

JAMA/JAPIA 3D drawing guidelines

- Guidelines for Combining 3D Models and 2D CAD Documentation -

JAMAEIC034

April 2007

The logo for JAMA (Japan Automobile Manufacturers Association) consists of the letters 'JAMA' in a bold, black, sans-serif font. The 'J' is particularly thick and stylized.

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SASIG

3D drawing guidelines

- Guidelines for Combining 3D Models and 2D CAD Documentation -

September 2006

FOREWORD

The automotive industry has increased the use of 3D CAD systems, beginning with the development stage and moving toward manufacturing and customer support. The combined or assembled 3D models created by these systems are commonly referred to as “digital mockups.”

Traditionally, 2D drawings have been the distribution medium used in manufacturing. Standards and practices have been well established and universally adopted. Design education is readily available at industrial high schools and universities with engineering faculties.

Although 3D models are becoming more commonly used and widely accepted, there are no standards, resulting in various problems being experienced within the automotive industry. And unlike 2D drawings, educational institutions do not consistently provide coursework on creating and reading 3D models.

The ISO (International Organization for Standardization) and the ASME (American Society of Mechanical Engineers) groups are engaged in activities that will standardize drawings using 3D. In July 2003, ASME published *Digital Product Definition Data Practices*, which defines the indication of geometrical tolerance in 3D models. At the same time, ISO was in the final stages of releasing its own version of this standard.

The Digital Visualization Workgroup (DEV) in the Strategic Automotive Product Data Standards Industry Group (SASIG) began a project to establish standards for combining 3D models and 2D drawings. The results of this project are hereby published in this document: *Guidelines for Combining 3D Models and 2D CAD Documentation, V. 1*.

The guidelines have been tailored to the current circumstances of SASIG and will be revised as the need arises.

Also, there are plans to issue *Standards for 3D Annotated Models*, in 2007. This document will deal in more depth with 3D annotated models.

ACKNOWLEDGEMENTS

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INTRODUCTION

These guidelines define standardized practices for creating and defining 3D models by organizing and consolidating the current drawing and usage methods of the members of SASIG.

Accordingly, this document has been developed for practical use as a guideline for designers and engineers in the automotive industry. While the focus remains on the 3D models, their interaction with 2D drawings has also been addressed.

When using these guidelines, refer to the ISO Standards on *Technical Drawings* for the basic standards for 2D drawings. And when indicating geometrical tolerances of 3D models, refer to the ASME Y14.41 document *Digital Product Definition Data Practices*.

1 TERM DEFINITIONS

This chapter stipulates the definitions of drawing and CAD terms as well as some generic terms used in these guidelines. Applicable standards include the following:

- ISO 10209-1: Technical Product Documentation Vocabulary - Part 1
- ISO 10209-2: Technical Product Documentation Vocabulary - Part 2
- JIS B 340: CAD terms

1.1 Drawing Terms

1.1.1 General Drawing Terms

No.	Term	Definition
1001	Drawing practices	The act of model creation.
1002	Technical drawing	Technical information displayed in the form of models or diagrams, which are drawn based on rules and information databases, often drawn to a set scale.
1003	Notes	Explanatory notes included in models, which give supplementary information regarding content.

1.1.2 Drawing Terms

No.	Term	Definition
2001	Product characteristics	Notes regarding specification information such as product dimensions, tolerance and geometrical characteristic indications, surface property and surface treatment, and precautions for manufacturing and inspection.
2002	Management information	Management of such data elements as parts lists, parts columns, title columns, and design change history, and product characteristics such as materials and surface treatment.
2003	Item list	Complete list of parts composing a single assembly part (or a single subassembly) or details of parts indicated on a single drawing.
2004	Title block	Specific area provided as part of a drawing for the entry of items required for drawing management: formatted items identifying the contents of the drawing, such as drawing number, drawing name, company name, etc. in a

		single group.
2005	Item block	Area provided on the drawing to enter the details (part name, material, quantity, etc.) of the object shown in the drawing or its component parts (members).
2006	2D drawings	Two-dimensional documents displaying product shape and characteristics (notes and attributes), product characteristic notes, and management information details.
2007	3D models	3D geometric representations used to define product shape and characteristics (notes and attributes) used in conjunction with simplified 2D drawings.
2008	Simplified 2D drawings	Two-dimensional documents displaying product shape and characteristics (notes and attributes) not shown in 3D models management information. Because of their limited content, simplified 2D drawings must be used in combination with 3D models to provide complete product definition.
2009	3D annotated models	3D models that display product shape and characteristics (notes and attributes), and models that contain information such as product characteristics and management information items.

1.2 CAD Terms – Modeling

No.	Term	Definition
3001	Geometric model	A model that describes the shape of a physical or mathematical object by means of geometric concepts.
3002	3D model	Geometric model displaying a three-dimensional shape. It can be classified into solid models based on volume information, surface models based on surface information, and wire frame models based on line information. 3D models may also contain non-geometric characteristics such as annotations, attributes, etc.
3003	2D model	Geometric model displaying a product shape in a two-dimensional form. 2D models may also contain non-geometric characteristics such as annotations, attributes, etc.
3004	Wire frame model	Geometric model displaying a three-dimensional shape using edge lines.
3005	Surface model	Geometric model displaying a three-dimensional shape

		using surfaces.
3006	Solid model	Geometric model displaying a three-dimensional shape so that the space (volume) occupied by this shape is completely specified.
3007	Annotations	Explanations of product characteristics that are displayed using characters and symbols added to the geometric model.
3008	Viewer	Tool that enables the viewing of data created by CAD systems even if a CAD system is not available. The tool can display and print the data but cannot edit it. Some types of viewers can display notes, annotations, and attributes attached to 3D models; make interference checks; perform measurements; or mark up. Essentially, the original data cannot be changed.
3009	Fillet surface	Curved surface that is inserted to smooth connections between multiple surfaces.
3010	Global coordinate	Highest level coordinate system that is defined for the product. In the automotive industry, these typically define "Body Position."
3011	Local coordinate	Localized coordinate system that is defined relative to global coordinates.
3012	Layer	Single level of a model with multiple images in a superimposed form.
3013	STEP	Standard for the Exchange of Product model data. Generic term for the standards developed by ISO (International Organization for Standardization) related to displaying and converting product models.
3014	Product shape	Shape of the product that was actually manufactured. However, for 3D models that are handled for reference, the draft angle and fillet surface may not be included.
3015	Attributes	Dimension, tolerance, note, text, or symbol required to complete the product definition or model feature of the product that is not visible but available upon querying the model. The product features and dimensions in product characteristics.
3016	CAM model	Model for processing and/or manufacturing.
3017	Design change content	The details of a design change.

3018	Design change number	Number displayed on the model to enable distinction of the design change locations.
3019	Design change history	The history (records) of design changes.

2 DRAWING STYLE TYPES

2.1 General Drawing Style Rules

This chapter stipulates the drawing style types (mainly part drawings and assembly drawings) used by CAD systems in the automotive industry.

With the adoption of 3D CAD systems and the lack of standards for documenting 3D models, the potential combinations of 3D models and 2D drawings is infinite. In the future, it is envisioned that 2D drawings will be replaced by fully annotated 3D models. The designers who create the drawings and the industrial engineers, service technicians, suppliers' engineers and others who use the drawings, must be able to understand the potential combinations of 2D drawings and 3D models. Therefore, it is necessary to define the differentiation between the 2D drawings and the 3D models.

Applicable standards include the following:

- ISO 10209-1: Technical Product Documentation Vocabulary - Part 1
- ISO 10209-2: Technical Product Documentation Vocabulary - Part 2
- JIS B 3401: CAD Terms

2.1.1 Types of Drawing Styles

The drawing styles stipulated in these guidelines consist of 2D drawings and 3D models that are drawn using CAD systems and information that is added using PC software.

The 2D drawing style is composed of 2D drawings and simplified 2D drawings, while the 3D drawing style is composed of 3D models and annotated 3D models.

Drawing styles are combinations of drawing types. Drawing styles are divided into the following five types:

- (a) Drawings using only 2D drawings
 - (1) 2D drawings
- (b) Combinations of 3D models and 2D CAD documentation
 - (2) 3D models and simplified 2D drawings
 - (3) 3D models, simplified 2D drawings, and management information
- (c) Drawings using only 3D models
 - (4) 3D annotated models
 - (5) 3D annotated models and management information

Table 1. A combination of drawing style and information tool

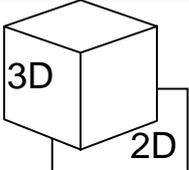
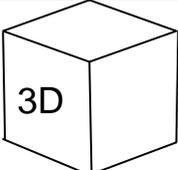
Drawing style types	Geometric representation		Product characteristics attached to Geometry (Annotations)		Product characteristics not attached to Geometry (ie. General notes)		Management information	
	2D	3D	2D CAD	3D CAD	CAD *1	Other electronic format	CAD *1	Other electronic format
2D drawings	✓		✓		✓		✓	
3D models & simplified 2D drawings	✓	✓	✓	✓	✓	✓	✓	✓
3D annotated models		✓		✓	✓	✓	✓	✓

*1: 2D or 3D

2.1.2 Drawing Style Marks

Table 2 shows the drawing style marks that can be attached to drawings. These marks enable users to easily identify the various drawing styles.

Table 2. Drawing style marks

2-D drawings	3-D models & simplified 2-D drawings 3-D models, simplified 2-D drawings & management information	3-D annotated models 3-D annotated models & management information
		

2.1.3 Principal Drawing Information

Drawing information included in the drawing types can largely be divided into product shapes, product characteristics, and management information. Table 3 shows the principal drawing information.

