

CAD GDT Data Standards

Metrology Interoperability Consortium

August 29, 2001, Detroit

Tom Hendrix, Boeing

Agenda

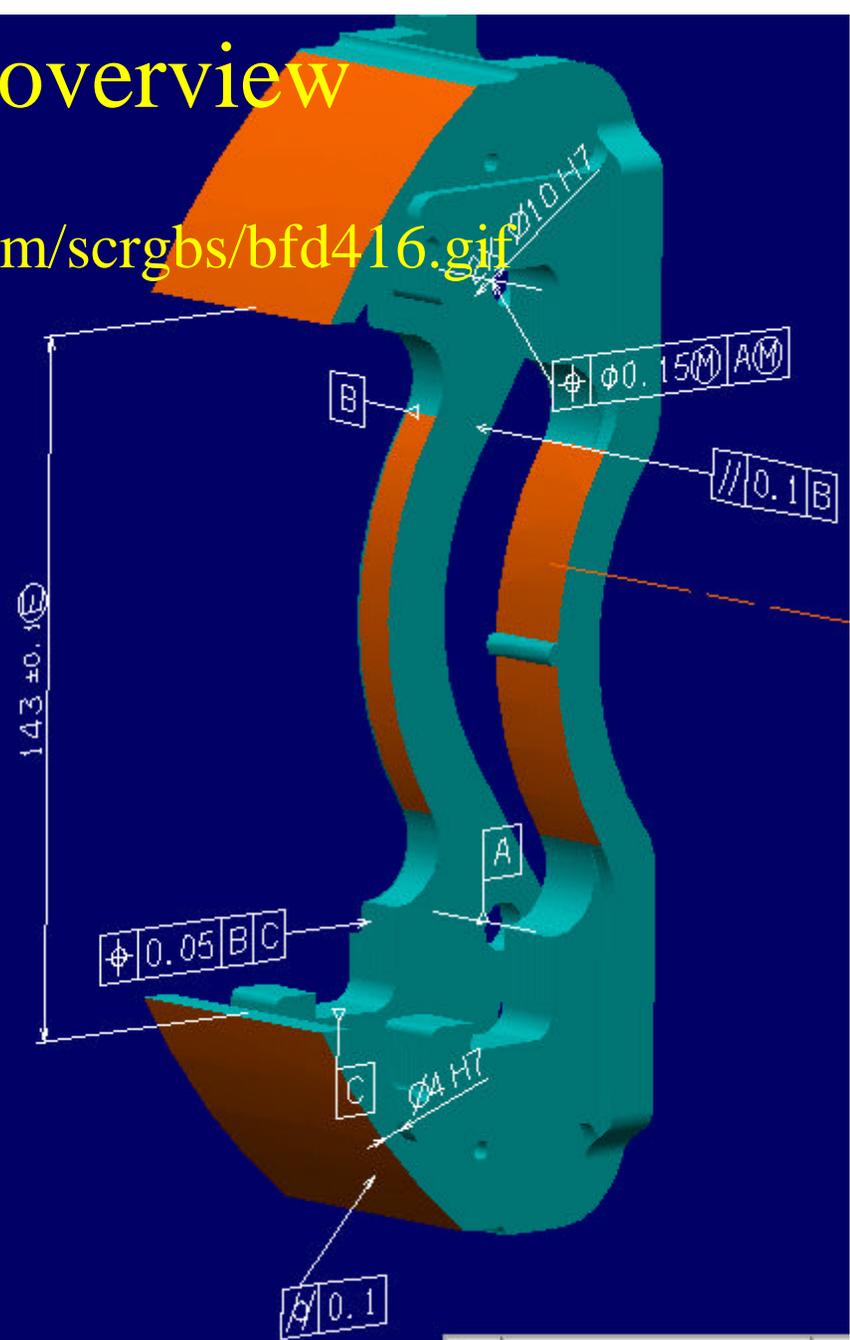
