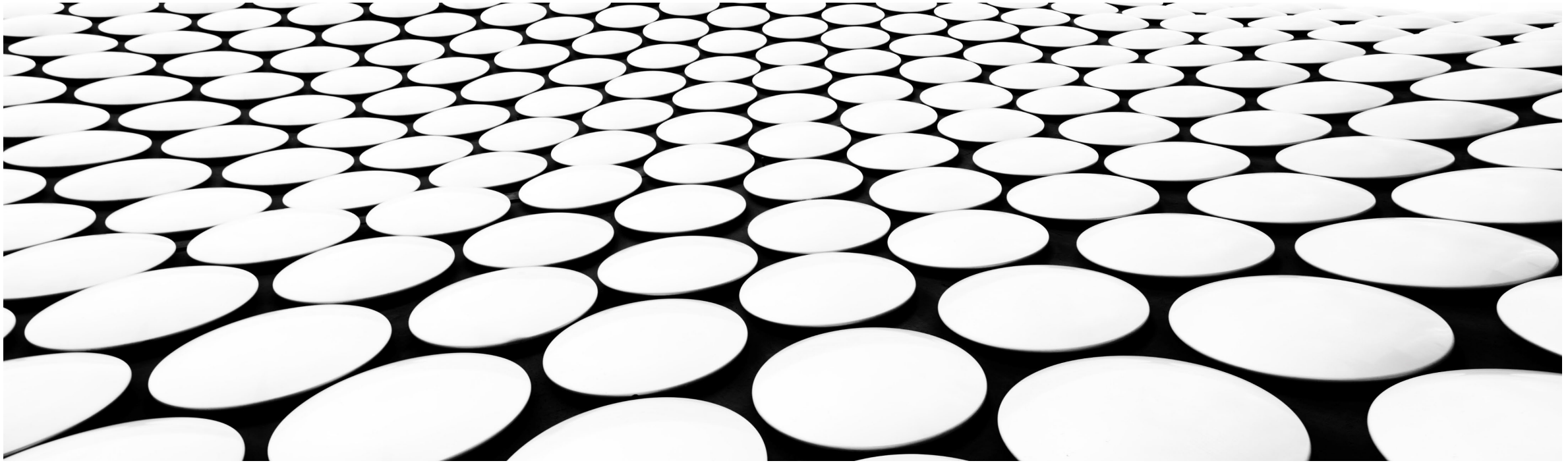
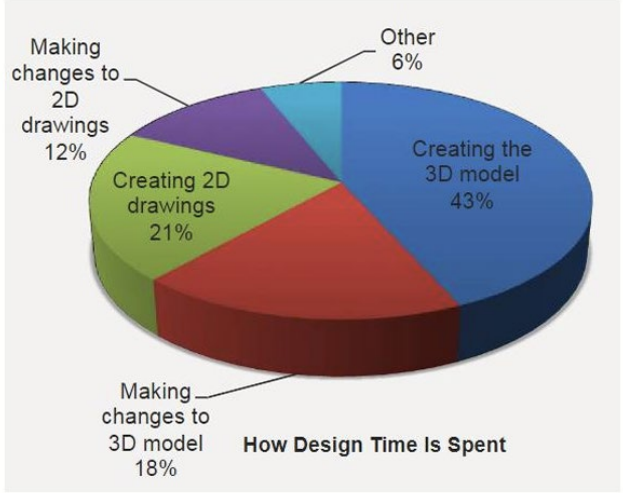
FROM 2D TO 3D: THE APPLICATION OF GD&T IN MBD

FIRAT BUYUKCIVELEK – MDEV ARCHITECT / TECHNICAL TRAINER



DEFINING GD&T IN 3D – INTRODUCTION

"practice of documenting the information necessary to manufacture and inspect parts, assemblies, and products in **3D Computer Aided Design (CAD)** models, as opposed to traditional 2D-production drawings."



(Boucher, 2017)

- 3D CAD improves production quality and technical content.
  - Reduce ambiguity.
- Reduces design time and improves efficiency.
- 3D design promotes CAD/CAM integration.
  - Faster NC programming.
- 3D design promotes CAD/CMM integration.
  - Faster inspection setups.
- Better Quality & Lower Cost

Improved asset efficiency (10-20%)	**Improved quality (10-35%)**	**Reduced cost (20-30%)**
• Optimized capacity • Asset utilization • Changeover time • Down time	• Scrap rates • Fill rates • Yield • Lead Times	• Labor cost • Sourcing cost • Inventory levels • Maintenance cost • Warranty cost

Deloitte study on digital manufacturing (Laaper & Kiefer, 2020

ISO GD&T STANDARDS – A SHORTENED OVERVIEW

ISO-16792: Technical product documentation — Digital product definition data practices

ISO-8015: Geometrical product specifications (GPS) — Fundamentals — Concepts, principles and rules

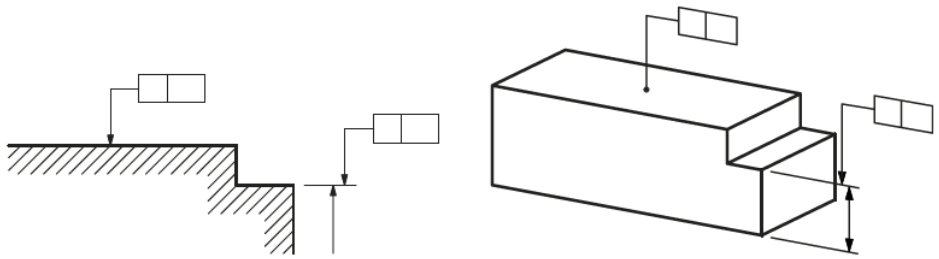
ISO-1101: Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out