Table 3. Principal 3D models and 2D CAD documentation information

Group	Principal drawing information
<i>Product shape</i>	3-D shape, 2-D shape, and coordinate system
<i>Product characteristics</i>	Dimensions and tolerance, geometrical tolerance, mounting angle and position, hardness, surface property, heat treatment and surface treatment, material, mass, scale, specification table, graph, annotation attached to drawing, itemized note, quality control
<i>Management information</i>	Part name, part number, quantity used, approval signature/date, design change history, destination, variation, drawing style mark, other management information entries and itemized notes

2.2 Drawings Using Only 2D Drawings

This type of drawing displays 2D models in which the product shape and product characteristics (annotations and attributes) are displayed in a two-dimensional form. The notes of product characteristics and management information are included on the 2D drawing.

Refer to Figure 1 for the information configuration of a 2D drawing and to Figures 2 and 3 for examples of 2D drawings.

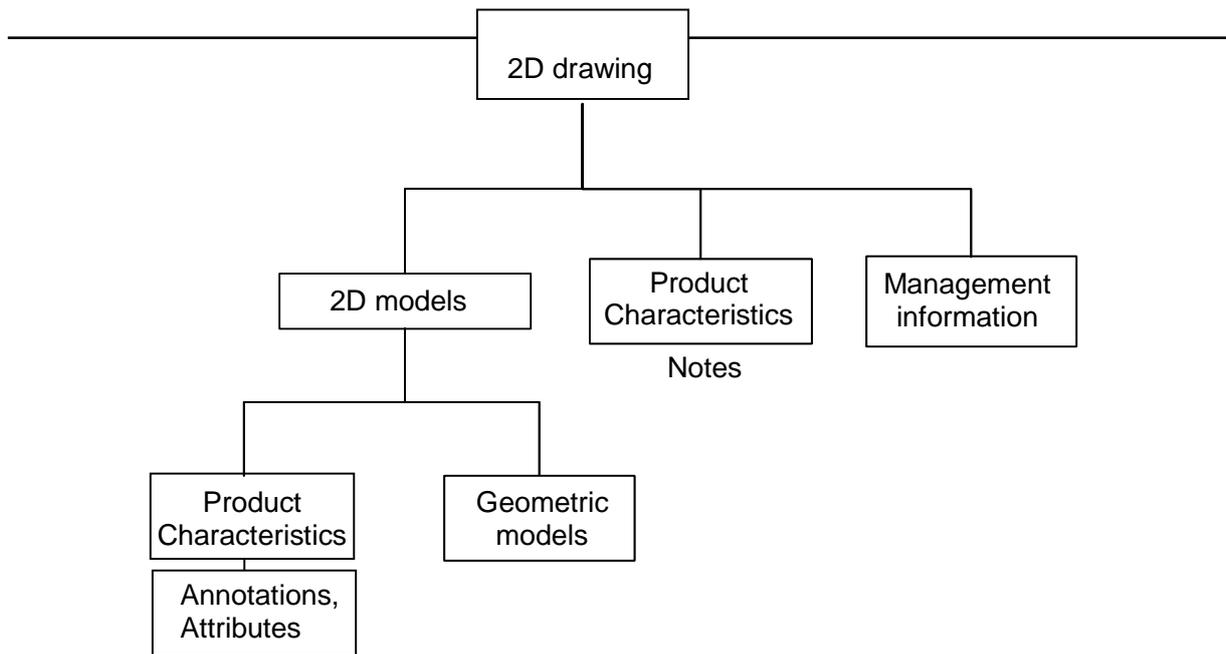


Figure 1 Information configuration of a 2D drawing

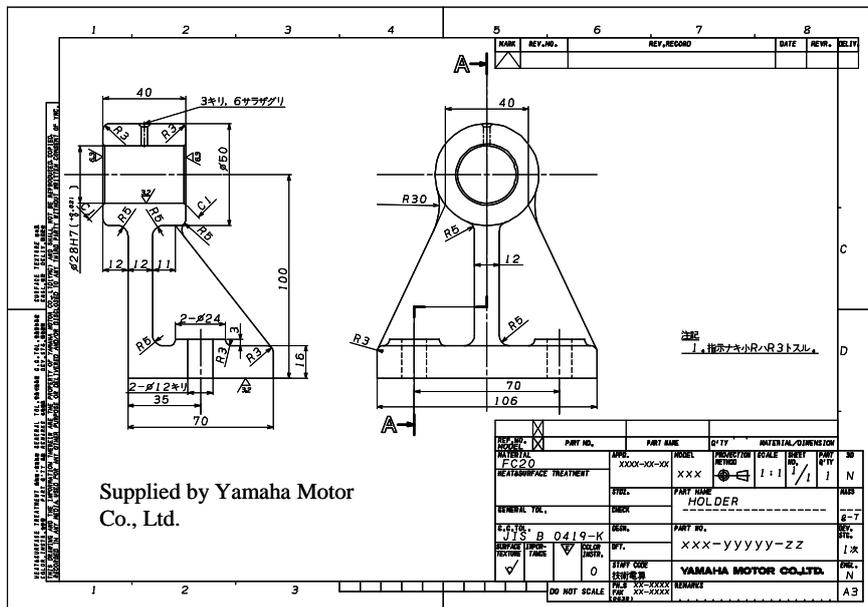


Figure 2 2D drawing (Example)

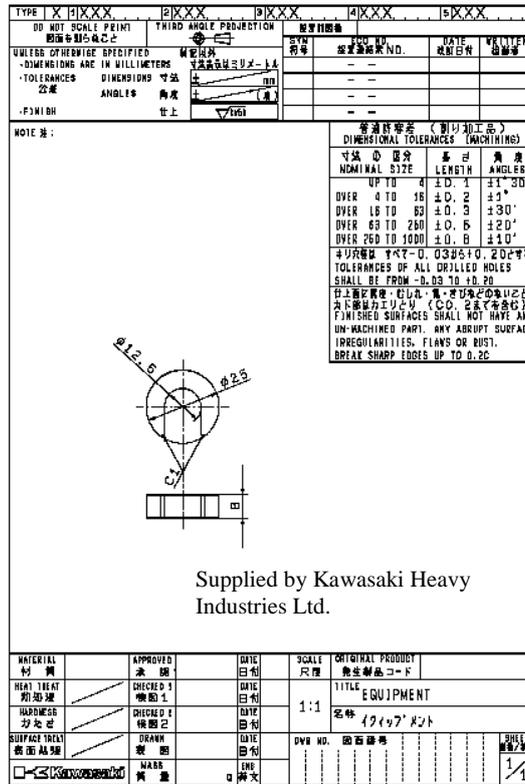


Figure 3 2D drawing (Example)

2.3 Combinations of 3D Models and 2D CAD Documentation

2.3.1 3D Models and Simplified 2D Drawings

3D models and simplified 2D drawings are a combination of 3D models that depict product shapes and characteristics (annotations and attributes) and simplified 2D drawings that provide supplementary information regarding 3D models. In some cases, product characteristics are not included in 3D models.

Figure 4 shows the information configuration of 3D models and simplified 2D drawings. Figures 5 and 6 show examples of 3D models and simplified 2D drawings.

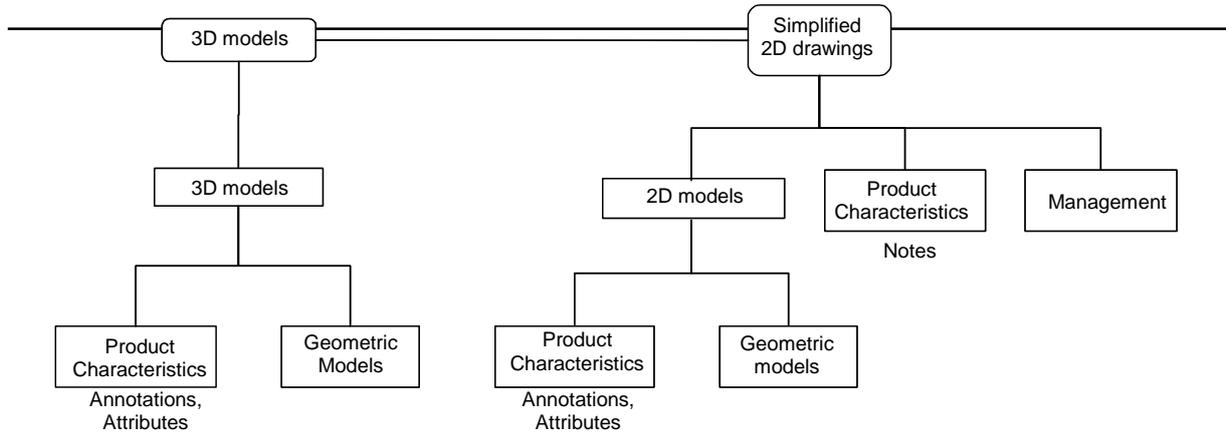


Figure 4. Information configuration of 3D models and simplified 2D drawings

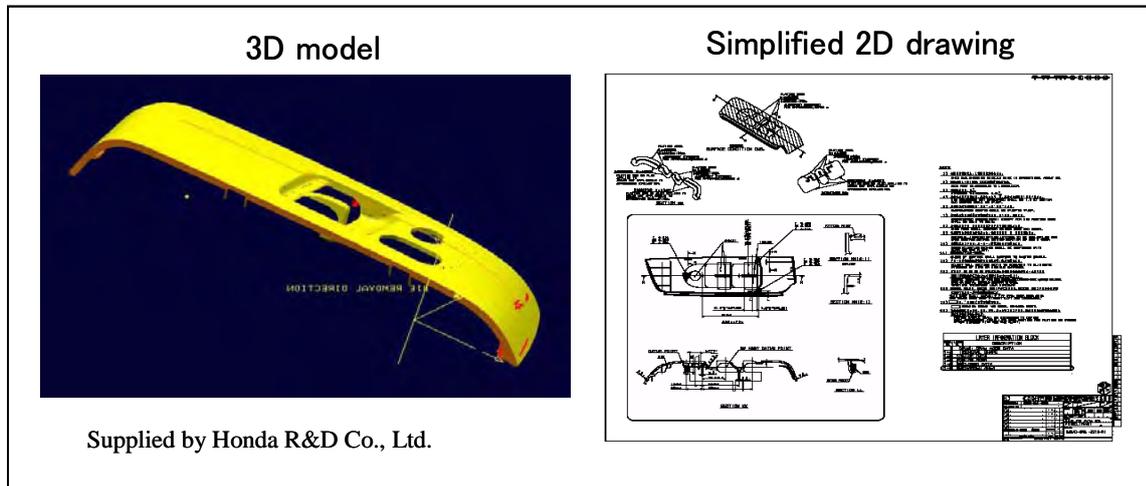


Figure 5 3D model with an annotation (Example)