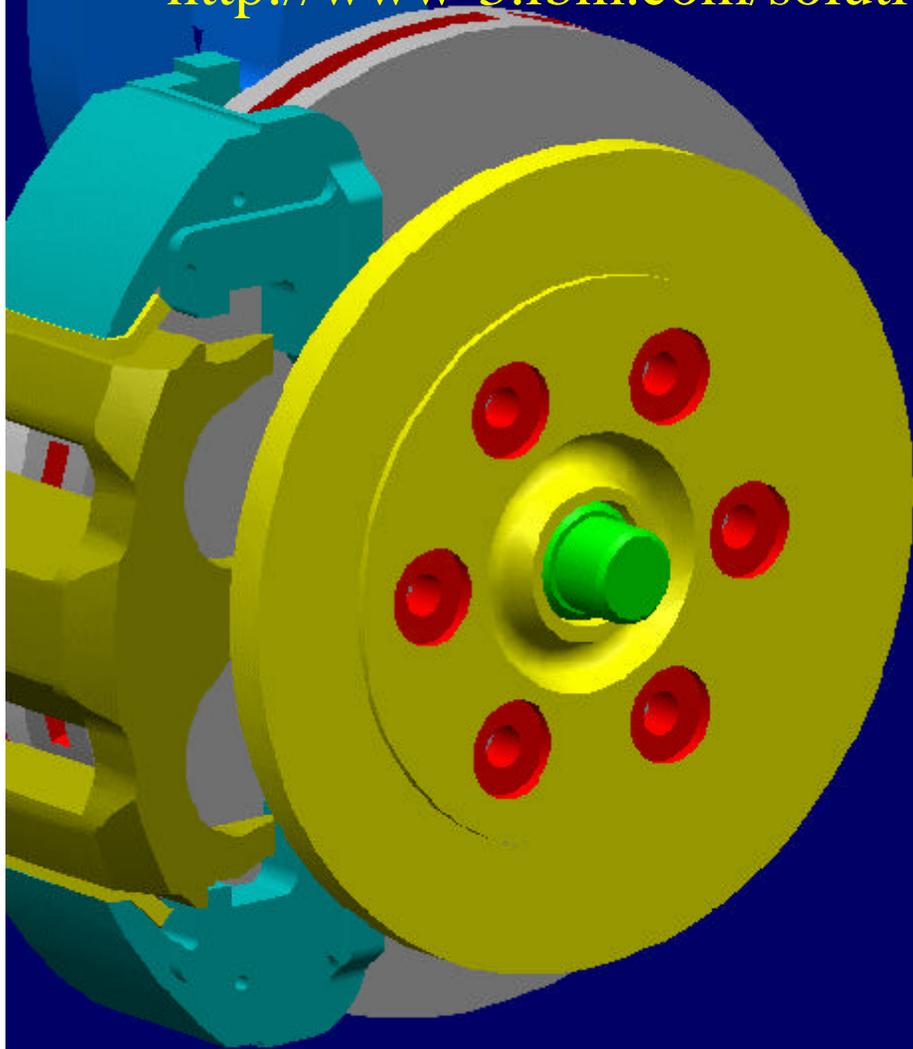
- CAD systems capabilities
- ASME Y14.41
- STEP
- AP 203 ed 2
- Application Modules
 - Geometry
 - PDM
 - GDT