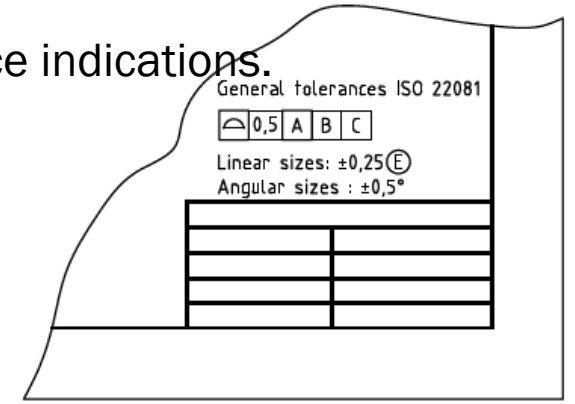
ISO-22081: Geometrical product specifications (GPS) — Geometrical tolerancing — General geometrical specifications and general size specifications

ISO-14405: Geometrical product specifications (GPS) — Dimensional tolerancing

ISO-5459: Geometrical product specifications (GPS) — Geometrical tolerancing — Datums and datum systems

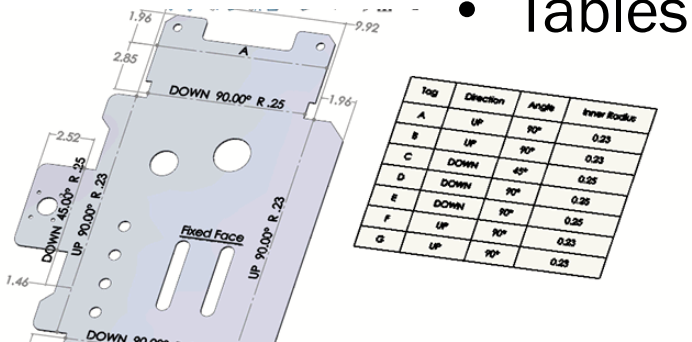
ISO-2768-1: General Tolerances for Linear and Angular Dimensions without individual tolerance indications.



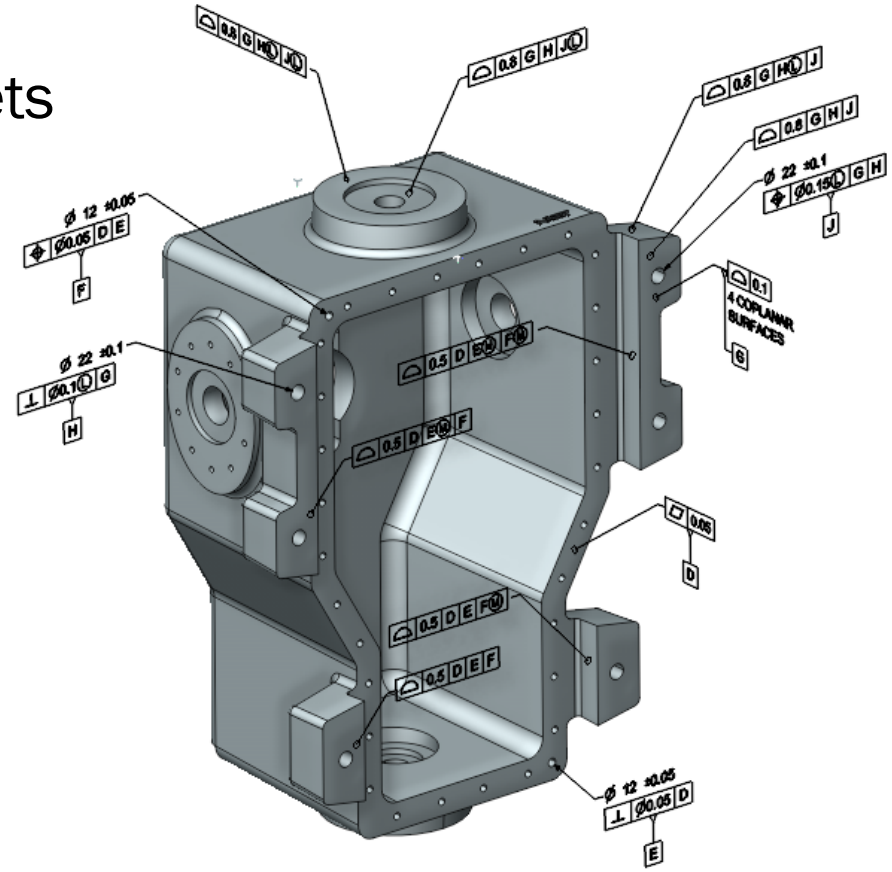


DEFINING ISO GPS - GD&T IN 3D – MBD METHODOLOGY

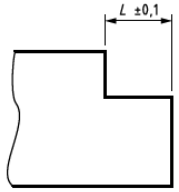
- Dimensions and linear tolerances
- Geometric tolerances - Indications
- Datum Feature Symbols and Datum Targets
- Notes
- Symbols
- Surface finishes
- Tables