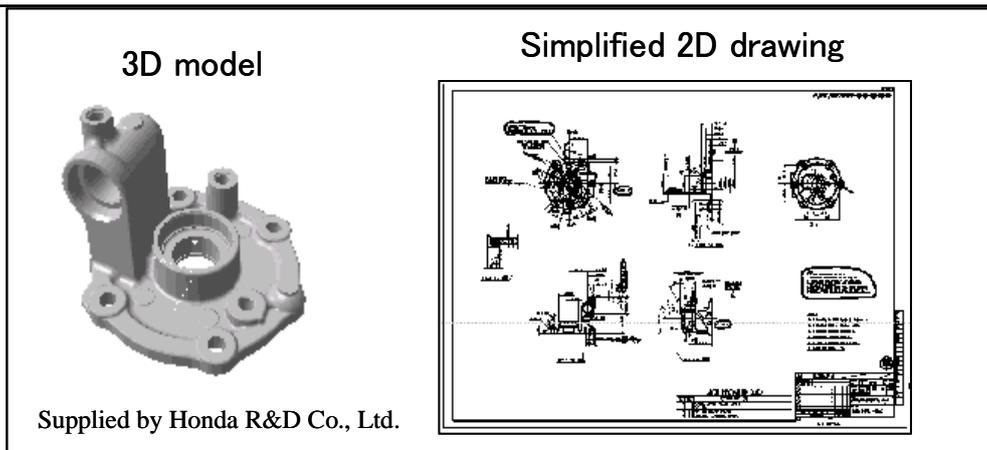


Figure 6 3D model with no annotation (Example)

2.3.2 3D Models, Simplified 2D Drawings and Management Information

3D models, simplified 2D drawings, and management information are a combination of 3D models that depict product shape and characteristics (annotations and attributes), simplified 2D drawings that provide supplementary information regarding 3D models, and management information entries created by other electronic format. When product characteristics are not included in the 3D model, they must be provided in either a simplified 2D drawing or in an additional information file. Figure 7 shows the information configuration of 3D models, simplified 2D drawings, and management information. Figures 8 and 9 show examples of 3D models, simplified 2D drawings, and management information.

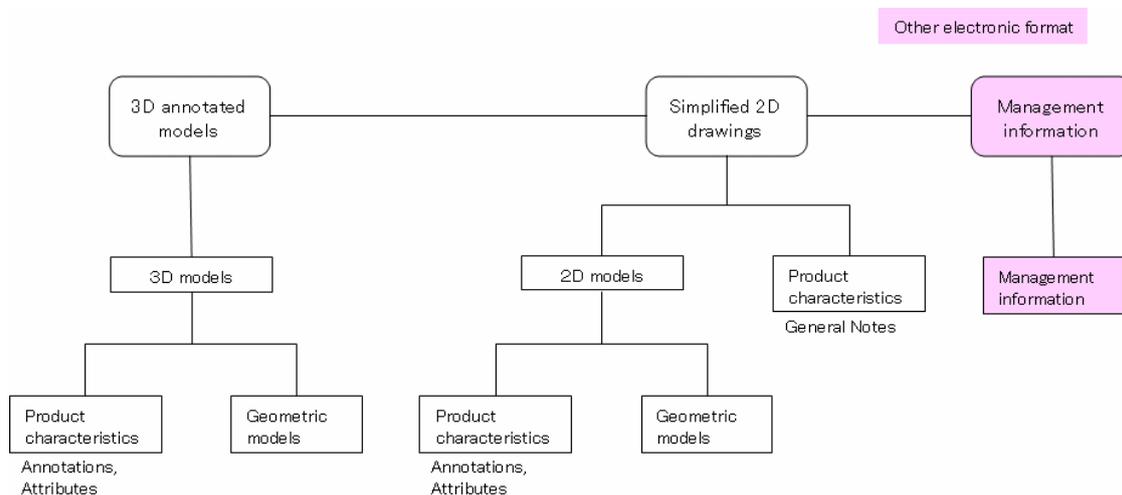


Figure 7 Information configuration of 3D models, simplified 2D drawings, and management information

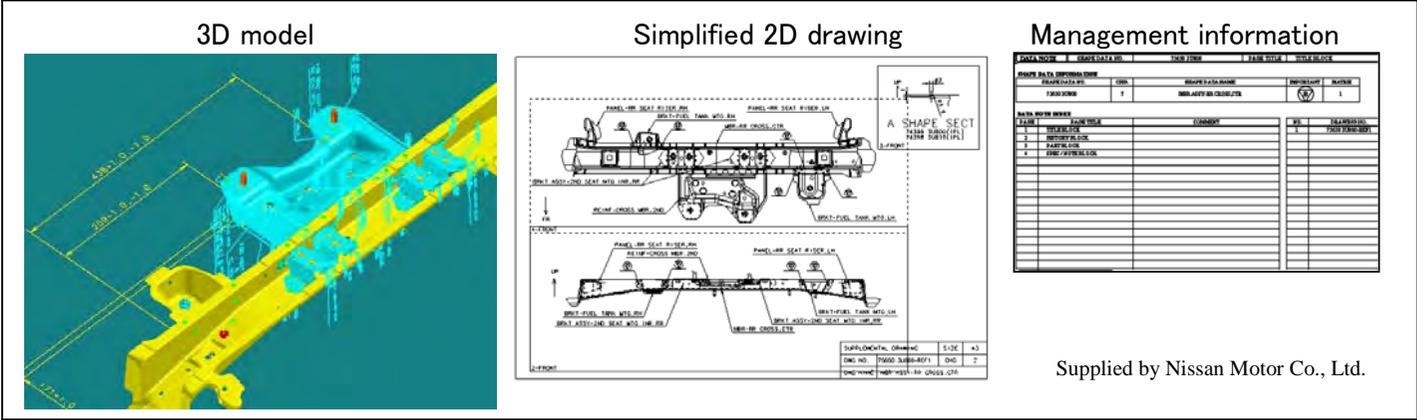


Figure 8 3D model, simplified 2D drawing, and management information (Example)

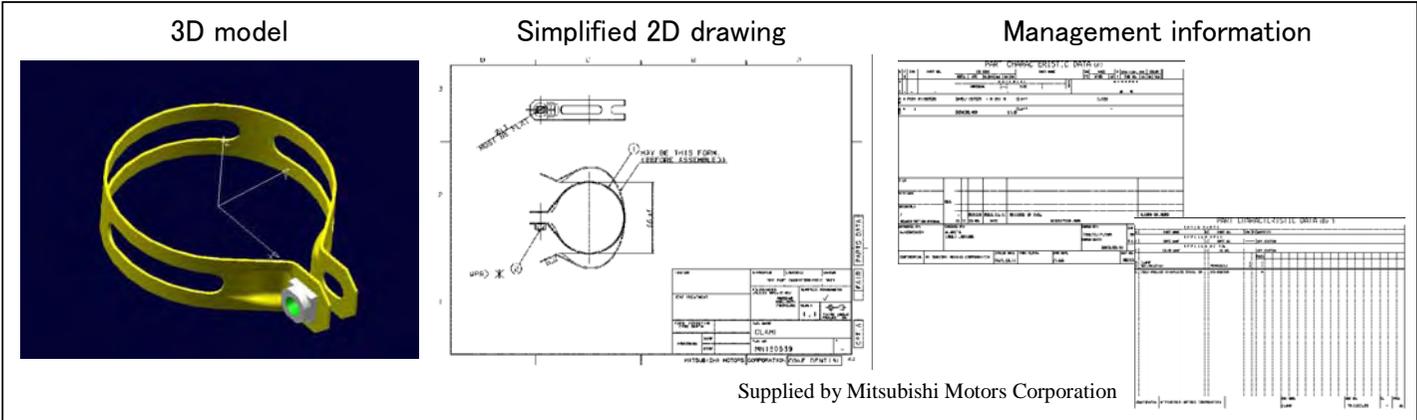


Figure 9 3D model, simplified 2D drawing, and management information (Example)

2.4 Drawings Using Only 3D Models

2.4.1 3D Annotated Models

3D annotated models provide product shape and characteristics (annotations and attributes), notes of product characteristics, and management information. Figure 10 shows the information configuration of 3D annotated models. Figure 11 shows an example of a 3D annotated model.