CAD Vendor capabilities.

Vendor Capability overview

CATIA FDT

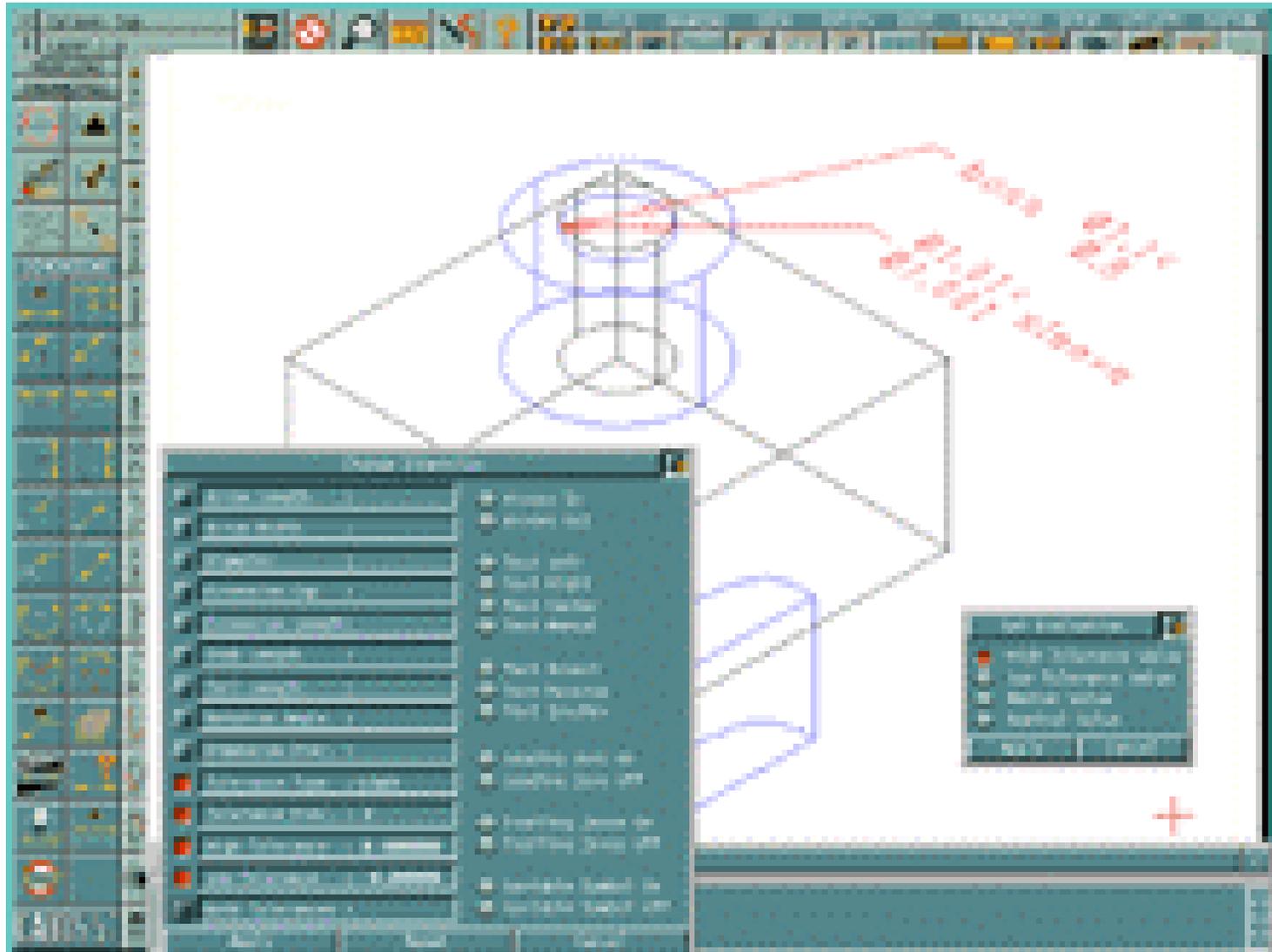
<http://www-3.ibm.com/solutions/plm/scrgbs/bfd416.gif>



Vendor Capability overview

PTC Parametric tolerancing

http://www.ptc.com/products/cadds/datasheets/param_tol.htm



CAD Dataset requirements standards

ASME Y14.41

- Industry objective
 - Support use of either model plus drawing, or model alone as a complete product specification.
 - Capture GDT and other specifications in a master dataset along with the geometric model.
 - Present GDT in 3D along with the product's shape.
 - Support dimensions by queries or call-outs.
 - Associativity between tolerances, datums, etc, support highlighting when selecting with mouse.

3D Only Data Exchange Requirements

- Geometry- solids, wireframe, surface.
- Dimensions, Dimensional Tol. ; Geom. Tol.
- Local and general notes, including embedded GDT references.
- Supplemental Geometry - limited regions of features, tooling references, true geometric counterparts, 2D sketches.
- Annotation
 - Local: Symbols for Dim, Tol, GDT and Notes but placed in 3 D.
 - Model: Tabulated D and T, Parts list, including flag notes.
- Associativity - connect the above for query support
- Presentation
 - Stored views with zoom, supplement geom, visible entity list

ASME Y14.41

- Status
 - In final draft
- Contents
 - Consistent with goals
 - Very thorough and detailed
- Will enable a new kind of product specification.

