An Overview of ASME Y14.41 - 2003

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- Embedded GD&T implementation project at GM Powertrain
- Chair of ASME Y14.41 Digital Product Definition Data Practices
- Member of ASME Y14.5 Dimensioning and Tolerancing
- Member of ASME Y14 Main
- Author of 12 books on GD&T and Tolerance Analysis
Agenda

Today’s discussion includes:

- Why a new standard was needed.
- The challenge of creating the standard quickly.
- An overview of the standard.
- Benefits of the standard.
- Closing comments.

This presentation can be obtained from www.etinews.com.
The Need for a New Standard

• The model is “nominal” only

From ASME Y14.41 - 2003
The Need for a New Standard

• The model is “nominal” only

• Current standards did not include tolerancing of models
The Need for a New Standard

- The model is “nominal” only
- Current standards did not include tolerancing of models
- Current standards did not include tolerancing of axonometric views

From ASME Y14.41 - 2003
The Need for a New Standard

• The model is “nominal” only
• Current standards did not include tolerancing of models
• Current standards did not include tolerancing of axonometric views
• Reduced dimension drawings were becoming more common without any standard to support the practices.

From ASME Y14.41 - 2003
ASME Y14.41 Committee Formed

• ASME Y14.41 sub-committee formed in 1998
ASME Y14.41 Committee Formed

- ASME Y14.41 sub-committee formed in 1998
- 16 companies represented

Boeing Company
Caterpillar Inc
CNH Global NV
Department of the Army
Dassault Systems
EDS PLM Solutions
Ford Motor Co.
General Dynamics Land Systems
General Motors
Lockheed Martin Aeronautics
Raytheon
Rockwell Collins
Rolls-Royce Corp
SDRC
Seimens Power Generation
Thiokol Propulsion
ASME Y14.41 Committee Formed

- ASME Y14.41 sub-committee formed in 1998
- 16 companies represented
- Accelerated Development

Committee formed

1998  Y14.41  2003

Publication

0  Typical standard  10
ASME Y14.41 Standard

• Title of new standard

DIGITAL PRODUCT DEFINITION DATA PRACTICES

ASME Y14.41-2003
ASME Y14.41 Standard

• Title of new standard

• Standardizing new practices
ASME Y14.41 Standard

• Title of new standard
• Standardizing new practices
• Scope

• Establishes requirements and reference documents applicable to the creation of product definition data sets.

• Defines exceptions and additional requirements to existing ASME standards for using product definition data sets or drawings in digital format.
ASME Y14.41 Standard

- Title for new standard
- Standardizing new practices
- Scope
  - Structure of the standard
    - Product definition data set
      - Model only
      - Model plus drawing in digital format
## ASME Y14.41 Standard Contents

1 - General

2 - Data set Identification and control

3 - Data set requirements

4 - Model Requirements

5 - Common requirements for product definition data

6 - Notes and Special Notations

7 - Model Values and Dimensions

8 - Plus and Minus Tolerances

9 - Datum Applications

10 - Geometric Tolerances
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<table>
<thead>
<tr>
<th>30 Definitions</th>
<th>16 Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Annotation</td>
<td>• Hard copy</td>
</tr>
<tr>
<td>• Annotation plane</td>
<td>• Installation model</td>
</tr>
<tr>
<td>• Assembly model</td>
<td>• Management Data</td>
</tr>
<tr>
<td>• Associated entities</td>
<td>• Model</td>
</tr>
<tr>
<td>• Associated group</td>
<td>• Model coordinate system</td>
</tr>
<tr>
<td>• Associativity</td>
<td>• Model geometry</td>
</tr>
<tr>
<td>• Attribute</td>
<td>• Model value</td>
</tr>
<tr>
<td>• Data</td>
<td>• Product definition data set</td>
</tr>
<tr>
<td>• Datum system</td>
<td>• Query</td>
</tr>
<tr>
<td>• Derivative</td>
<td>• Represented line element</td>
</tr>
<tr>
<td>• Design model</td>
<td>• Resolved dimension</td>
</tr>
<tr>
<td>• Digital element</td>
<td>• Saved view</td>
</tr>
<tr>
<td>• Digital element identifier</td>
<td>• Supplemental geometry</td>
</tr>
<tr>
<td>• Direction dependent tolerance</td>
<td></td>
</tr>
<tr>
<td>• Geometric element</td>
<td></td>
</tr>
</tbody>
</table>