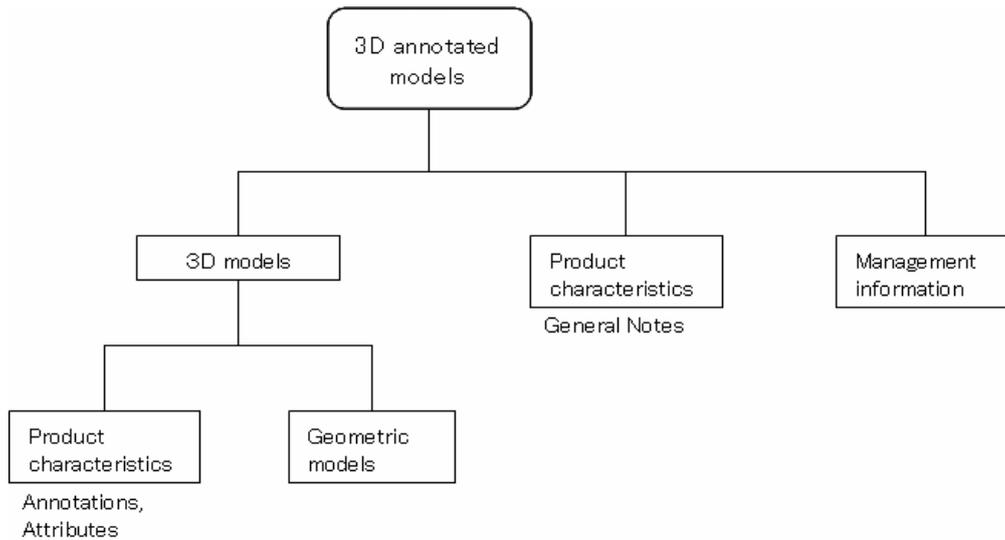


Figure 10 Information configuration of a 3D annotated model

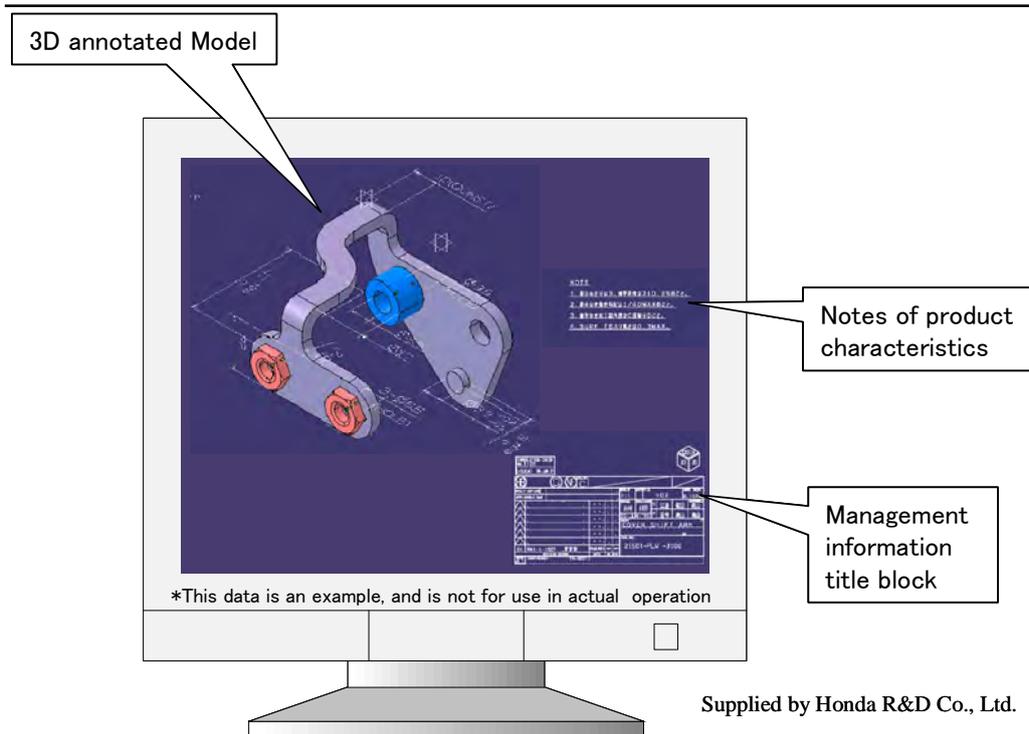


Figure 11 3D annotated model (Example)

2.4.2 3D Annotated Models and Management Information

3D annotated models and management information are a combination of 3D models depicting the product shape and product characteristics (annotations and attributes), notes of product characteristics, and management information details on a plane, and forms that combine the management information entries supplied by other electronic format.

Figure 12 shows the information configuration of 3D annotated models and management information. Figures 13 and 14 show examples of 3D annotated models and management information.

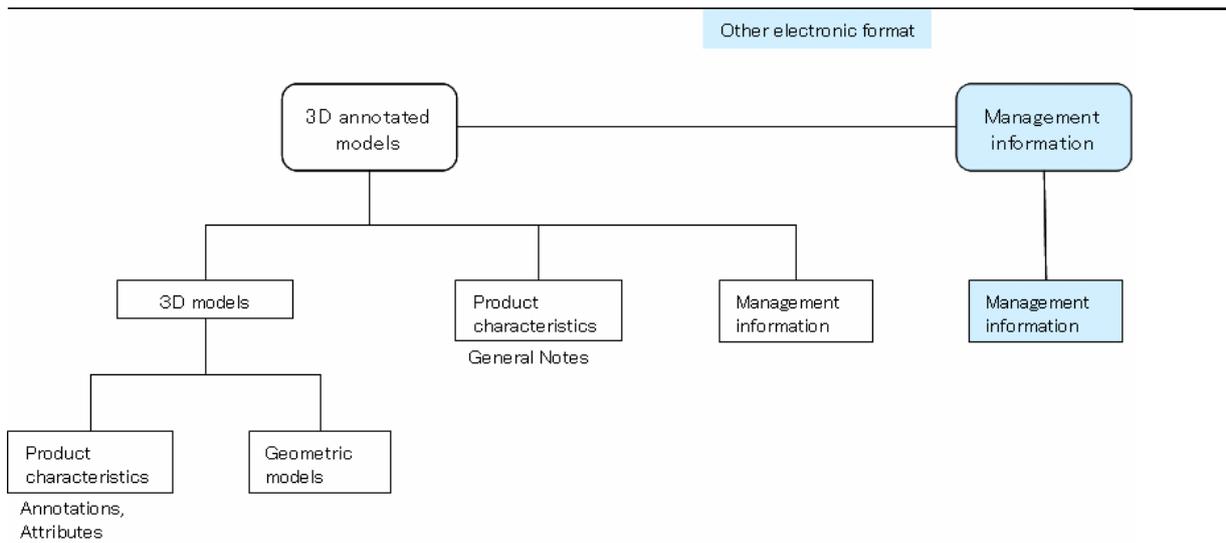


Figure 12 Information configuration of a 3D annotated model and management information

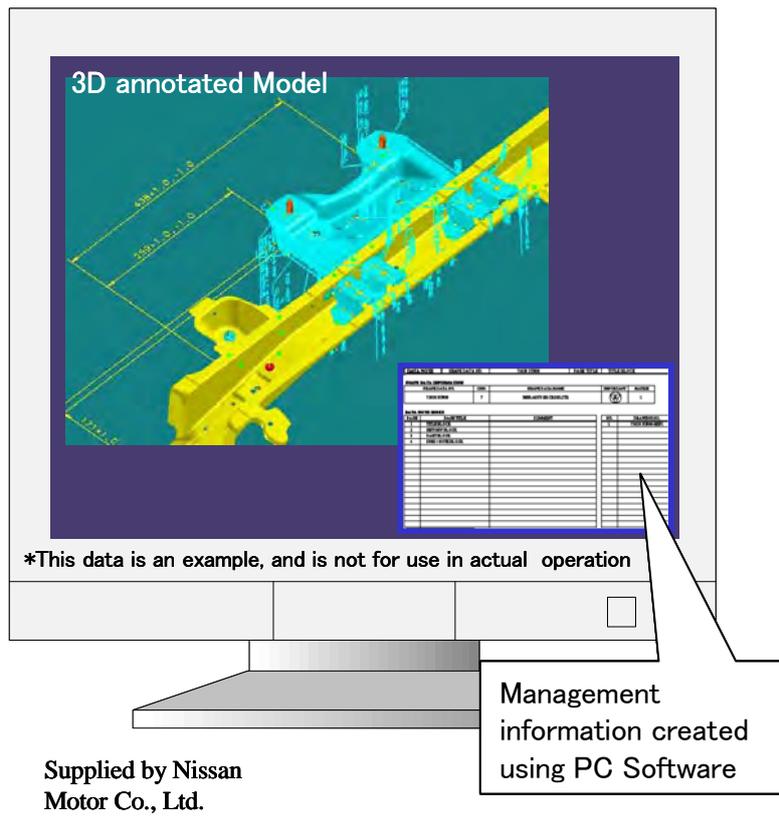
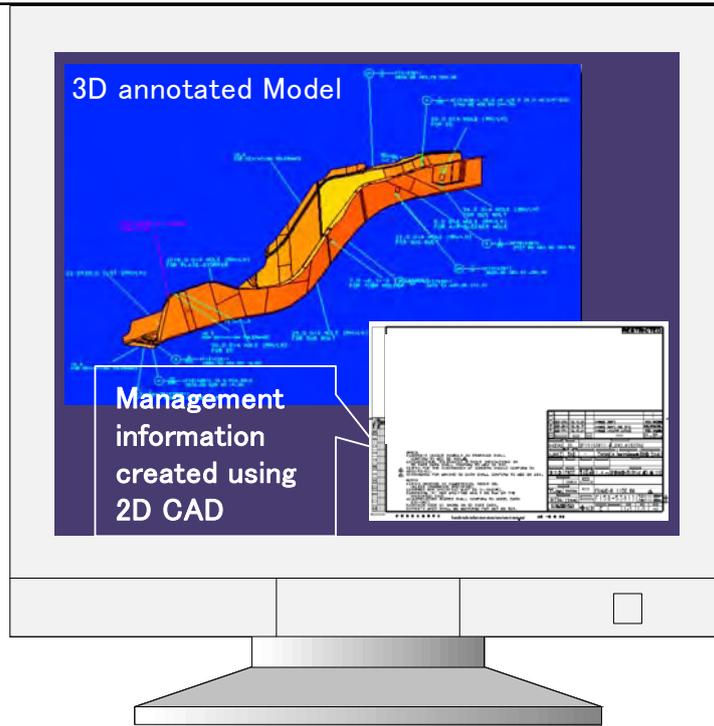