Data Exchange Standards

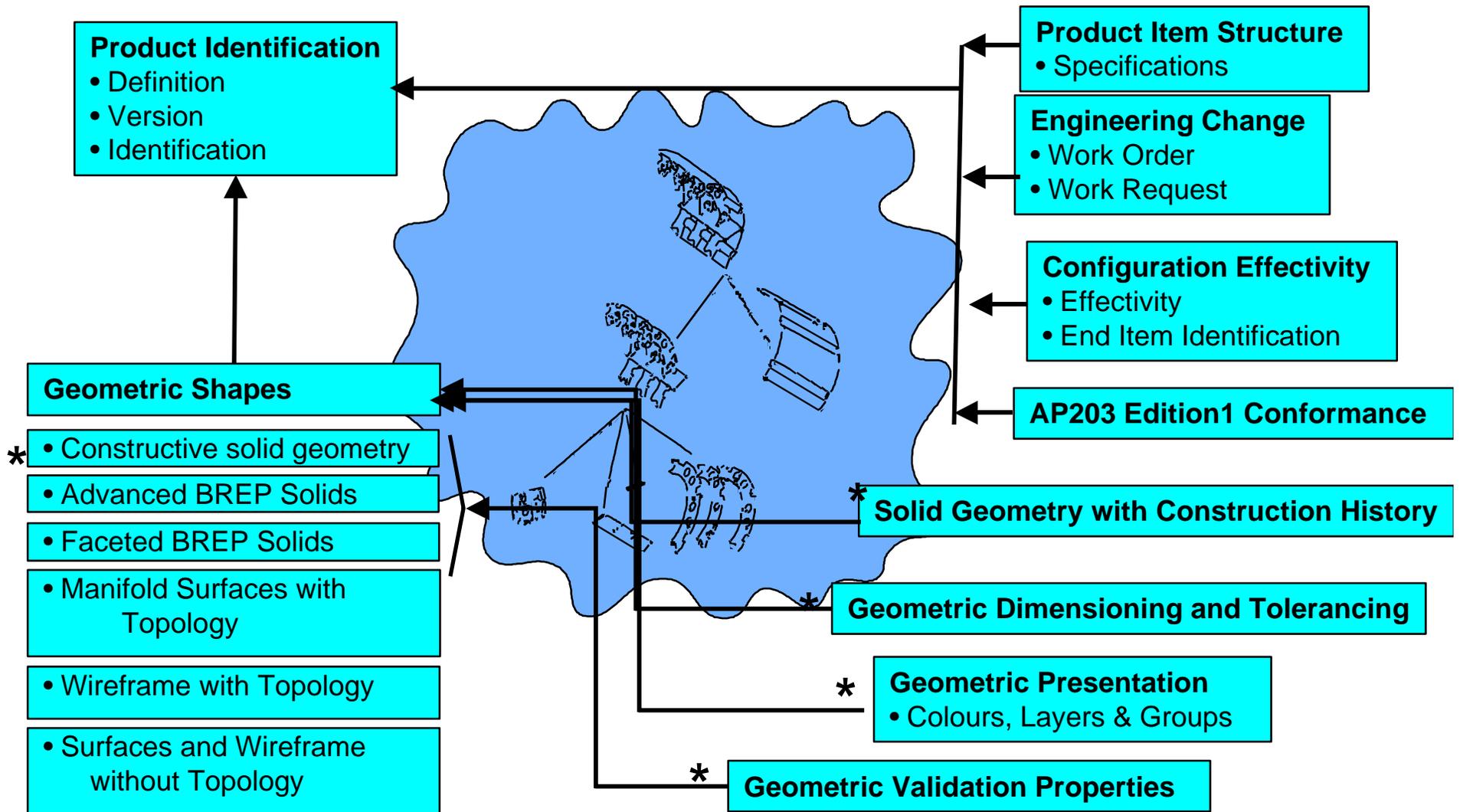


Boeing Position on STEP

- STEP is identified as The Boeing Company Standard for product data exchange.
- Boeing will only consider purchase of products that comply with STEP.
- It is Boeing's intent that our partners and suppliers comply with STEP as a requirement for maintaining business with Boeing.