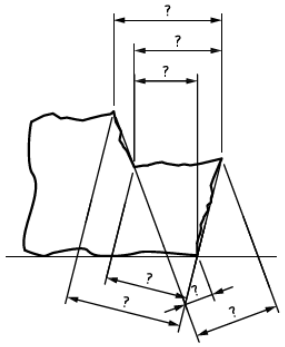


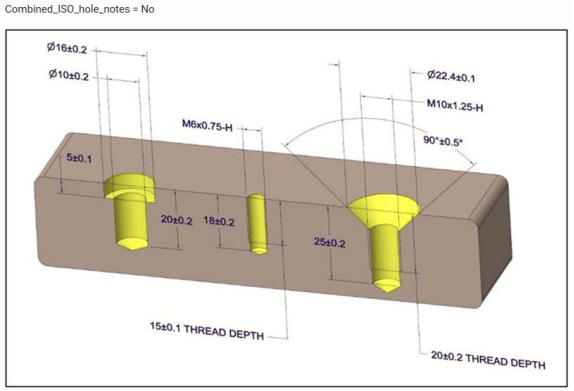
Tag	Direction	Angle	Inner Radius
A	UP	90°	0.23
B	UP	90°	0.23
C	DOWN	45°	0.25
D	DOWN	90°	0.25
E	DOWN	90°	0.25
F	UP	90°	0.23
G	UP	90°	0.23

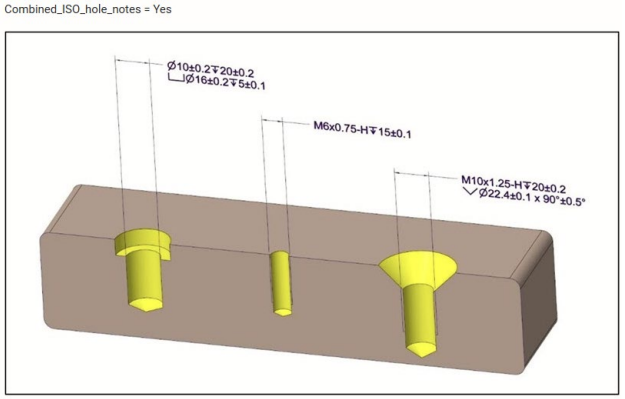


DEFINING GD&T IN 3D – MBD METHODOLOGY

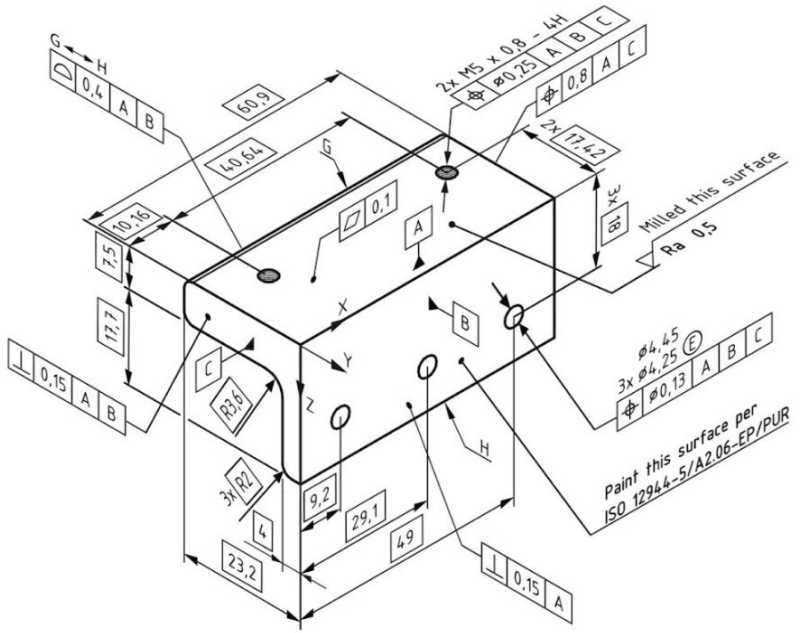








PMI Type	Association
Linear Dimensions***	At least 2 faces • 2 parallel flat (planar) faces • 2 hole faces of parallel holes • 1 flat face and 1 hole face parallel to each other
Hole and Thread Callouts	Hole feature or all cylindrical and flat faces in the hole.
Radial Dimension	Face of the hole / Face of the Shaft
Angular Dimensions	2 faces where the angle is in between.
Thickness / Arc Length	Seldom or never used
GD&T Indication	All faces where the GD&T apply to.
Datum Features	All faces of the datum



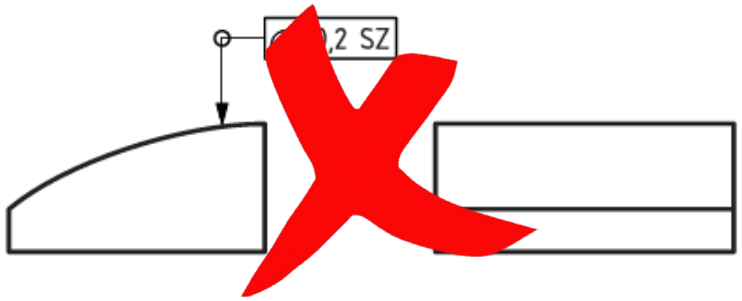
ISO GD&T STANDARDS – MBD RELEVANT CHANGES

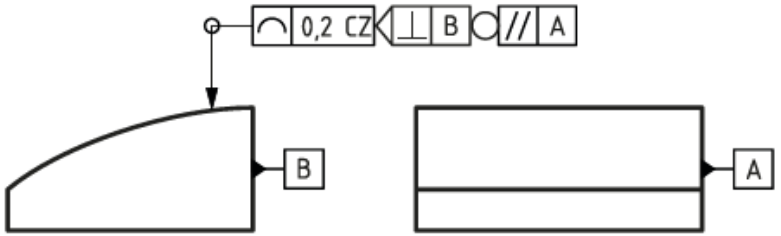
ISO 1101

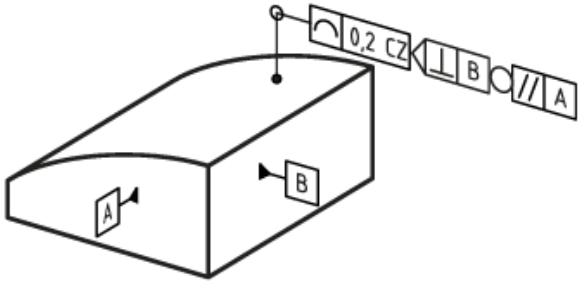
Fourth edition
2017-02

- Collection Plane Indicator

A collection plane indicator **shall be used** to identify the collection plane in 3D and is **preferred** in 2D with all around continuous, closed tolerance features.