Figure 13 Indicating management information using PC software



Supplied by Mazda Motor Corporation

Figure 14 Indicating management information using CAD

3 CREATING COMBINATIONS OF 3D MODELS AND 2D CAD DOCUMENTATION

This section outlines the methods for creating combinations of 3D models and 2D CAD documentation.

The combination of 3D models and 2D CAD documentation is used in the design and manufacturing of parts. The lack of standardized creation methods such as those used for 2D drawings has raised concerns over the resulting problems. In March 2003, the JAMA workgroup for 3D models and 2D CAD documentation standardization held meetings with suppliers. The meetings confirmed that the lack of standardized 3D drawing creation methods is indeed causing problems. To avoid such problems, it has become necessary to create the standardized methods discussed in Chapter 3, “Creating Combinations of 3D Models and 2D CAD Documentation;” Chapter 4, “Creating 3D Models;” and Chapter 5, “Managing 3D CAD Data.”

3.1 Creating Drawings Using 3D Models and Simplified 2D Drawings

This section stipulates the method of drawing 3D models and simplified 2D drawings as well as 3D models, simplified 2D drawings, and management information. The portion of management information to be created with other electronic format is stipulated separately.

The 3D model and simplified 2D drawing combination is a package in which the information displayed on the 3D model is omitted from the existing 2D drawing. This drawing style is in the development stage where 3D models are used only as a tool for workflow innovation. Some divisions carry out all operations based on received 3D models. The recipient of this drawing style must be prepared to receive 3D models because die design, production technique inspection, and CAE are performed with the product characteristics and product shape indicated in the 3D models. If these preparations are not complete, drawings cannot be read, resulting in downstream operations being unable to complete their tasks. To avoid this situation, it is necessary to specify appropriate methods for both the creator side and user side of this drawing form.

Requirements

- (a) Indicate product shape and product characteristics according to the specifications provided in 2.3.1 “3D Models and Simplified 2D Drawings” and 2.3.2 “3D Models, Simplified 2D Drawings, and Management Information.”
- (b) Indicate the product shape and product characteristics in 3D models. Any information not indicated in 3D models must be included in the associated simplified 2D drawings. See Figure 15.
- (c) Synchronize and calibrate the basic coordinates between 2D drawings and 3D models. See Figure 15.
- (d) Indicate the drawing style types in or near the title block using the drawing style mark, note, etc. See Figure 15.
- (e) The information to be displayed should be assigned to 3D models and simplified 2D drawings so that all relevant information is presented.
- (f) Assign the product shape and product characteristics denoted by 3D models and simplified 2D drawings in a consistent manner so as to facilitate the downstream users’ ability to find the information. For example, for casting parts, the 3D model will indicate the raw material shape and the finished shape, and the 2D drawing will indicate removal working. See Figure 15.

(g) If the product shape and product characteristics to be shared between 3D models and simplified 2D drawings cannot be determined clearly, note the shared contents in the simplified 2D drawing. Also indicate the shared content by annotation, coloring, or hatching on the 3D model. Figure 16 shows an example of 3D model data given as an explanatory note in a simplified 2D drawing. Figure 17 shows an example of 3D model data being shown with a colored marker.

(h) Indicate on the simplified 2D drawing any product characteristics such as tolerances, dimensions, surface property, heat treatment, material, and mass that are not indicated in the 3D model.

(i) Indicate geometric attribute data on 3D models only, including holes, tolerances, machining data, and welding points. This information is not displayed on 2D drawings.

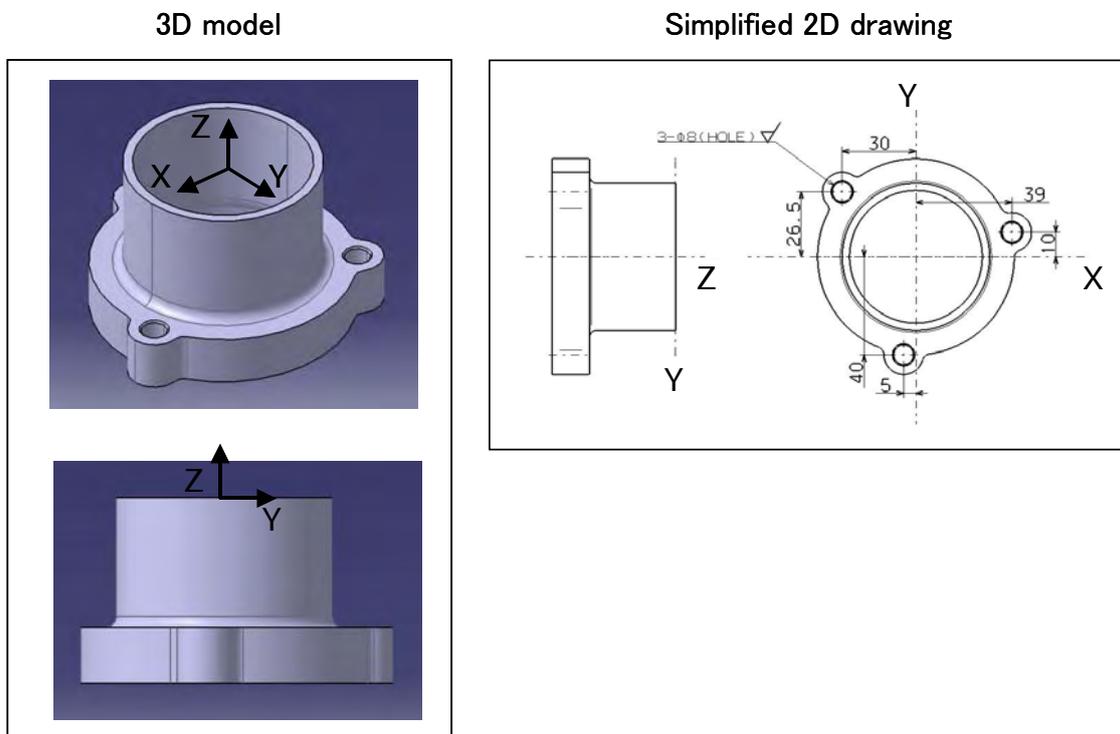


Figure 15 3D model and simplified 2D drawing (Example)

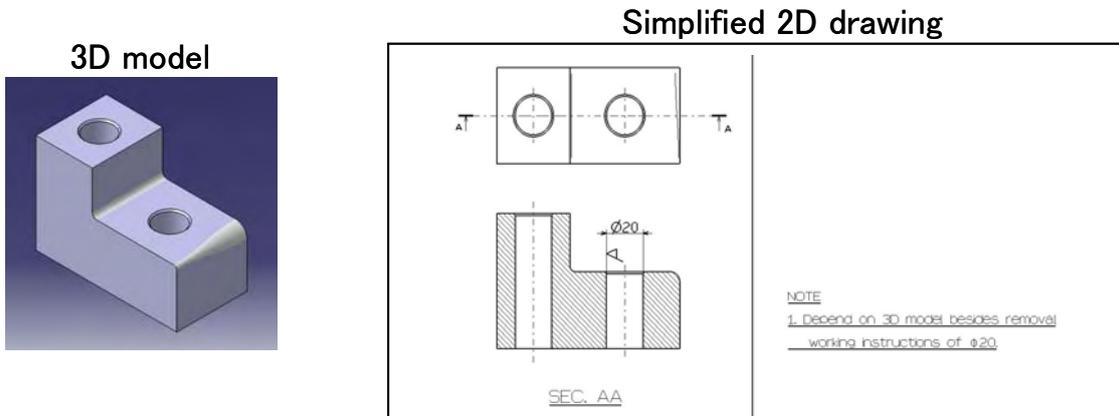


Figure 16 Addition of an explanatory note to a simplified 2D drawing to show shared 3D model data (Example)

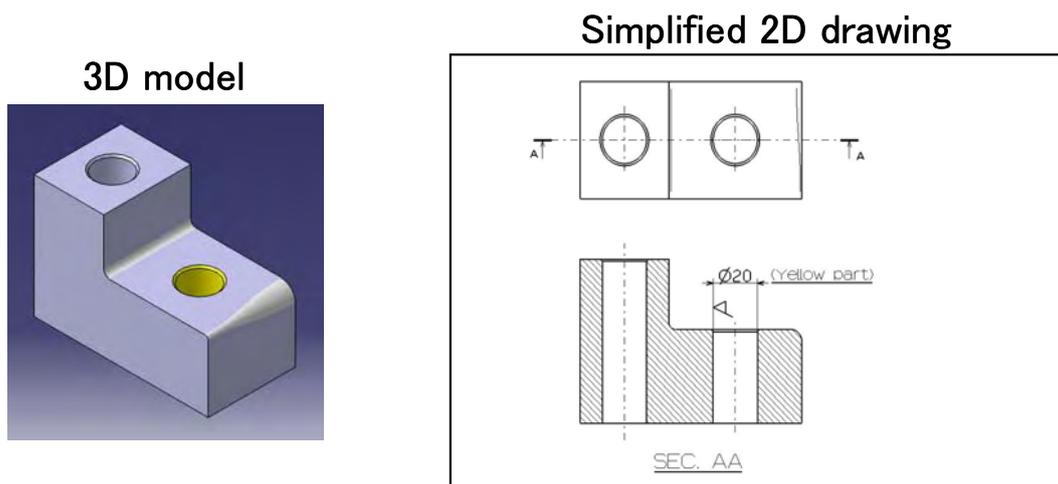


Figure 17 Shared 3D model data shown with a colored marker (Example)

3.1.1 Creating 3D Models

This section stipulates the methods for depicting product form and characteristics in 3D models only.

