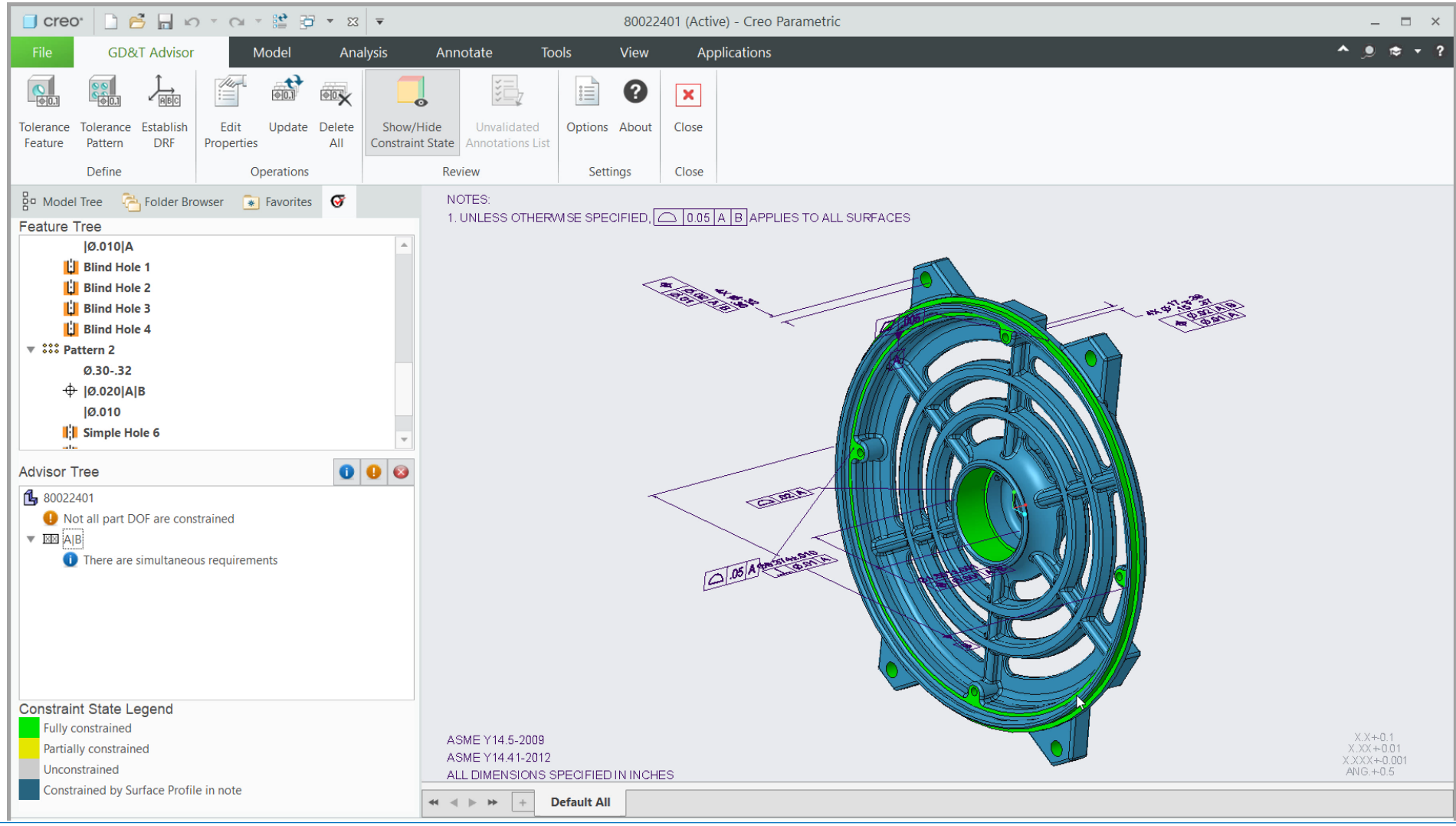


GD&T Authoring tools help with the definition - demo

GD&T Advisor

- Quickly add semantic GD&T
- GD&T applied per governing ASME or ISO standards
- Recommendations made to help provide consistency
- Visual feedback about status of control of each surface



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