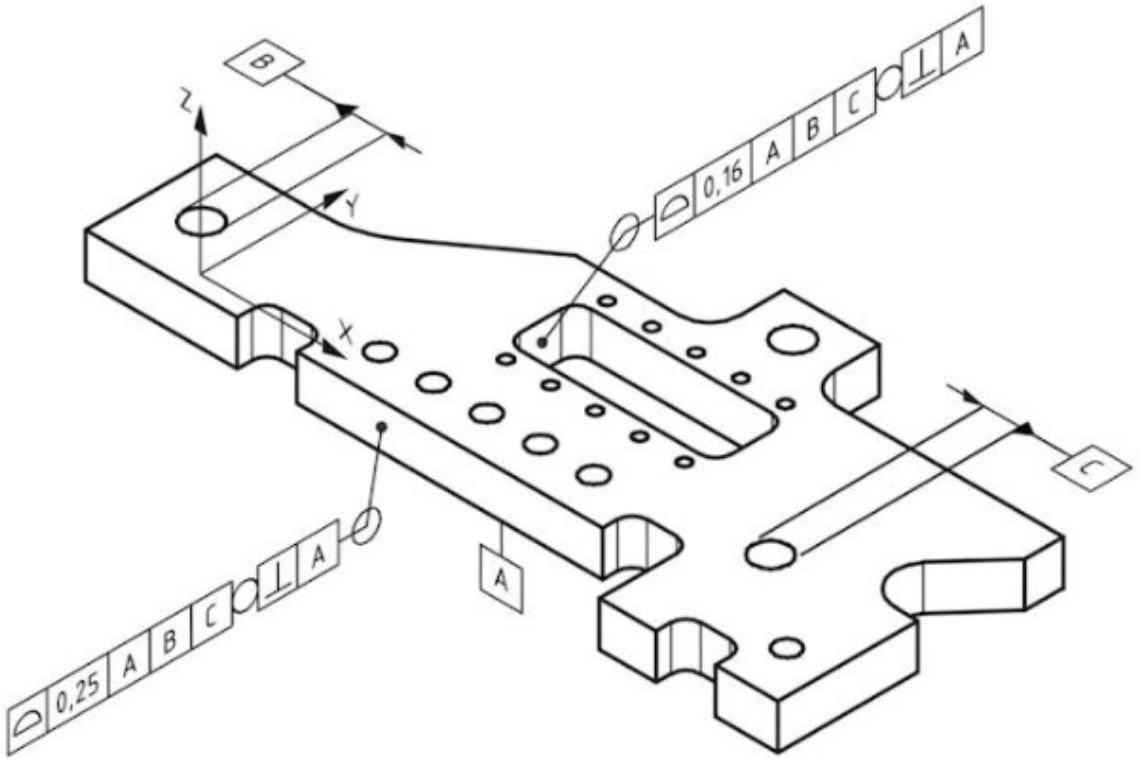


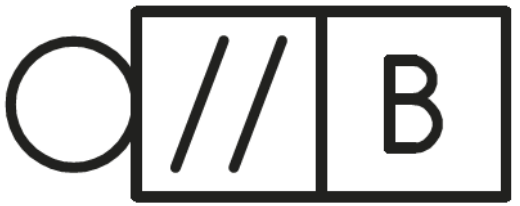
ISO GD&T STANDARDS – MBD RELEVANT CHANGES