Requirements

- (a) Display 3D models as described in 2.3.1. “3D Models and Simplified 2D Drawings.”
- (b) Create 3D models after the vehicle position has been determined.

(c) Do not use auxiliary dimension lines, dimension lines, or characters, which are unnecessary since 3D models indicate their own dimensions and notation of dimensions.

(d) Annotate tolerance to 3D models as required. Figure 18 shows the annotation of tolerance to a 3D model.

(e) Use coloring, shading, or division of the 3D models when specifying the area or feature being annotated. See Figure 18.

(f) Use simplified representation as prescribed in conventional standards when indicating the shapes of standard parts such as bolts, screw holes, gears, knurling, etc.

(g) Draw 3D models at Grade quality as a recommendation. See 4.1 "General Modeling Rules."

(h) Remove from the 3D model any 3D models of associated parts, tools, jigs, etc. used in the layout phase. This conforms to 5.3 "Rules Regarding Deleting Unneeded Data."

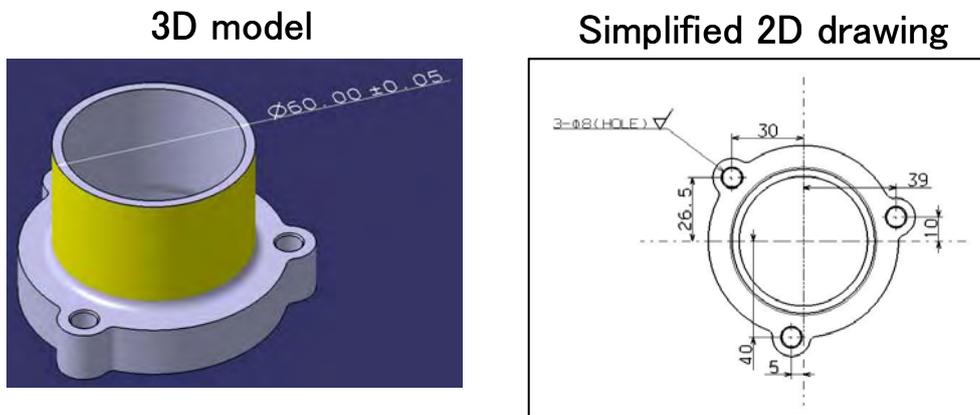


Figure 18 Annotation of tolerance to a 3D model (Example)

3.1.2 Creating 3D Assembly Models

This section stipulates the methods for depicting assemblies in 3D models.

Requirements

(a) Create 3D models for each component used in a 3D assembly model. See Figure 19.

(b) Assemble a 3D model after aligning the components at pertinent global coordinates.

(c) Link the components of a 3D assembly model adequately.

(d) Create 3D models at Grade I or II. See 4.1 "General Modeling Rules."

(e) Create 3D assembly models as outlined in 3.1.1 "Creating 3D Models" except in cases described above.

(f) Note: When creating a 3D assembly model as a reference figure, using a 3D model with numerous components, or on a Grade III model, the above requirements do not apply.

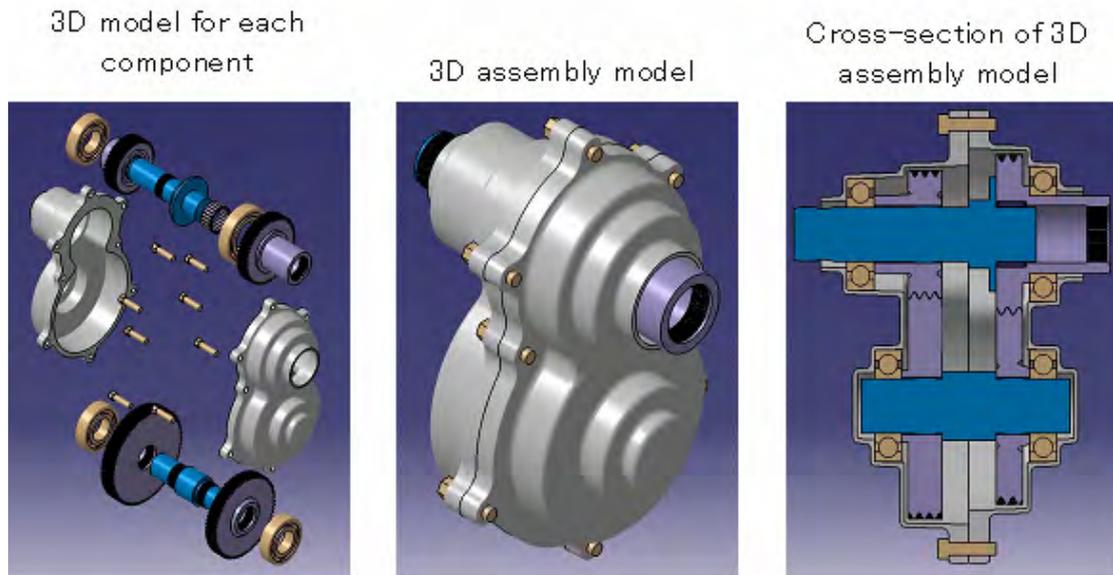


Figure 19 3D models are to be created for each component that a 3D assembly model is created from (Example)

3.1.3 Creating Simplified 2D Drawings

This section describes the methods for depicting product shape and characteristics in simplified 2D drawings.

Requirements

- (a) Depict simplified 2D drawings according to term definition 2008, "Simplified 2D Drawings."
- (b) Draw the elevation views, plane views, lateral views, cutaway views, etc. necessary for simplified 2D figures. Include annotations regarding dimensions, tolerance, geometrical tolerance, etc. to indicate product shape and characteristics. See Figure 20 for an example of a simplified 2D drawing including annotations of dimensional tolerance and geometrical tolerance.
- (c) Draw simplified 2D drawings so that their product shape correlates with those of related 3D model features.
- (d) Do not depict product shapes and characteristics in simplified 2D drawings that are modeled in related 3D models.
- (e) Do not include annotations in simplified 2D drawings that are noted in the 3D models.

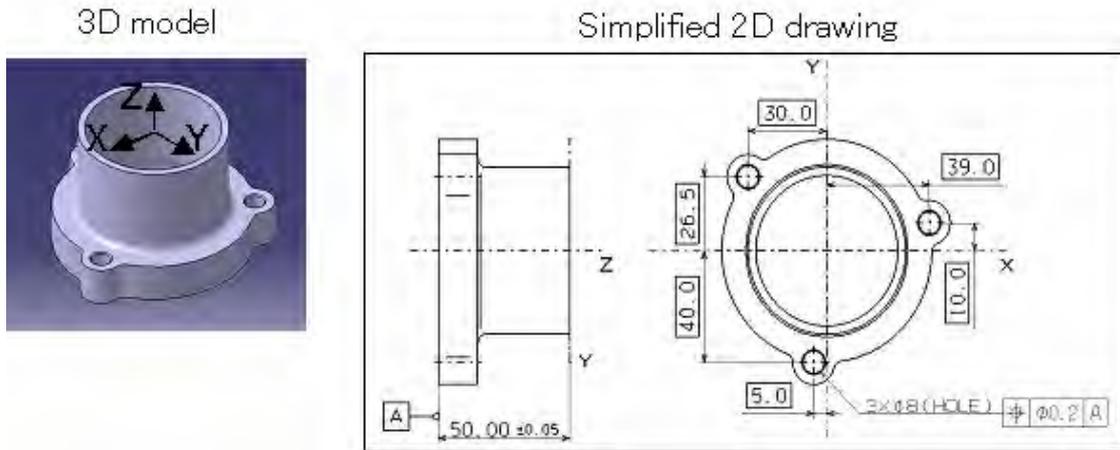


Figure 20 Annotations of dimensional tolerance and geometrical tolerance should be included in displays of simplified 2D drawings (Example)

3.1.4 Preventing Double References in 3D Models and Simplified 2D Drawings

This section discusses the steps required to avoid double references when indicating product shape and characteristics in 3D models and simplified 2D drawings.

Requirements

- Represent product shapes and characteristics in both 3D models and simplified 2D drawings. See Figure 21 for an example of duplicate product characteristics in an annotated 3D model and a simplified 2D drawing.
- Do not display geometric dimensions in simplified 2D drawings since 3D models indicate their own geometric dimensions.
- Use the following methods whenever it is necessary to include duplicate displays in 3D models or simplified 2D drawings. Figures 22 and 23 show examples of duplicate displays of product characteristics in an annotated 3D model and a simplified 2D drawing.