AP203 Edition 2
Configuration Controlled Design

Configuration Controlled 3D Design of Mechanical Parts and Assemblies



③

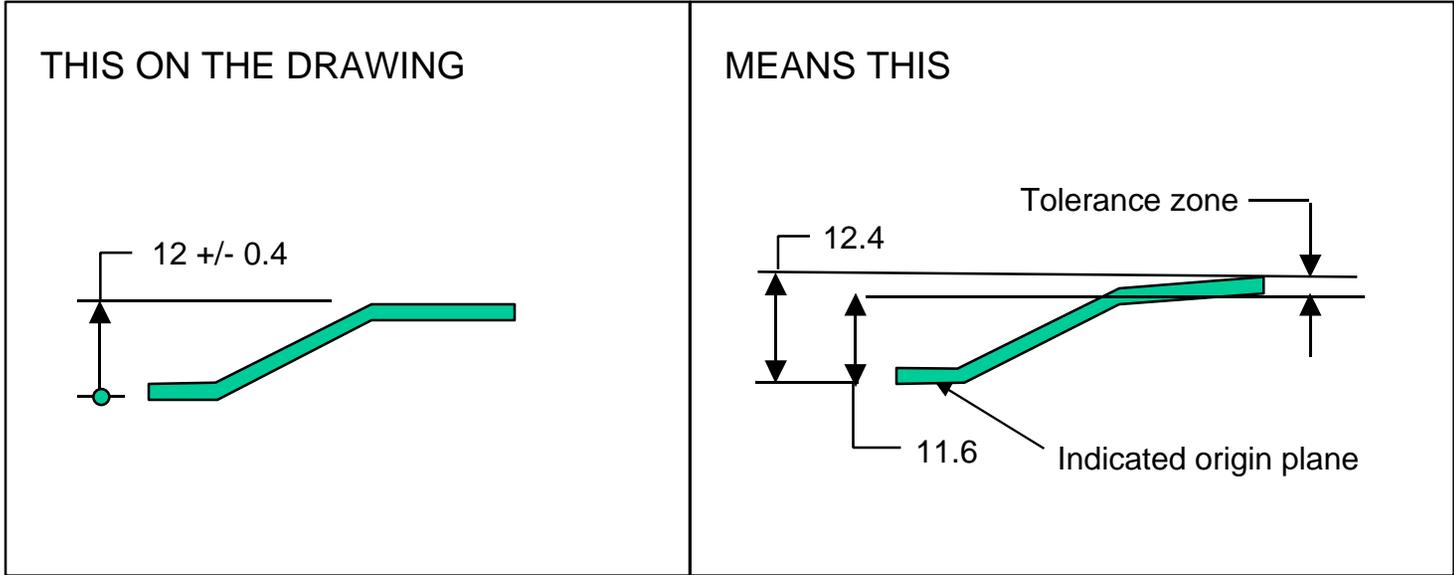
GDT Concepts in STEP

GDT and STEP

- GDT concepts and structures are modeled in several STEP standards as
- Drafting and Annotation
 - The alphabet: curve, text, symbol, ..., in 2D or 3D
 - The words: dimension callout, geometric tolerance callout, datum feature callout,
- GDT - the meanings
 - directly presented by annotation (not always 1-1)
 - geometric dimension, geometric tolerance, datum, ...
 - Implied by annotation
 - conical tolerances, virtual condition boundaries, ...
 - datum system, datum reference frame, ...
- A big question - Is there a market for adding 3D annotation to STEP
 - Or should we use machine readable GDT as product definition..

Annotation vs GDT

Typical figure from ASME Y14.5



Summary of GDT in STEP Standards

Part	214	202	224	210	AIC	IR(s)
GDT						
Defaults	Yes					
Geom Dims	Yes	Yes	Yes	Yes		47
Dim Tol	Yes	Yes	Yes	Yes		47
Geom Tol	Yes	Yes	Yes	Yes	519	47
GDT “deep”			Yes			
Drafting 2D&3D						
Dimensions	Yes	Yes			506	46,101
Other annotation	Yes	Yes			504	46,101
Associative	Yes	Dim			506	101

Existing GDT STEP models

<u>AP</u>	<u>219</u>	<u>224</u>	<u>210</u>	<u>207</u>	<u>202</u>
Application Objects	(AP214) 54	167	17	11 + 25*	
Mapping Table (pages)	29	89	5	8 + 13*	
AIM Entities	38	52	17	13 + 17*	

* 2D drafting annotation entities

GDT Requirements

Not explicitly supported in any STEP AP

- Functional vs non functional dimensions (ISO concept).
- Reference dimensions.
- Taper ratios, fractional dimensions.
- Composite form tolerances (maybe in AP 214).
- Association of material modifier to a sizing tolerance for form tolerances.
- Perfect vs imperfect derived “features”.
- Derived medians vs opposing elements.