ISO
1101

Fourth edition
2017-02

- Collection Plane Indicator



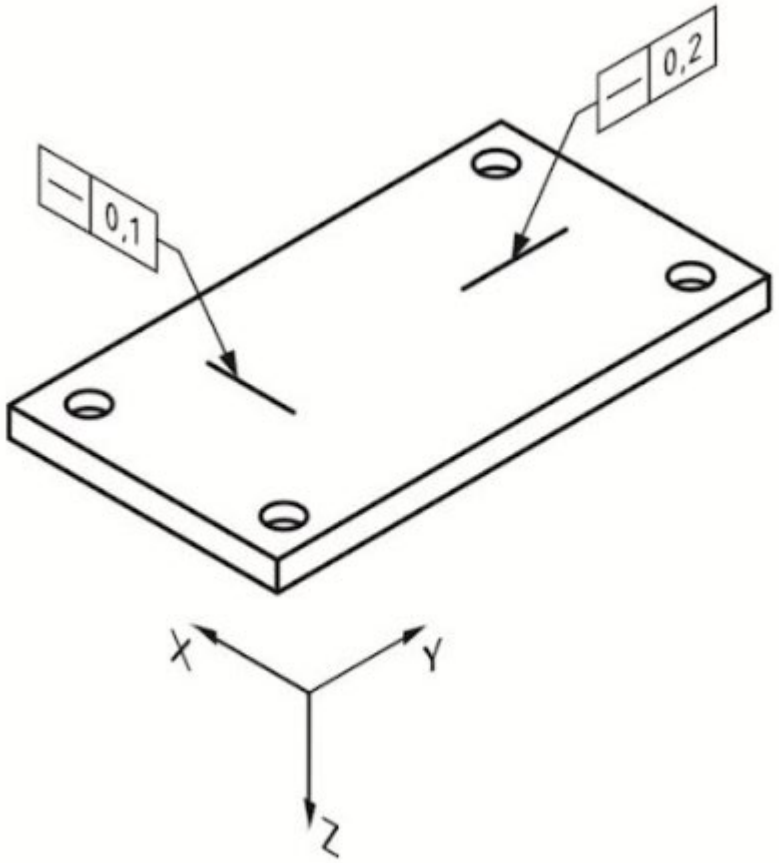


ISO GD&T STANDARDS – MBD RELEVANT CHANGES

ISO
1101

Fourth edition
2017-02

- Line Elements - Former MBD Practice



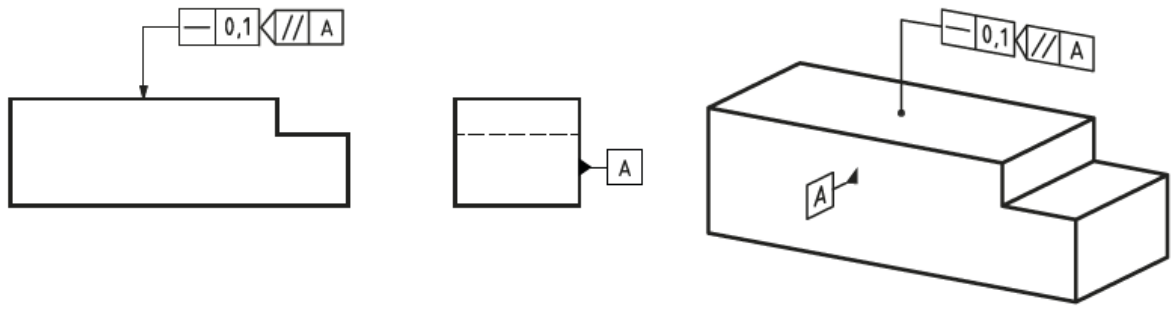
ISO GD&T STANDARDS – MBD RELEVANT CHANGES

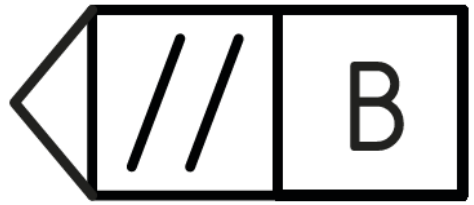
ISO 1101

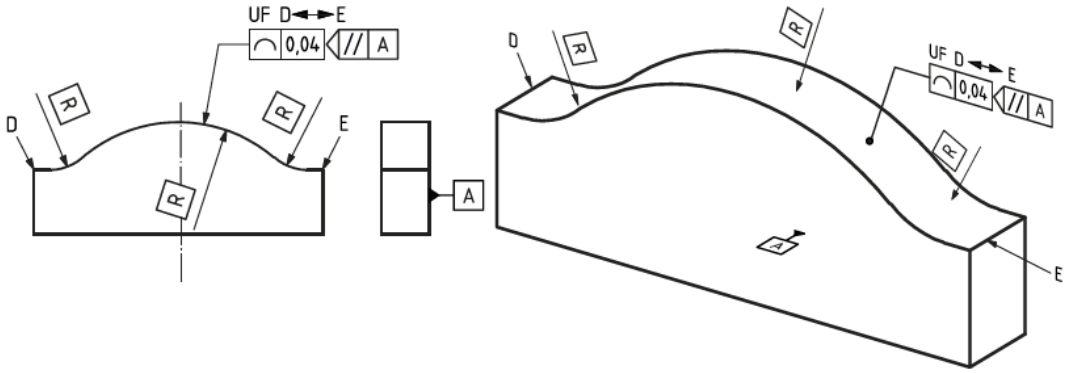
Fourth edition
2017-02

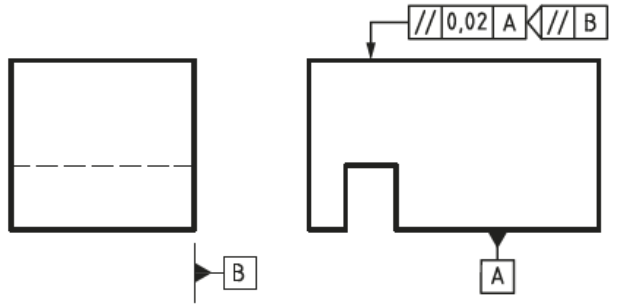
- Intersection Plane Indicator

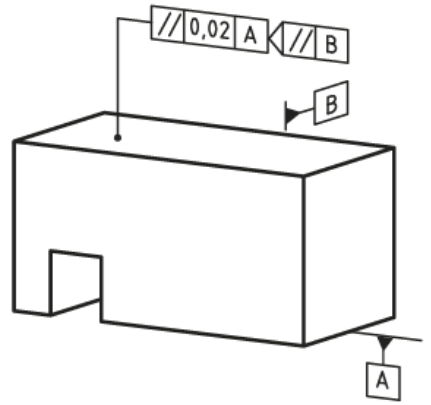
  Deprecated practice from ISO 1101:2012, The practice of relying on the drawing plane to define the intersection plane, e.g. for a straightness tolerance has been deprecated!