- Dimensions and areas of duplications shall be noted in simplified 2D drawings.
- When defining a region in a simplified 2D drawing that duplicates the area dimensions given in a 3D model, the dimensional tolerance shall be included in parentheses as the reference dimension.
- The reference dimension should be changed to a normal dimension with tolerance. See 4.2 "How to Create 3D Models with Tolerance."

See below for examples of situations requiring the use of duplicate displays.

References

- When the desired dimension is set within tolerance limits, and not only shown in a 3D model but also in a simplified 2D drawing or annotated 3D model, include the dimensions and tolerance.

- When requested for production, review, etc., dimensions can be indicated on simplified 2D drawings or annotated 3D models for reference.

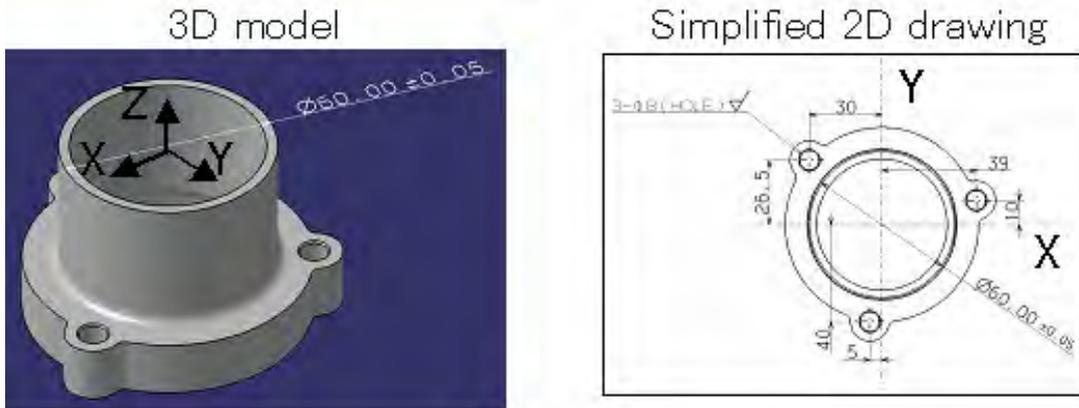


Figure 21 Duplicate displays of product characteristics in a simplified 2D drawing and an annotated 3D model (Bad example)

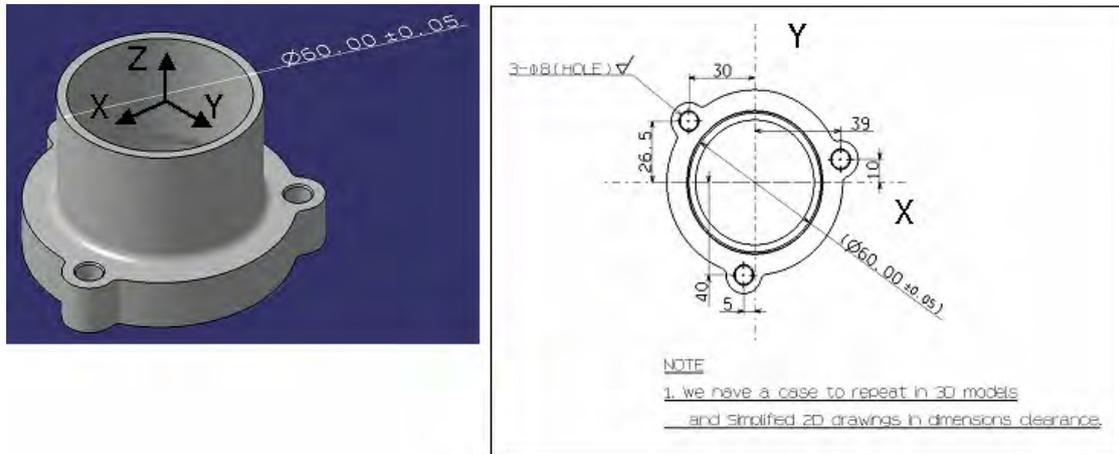


Figure 22 Duplicate displays of product characteristics in a simplified 2D drawing and an annotated 3D model (Example)

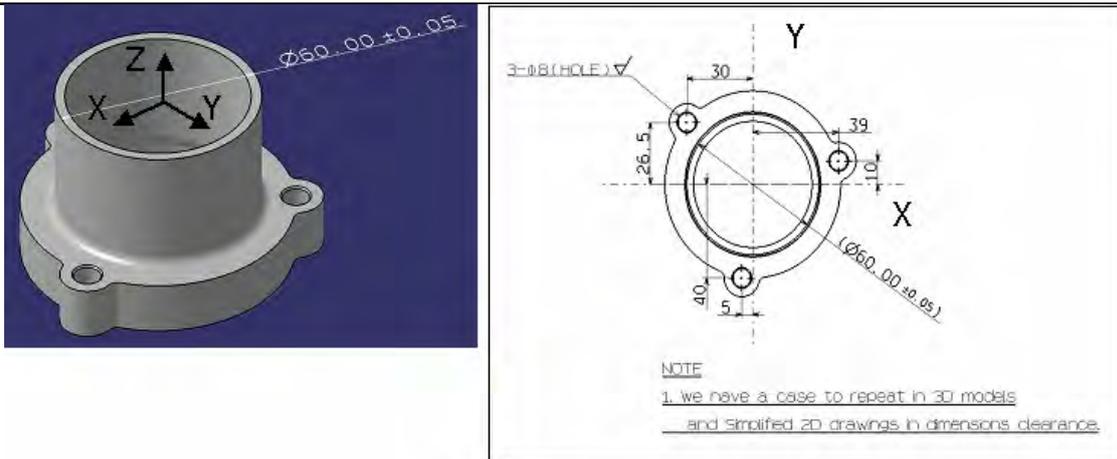


Figure 23 Duplicate displays of product characteristics in a simplified 2D drawing and an annotated 3D model (Example)

3.1.5 Synchronizing 3D Models and Simplified 2D Drawings

This section stipulates the recommended methods for synchronizing product shape and characteristics for use in 3D models and simplified 2D drawings.

Requirements

- (a) Synchronize 3D model data and simplified 2D drawing data to prevent the existence of mismatched files resulting from creating new files or updating old files.
- (b) Update the design change histories of 3D models and simplified 2D drawings simultaneously.
- (c) Distribute product form and characteristics between 3D models and simplified 2D drawings based on 3.2 “3D Models, Simplified 2D Drawings, and Management Information.”

Recommended methods

- (a) Recommended methods for synchronizing 3D models and simplified 2D drawings.
 - Use CAD functions to generate necessary 2D views and sections of 3D models for use in simplified 2D drawings. See Figure 24.
 - Preserve the links to views and sections of 3D models that have been generated from 3D models using CAD functions.
- (b) Adopt CAD file naming conventions enabling correlation and synchronization between 3D models and simplified 2D drawings.
- (c) Adopt CAD data management methodology that enables correlation of the design change histories of 3D models and simplified 2D drawings.

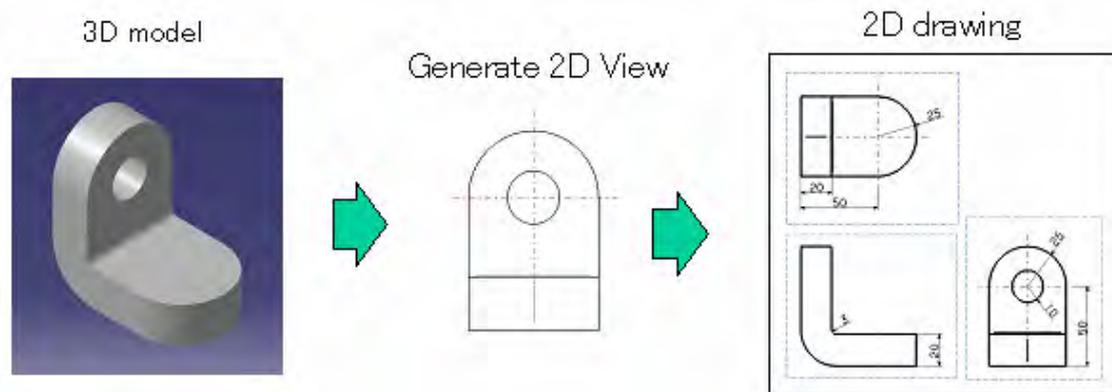


Figure 24 Generating views from a 3D shape model (Example)

3.2 3D Models, Simplified 2D Drawings, and Management Information

This section discusses the methods for creating management information entries on 3D models and simplified 2D drawings.

The easier that characteristics can be registered and design history changes can be logged, the more effectively management information can be used. Therefore, the widespread use of other electronic format such as Excel creates the need for rules.

Requirements

- (a) Management information details are to be indicated as in 2.3.2 "3D Models, Simplified 2D Drawings, and Management Information."
- (b) Product characteristics such as tolerance, dimension, surface property, heat treatment, materials, mass, etc. not indicated in 3D models or simplified 2D drawings shall be noted in management information entries, using other electronic format.
- (c) Product characteristics indicated in 3D models or simplified 2D drawings shall not be duplicated by management information. However, if a need for such duplication exists, it shall be indicated in the simplified 2D drawings or management information entries.
- (d) In cases other than those above, refer to 3.1.3 "Creating Simplified 2D Drawings."

4 CREATING 3D MODELS

This chapter covers the methods for creating 3D models that are composed of 3D models and 3D annotated models.