- Assembly model
- Associated entities
- Associated group
- Associativity
- Attribute
- Datum system
- Derivative
- Design model
- Digital element
- Digital element identifier
- Direction dependent tolerance
- Geometric element
- Hard copy
- Installation model
- Management Data
- Model
- Model coordinate system
- Model geometry
- Model value
- Product definition data set
- Query
- Represented line element
- Resolved dimension
- Saved view
- Supplemental geometry
# ASME Y14.41 Standard Contents

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### Rules and guidelines

- Data set identifier
- Drawing Identification
- Related data
- Data management
- Approval
- Revision history
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Requirements, guidelines, options

• Fundamental dimensioning & tolerancing requirements
• General model requirements
  • Associativity
  • Model coordinate systems
  • Application of supplemental geometry
  • Part features not fully modeled
  • Model views
    • Saved views
    • Section views

Example
Model Requirements

- Geometric Scale, Units and Precision
  - Scale 1:1
  - Units Must be specified in data set
  - Precision Must be specified in data set

- Model completeness
  - Partial model (i.e. threads not modeled)
    - Must be specified in data set
  - Assembly Model
    - May be exploded, partially assembled, or completely assembled state.
    - Only requires enough detail to ensure correct identification, orientation, and placement of parts.
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- Common requirements
  - Ability to enable or disable the display of annotation
  - Hard copy available upon demand
- Model requirements
  - Associativity
  - Attributes available upon demand
  - Annotation planes
  - Leader lines
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- Requirements
  - All notes must be in a single annotation plane
  - General notes do not require association
  - Flag notes require association
• Resolved dimensions
  • Rounded to the number of places required for the design
  • Applies to all dimensions obtained from the model.

• Basic Dimensions
  • Queried model values shall be interpreted as basic dimensions unless superceded by a toleranced dimension or defined as a reference dimension.
  • If basic dimensions are displayed, they shall be in accordance with Y14.5.

• Size dimensions
  • **Bilateral or unilateral tolerance** – The displayed size dimension must agree with the queried model value.
  • **Limit Dimensions** – The resolved model value may equal one of the limit dimensions, or be any value within the displayed range of limits.
### ASME Y14.41 Standard Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - General</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>7 - Model Values and Dimensions</td>
<td></td>
</tr>
<tr>
<td>8 - Plus and Minus Tolerances</td>
<td>Limits the use of plus/minus dimensions to the following:</td>
</tr>
<tr>
<td></td>
<td>- Fillets, rounds, chamfers</td>
</tr>
<tr>
<td></td>
<td>- Reliefs, step surfaces</td>
</tr>
<tr>
<td></td>
<td>- Countersinks</td>
</tr>
<tr>
<td></td>
<td>- Oblique surfaces</td>
</tr>
<tr>
<td></td>
<td>- Entry depth and spotface</td>
</tr>
<tr>
<td></td>
<td>- Notches, flats and pin heights</td>
</tr>
<tr>
<td>9 - Datum Applications</td>
<td></td>
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<tr>
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<td></td>
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• Establishes Requirements for:
  • Datum reference frame and model coordinate system correspondence
  • Datum reference frame and model coordinate system associativity
  • Multiple Datum reference frame and model coordinate system relationship

• Shows attachment methods for identification of datum features and datum targets
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- Establishes Requirements for:
  - Attachment methods for geometric tolerances
  - Display in axonometric views

- Establishes exception / expansions of Y14.5
  - New symbol for unilateral profile
  - New method for denoting view dependent controls
  - Uses symbol from Y14.8 (castings) for movable datum targets

Example
ASME Y14.41 Standard Benefits

The new standard provides several benefits to industry.

• Standardize communications relative to digital data (30 new terms defined)
• Provides guidance on how to display tolerances on models and axonometric views
• Introduces the concept of a product definition data set
• Provide guidance to software manufacturers
• Methods for creating and using digital data are being addressed
Closing Comments

The first version of new standard leaves several challenges to be addressed.

• Currently the standard is more of a collection of practices or a toolbox of math based practices in industry.
Closing Comments

The first version of new standard leaves several challenges to be addressed.

- The current focus is the display of annotation.
The first version of new standard leaves several challenges to be addressed.