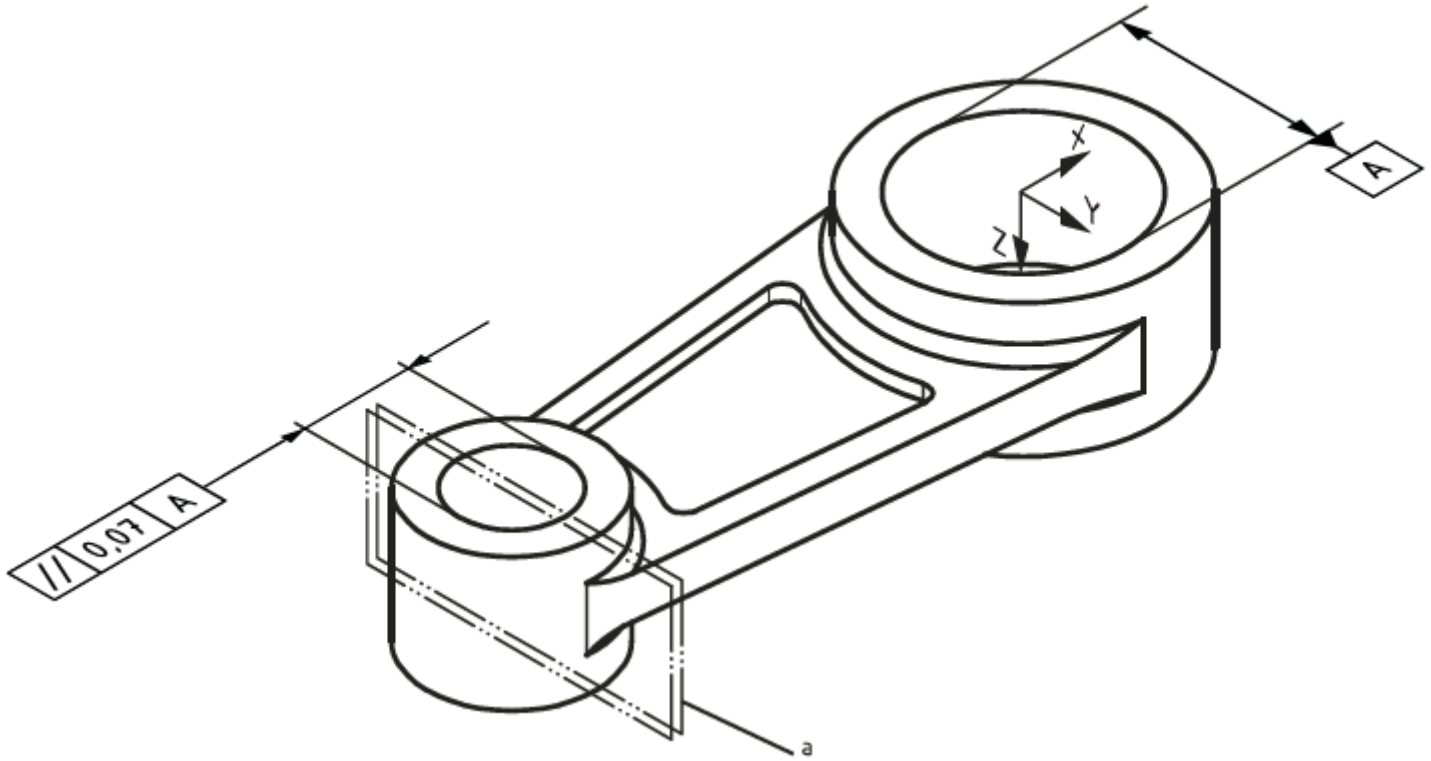






ISO GD&T STANDARDS – MBD RELEVANT CHANGES

- Orientation of Tolerance Zone – Former MBD Practice



The tolerance zone shown here is for clarification only and is not part of an actual presentation.

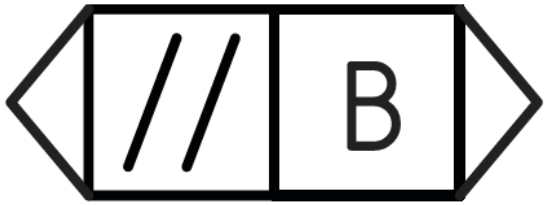
ISO GD&T STANDARDS – MBD RELEVANT CHANGES

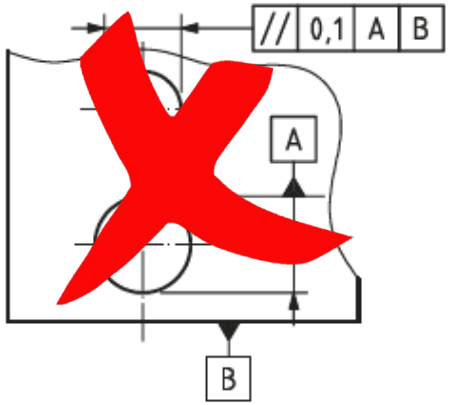
ISO 1101

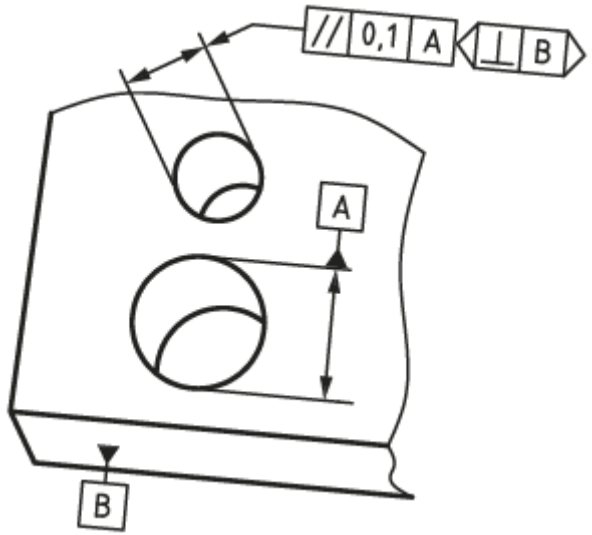
Fourth edition
2017-02

- Orientation Plane Indicator

  It was former practice in the case of a specification for a centre point or a median line in one direction that the arrow of the leader line defined the orientation of the tolerance zone, in some cases combined with a secondary datum.