D and T Requirements Only in AP 210

- Basic (nominal) dimensions.
- User defined and predefined D and T qualifiers.
- Maximum tolerance.
- Detailed model of all tolerances, categories, zones, boundary types.
- Statistical tolerancing, alternate tolerance.
- Separate and simultaneous requirements.
- Datum model that fully supports ASME Y14.5.

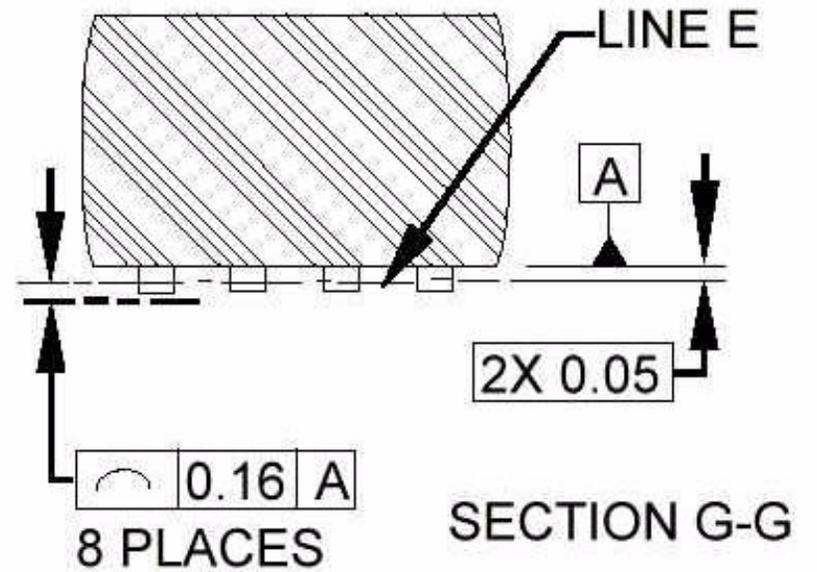
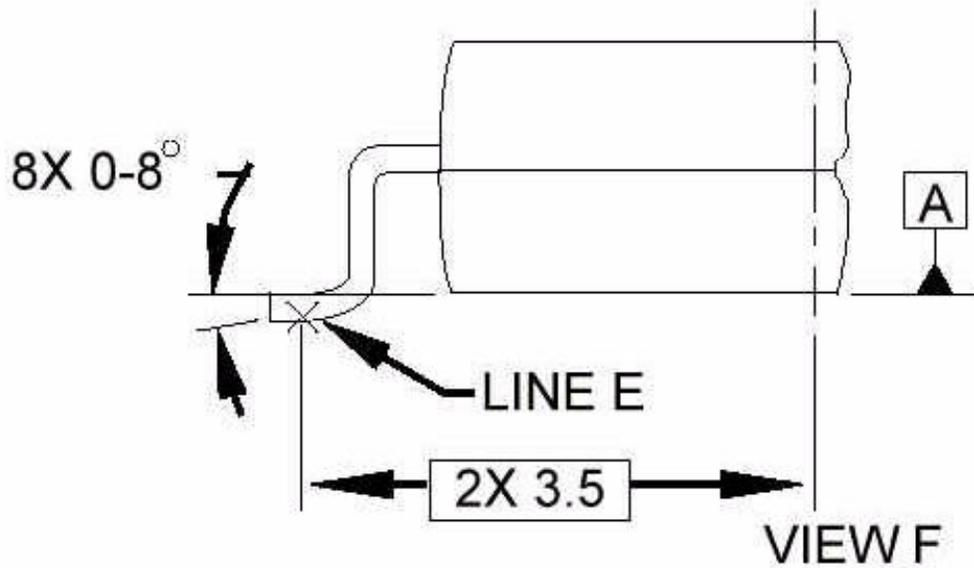
D and T Requirements

Only in AP 210

- Dimension associated to position tolerance.
- Datum type - SL etc (but could infer from shape rep if any).
- Management of release status (Frozen or not).
- Associated design requirements (form, fit, function).
- Bi-directional position tolerancing.
- Ability to reference an external controlling standard such as Y14.5