- Future versions need to address the transition between engineering specifications, the electronic model, and part inspection.
Closing Comments

The first version of new standard leaves several challenges to be addressed.

- There are gaps in ASME standards that need to be filled to support math processes (i.e. tolerances not mathematically sound, vague requirements, view dependent tolerances etc)
Closing Comments

The first version of new standard leaves several challenges to be addressed.

The Y14.41 standard is just one tool of the set needed for industry to become math based.
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The Y14.41 standard is just one tool of the set needed for industry to become math based.

The culture of the users is a key to implementing a math based process in industry.
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The Y14.41 standard is just one tool of the set needed for industry to become math based.

The culture of the users is a key to implementing a math based process in industry.

To make the math based process a reality in industry, it will take many tools coming together and working in harmony.
How to purchase a copy of the Y14.41 Standard

http://www.asme.org/codes/pr/y1441.html#description

ASME CODES AND STANDARDS


*This standard will be available in August 2003, however pre-orders can be placed at ASME Infocentral (contact information below)*

Overview | Contents | Pricing and Ordering Information

OVERVIEW | top of page

3D modeling is the future of design, and ASME Y14.41 sets the rules. Y14.41 extends ASME Y14.5M into the 3D world.

The development of this National Standard was initiated at the request of Industry and the U.S. Government.

The Y14.41 standard establishes requirements, and references documents applicable to the preparation and revision of digital product definition data, referred to as data sets. Y14.41 defines the exceptions and additional requirements to existing ASME standards for using product definition data sets or drawings in 3D digital format. This standard supports two methods of application:
Digital Tolerancing Forum: Join the Discussion

Although many companies are working on implementing model-based tolerancing, there is no forum to discuss technical issues, and lessons learned. To develop an accurate view of the state of the technology, and understand the technical issues and lessons learned in implementing model-based tolerancing, I have established a Digital Tolerancing Forum.

The Forum is comprised of individuals using various CAD Systems in the transition from 2-D drawings to using model-based tolerances. The Forum shares information on the capabilities, technical and implementation issues, and uses of digital tolerance information.

Topics of discussion:
- Benefits and uses for model-based tolerancing
- Embedded GD&T software capability
The End

Questions
(a) Targets with the same datum letter.
NOTE: The annotation planes shown here as dashed lines are for clarification only, and are not part of an actual presentation.

(a) Coincident annotation plane.  
(b) Perpendicular annotation plane.

Fig. 10-1  General Application of Geometric Tolerances – Coincident of Perpendicular Annotation Plane

From ASME Y14.41 - 2003
### Table 7-1 Resolved Dimension Examples

<table>
<thead>
<tr>
<th>ASME Y14.5</th>
<th>Model Value [Note (3)]</th>
<th>Resolved Dimension</th>
<th>Application Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic [Note (1)]</td>
<td>88.4100000...</td>
<td>88.4</td>
<td><img src="image" alt="88.4" /></td>
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<tr>
<td>Size [Note (2)]</td>
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<td>7.0</td>
<td><img src="image" alt="7.0" /></td>
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<tr>
<td>Linear</td>
<td>19.6666666...</td>
<td>19.67</td>
<td><img src="image" alt="19.67±0.12" /></td>
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<tr>
<td>Radial</td>
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<td><img src="image" alt="CR 3.2" /></td>
</tr>
<tr>
<td>Angular</td>
<td>28.5918273...</td>
<td>28.6</td>
<td><img src="image" alt="28.6°±0.4°" /></td>
</tr>
<tr>
<td>Single Limit [Note (1)]</td>
<td>12.0000000</td>
<td>12</td>
<td><img src="image" alt="12 MIN" /></td>
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<tr>
<td>Reference [Note (1)]</td>
<td>21.6018043</td>
<td>21.6</td>
<td>(21.6)</td>
</tr>
</tbody>
</table>

**GENERAL NOTE:** Table referenced in paras. 3.1.1(b)(3) and 7.1.1.

**NOTES:**

1. Linear, radial, angular, diametral, or spherical diameter.
2. Linear, diametral, or spherical diameter.
3. The values shown are examples. Actual values will reflect the defined precision of the model and the rounding requirements of each particular application.
(d) Chamfer – unequal offsets.

(e) Chamfer – offset and angle.