ISO GD&T STANDARDS – MBD RELEVANT CHANGES

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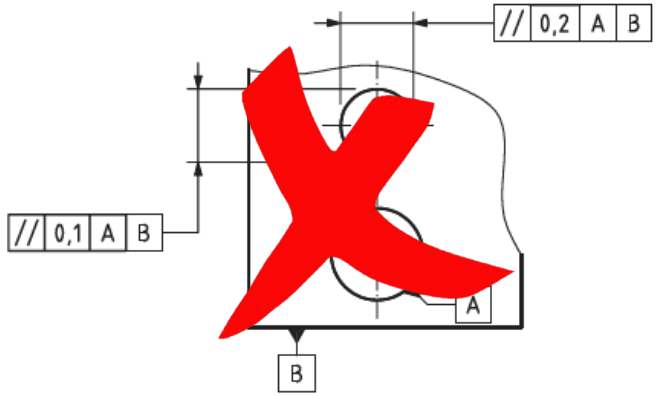

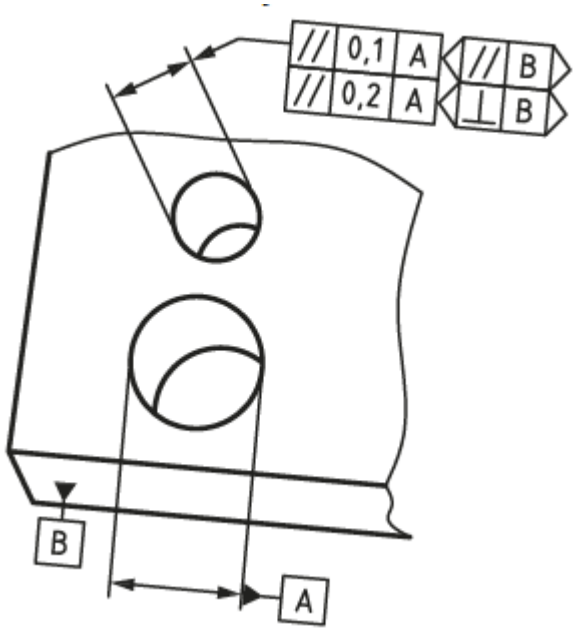

ISO GD&T STANDARDS – MBD RELEVANT CHANGES

ISO 1101

Fourth edition
2017-02

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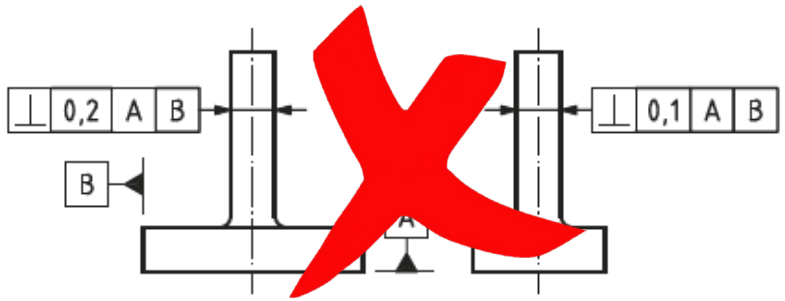
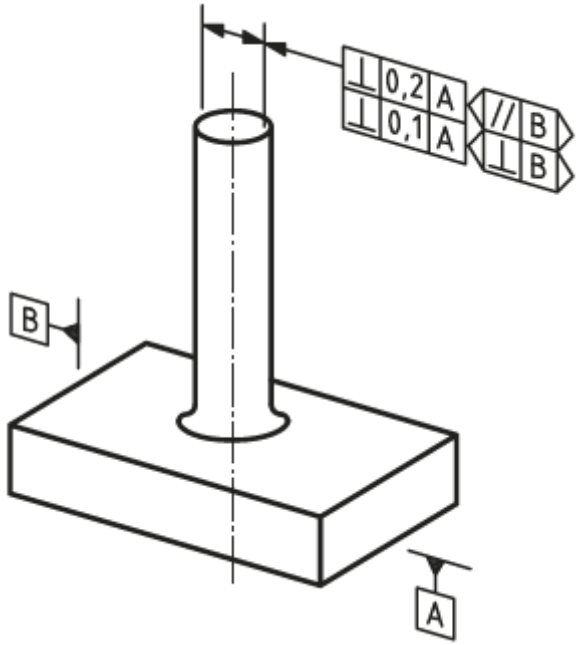
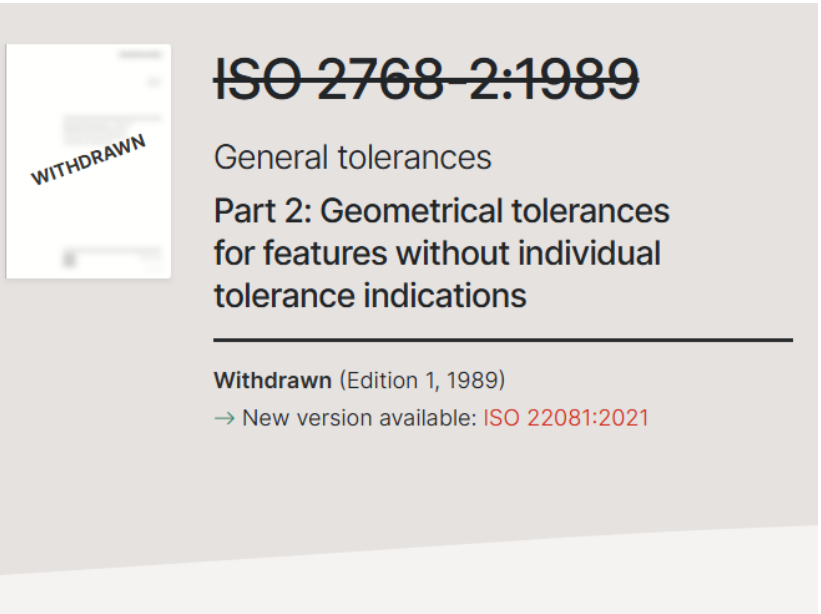