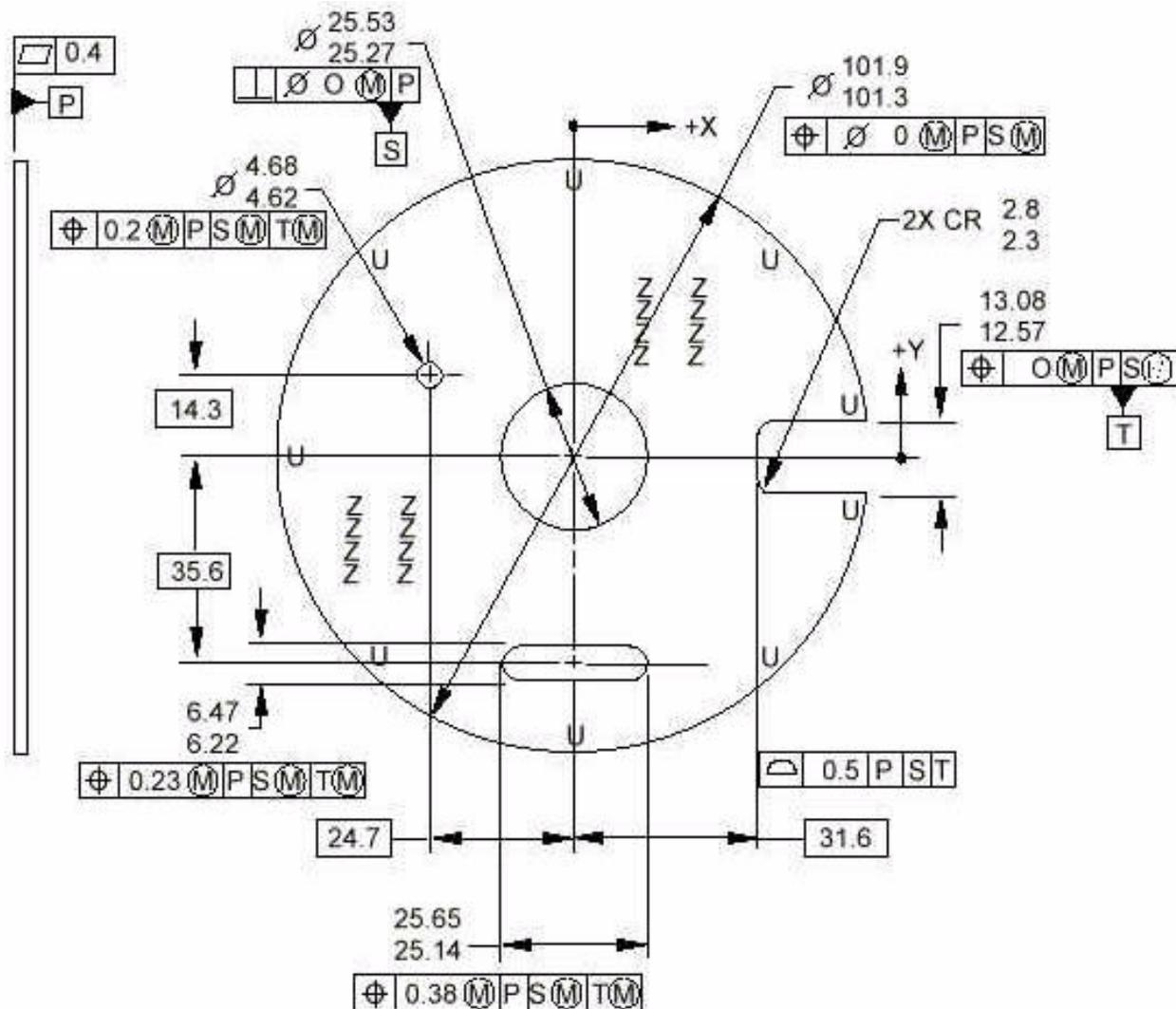
AP 210

Geometric Dimension Example



AP 210

Geometric Tolerancing Example

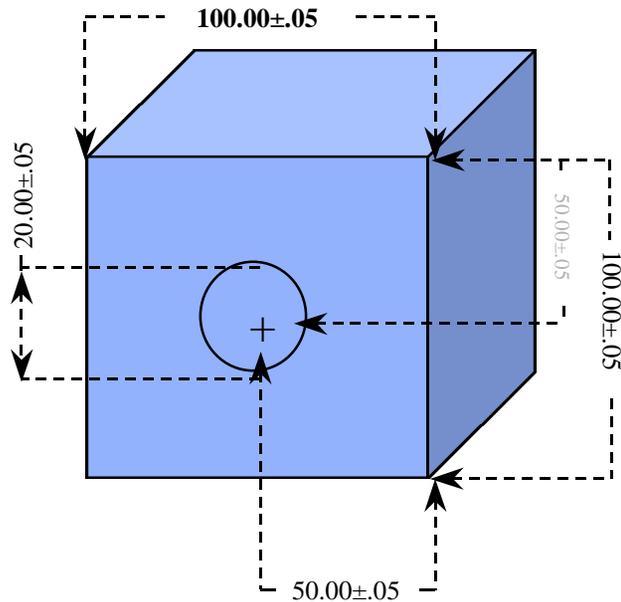


**Geometric Dimensioning and Tolerancing (GDT)
Modules development for PDES Inc.**

Benefits to STEP of Application Modules

- Standardize by functionality across user communities.
 - many APs support a large number of overlapping requirements
- STEP Processors can be certified for an application module.
 - valid for any Application Protocol that uses the module.
- Combat proliferation of 3000+ page APs.
- Modular APs are more easily created and extended.

Geometric Dimensions and Tolerances



USAGE SCENARIOS

- Identify critical dimensions and tolerances for components
- Provide Dimensions/Tolerance data independently of orthographic drawings
 - e.g., for Coordinate Measuring Machine programming

MILESTONES

- Q4 01 Recommended Practices complete
- Q4 01 Draft modules complete
- Q2 02 Submit to ISO as Tech Spec

TECHNICAL LEAD

Tom Hendrix

GDT Objectives

- Develop and validate application modules for geometric and dimensional tolerances
- Support CAD vendors implementing the modules

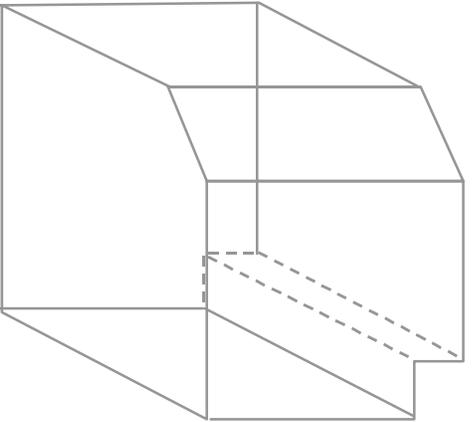
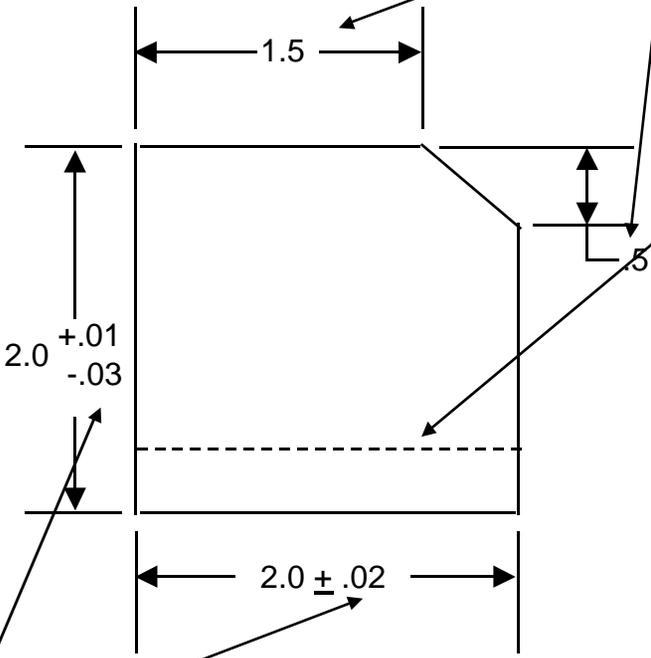
STEPnet/Test Rally

Round 1 Proposed Scope

Annotation is founded in view space
Single view is presented

Associative Linear
Dimensions

Style (font & color) associated
with hidden lines



Plus/minus tolerances

Association among dimensions,
tolerances, and geometry being
dimensioned captured in STEP file