ISO GD&T STANDARDS – RECENT CHANGES

ISO 22081

First edition
2021-02



- Ideal for MBD (Model-Based Definition)

Supports clean, structured PMI in 3D models without over-annotation.

- Reduces annotation clutter on models

Allows global general tolerances instead of individually calling out every feature.

- Enhances interoperability in digital workflows

Downstream tools (CAM, CMM, metrology software) can interpret tolerances more reliably.

- Modernizes general tolerance specification

Provides a clearer, updated way to define general tolerances.

- Fully aligned with the ISO GPS framework

ISO 8015 and ISO 17450, ensuring unambiguous, rules-based tolerancing.

ISO GD&T STANDARDS – RECENT CHANGES

ISO 22081

First edition
2021-02

- Applies specifically to integral features

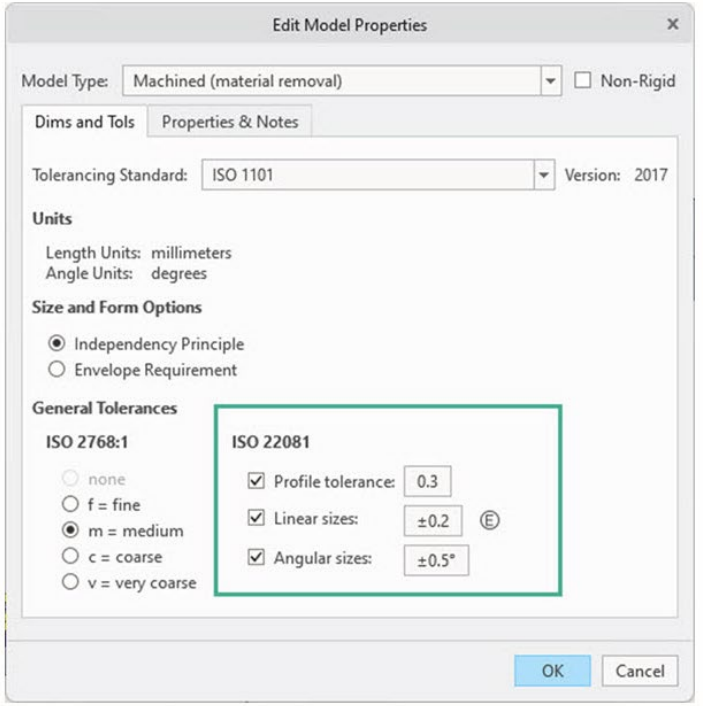
Targets features physically present in the model, a natural fit for MBD.

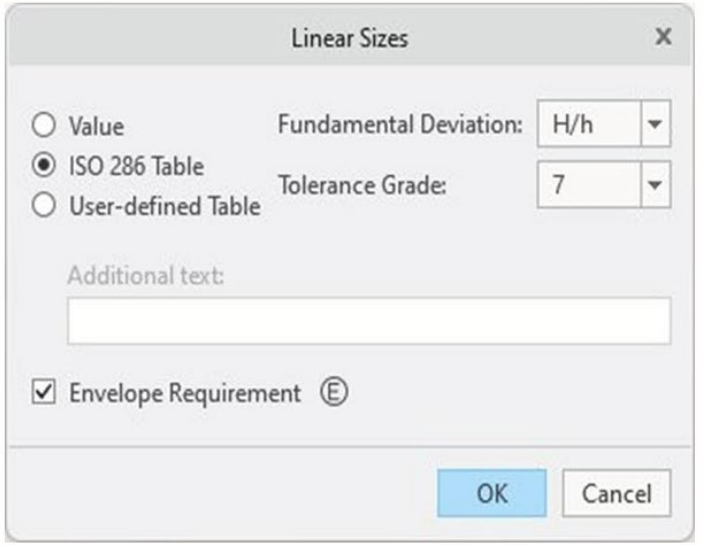
- Better suited for inspection and verification

Defined according to GPS semantics, making measurement results more consistent and traceable.

- Fits modern industry expectations for digital engineering

Addresses the need for clear, machine-interpretable tolerancing in model-based processes.





ISO GD&T STANDARDS – SUMMARY

“MBD not only follows the standards — it actively shapes their evolution.”

As digital engineering grows, standards like ISO 22081, ISO 1101 evolve to support clarity, automation, and interoperability.

“Successful MBD requires strong ISO GPS and GD&T mastery.”

Without deep understanding of GPS principles, even the best 3D models risk misinterpretation and downstream errors.