4.1 General Modeling Rules

This section defines the criteria for determining the grades of product form or shape data contained in 3D models.

To use 3D models in product design and manufacturing, it is necessary to define the grades of data contained in the models. Such definitions are given in *Level of CAD Form Data Details* published by JAMA in September 1999. However, the definitions have not been widely adopted because the method of use is not clearly defined. Therefore, these guidelines include a simplified version of *Level of CAD Form Data Details*, giving the grades of data based on 3D model forms.

Requirements

- (a) 3D models shall be drawn in accordance with the grade guidelines given in Chapter 3. However, it is not necessary to note the grade of the model.
- (b) The grades of 3D models are given in Table 4.
- (c) When the grade in model annotations must be specified in detail and the explanation in item (b) is not sufficient, please refer to *Level of CAD Form Data Detail* for a more thorough explanation.

Type	Grade criteria	3D model grade		
		III	II	I
Mode of expression	Wire frame	A		
	Trimmed surface	A	A	A
	Solid	A	A	A
Scope of creation	Fundamental shapes only	A	A	A
	Part mounting shapes		A	A
	Reinforcing/Weight reducing shapes		A	A
	Entire part shapes, including those reflecting production requirements			A
Draft angle	present		B	A
Fillet surface	present		B	A
(reference) usage	Definition level of product shape	Layout shape	Basic product shape	Completion product shape

Table 4 Grades of 3D models

*1 Select modes of expression from those marked "A"

*2 "A" indicates a requirement, "B" indicates a "preference"

*3 In this table, fillet surfaces are less than R5. If there are no fillet surfaces less than R5, specification of another R-value is recommended.

4.2 How to Create 3D Models with Tolerance

This section explains the methods for defining the 3D model dimensions based on the dimensional tolerance and geometrical tolerance indicated in 2D drawings. These methods are used for combination drawings composed of 3D models and 2D drawings.

When tolerancing a 3D model, it is important to create the model at the median dimensional tolerance. Creating the model at the median tolerance will make it easier for manufacturing to use the 3D model in the manufacturing process.

4.2.1 Dimensional Tolerance

Recommended methods

(a) The dimensions of 3D models shall be the basic dimensions of tolerance.

(b) In 3D models where a standard tolerance is given, the median value shall be used for dimensions. See Figure 25.

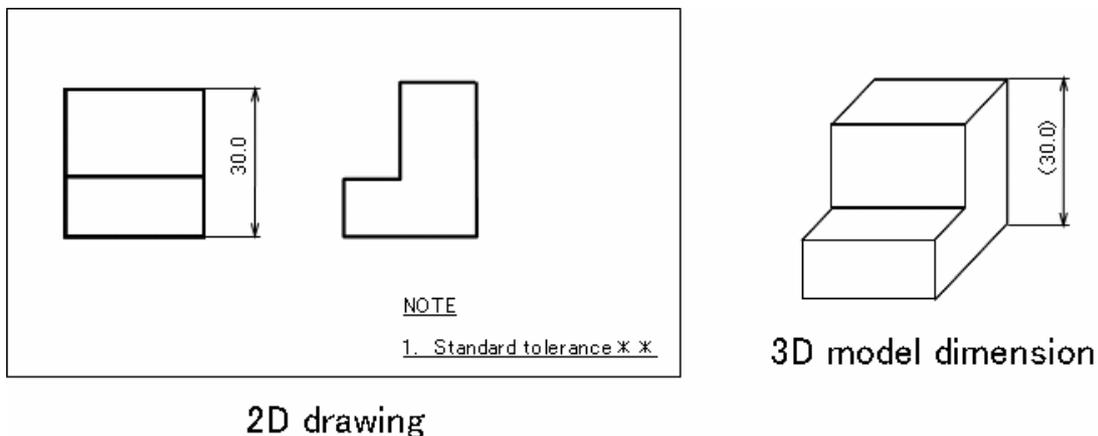


Figure 25 3D model created using median dimension value for standard tolerance

(c) In cases where a 3D model is created using a basic dimension value, the minimum value, the maximum value, or a discretionary value instead of the median value, the reason shall be given in an annotation. See Figure 26.

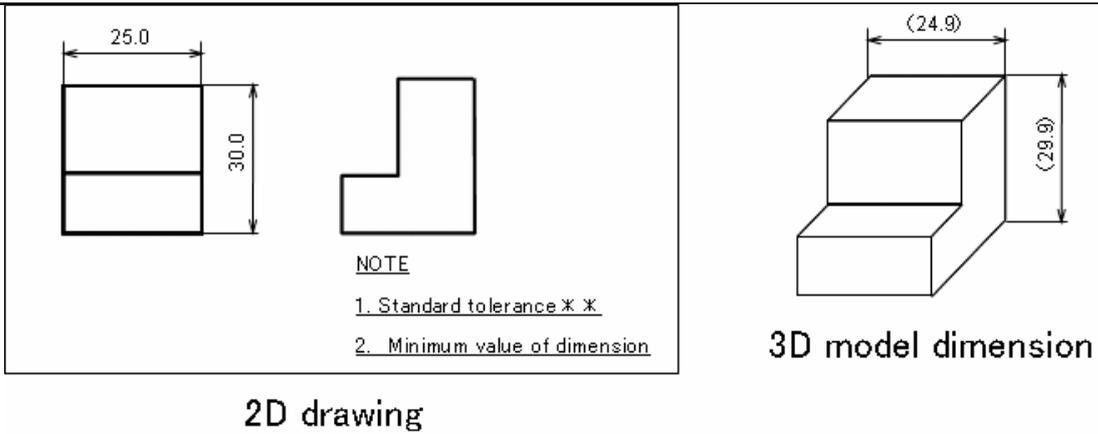


Figure 26 3D model created using the minimum value of standard tolerance.

(d) In 3D models where an arbitrary tolerance is given, the basic dimension value shall be used for dimensions. Given the usefulness of the basic dimension value in the machining process, it is recommended to use the median value. Figure 27 is an example of a 3D model created using the median value of standard tolerance.

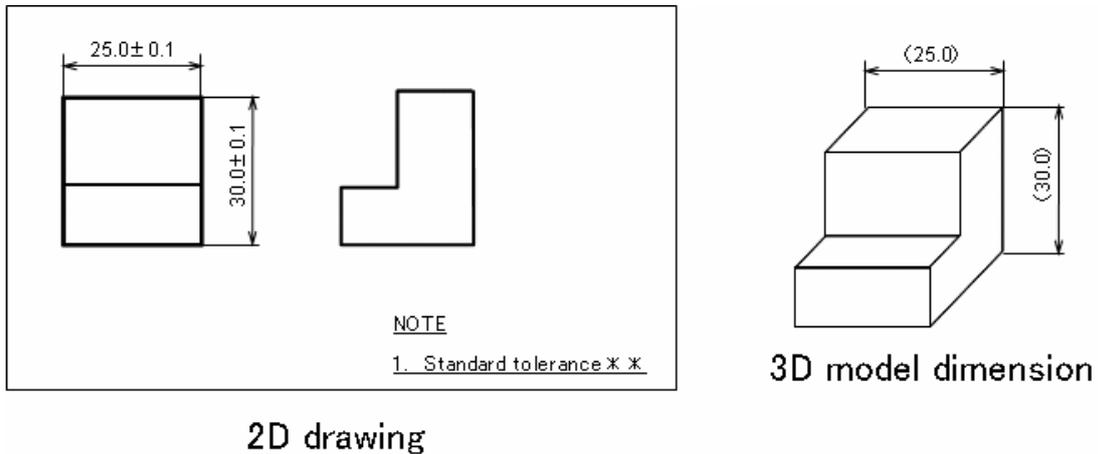
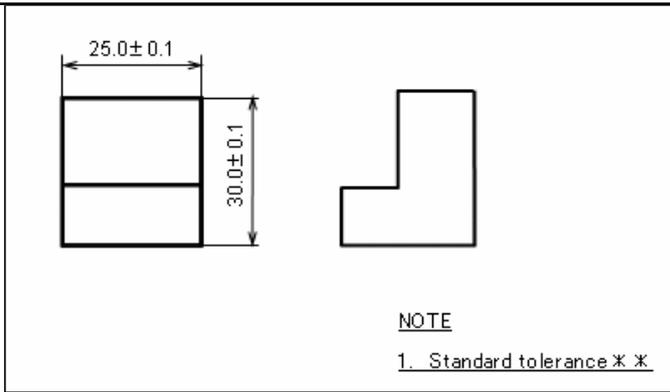


Figure 27 3D model created using the median value of standard tolerance (Example)

(e) In cases covered in (c), where a 3D model is created using a nominal measurement, the minimum value, or the maximum value that is not the median value, an annotation explaining the reason shall be included in the 3D model. Figure 28 is an example of a 3D model created using the minimum value of standard tolerance.



2D drawing

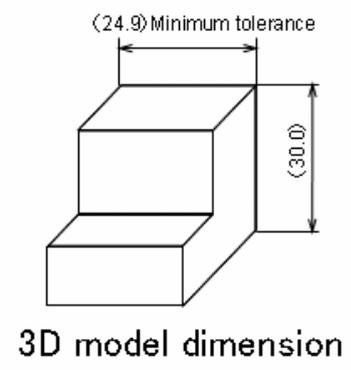


Figure 28 3D model created using the minimum value of standard tolerance (Example)

(f) When the median value, nominal measurement, minimum value, maximum value, or discretionary values are mixed in a single 3D model, a note explaining the reason shall be included. Figure 29 is an example of a 3D model created using the minimum value of standard tolerance.

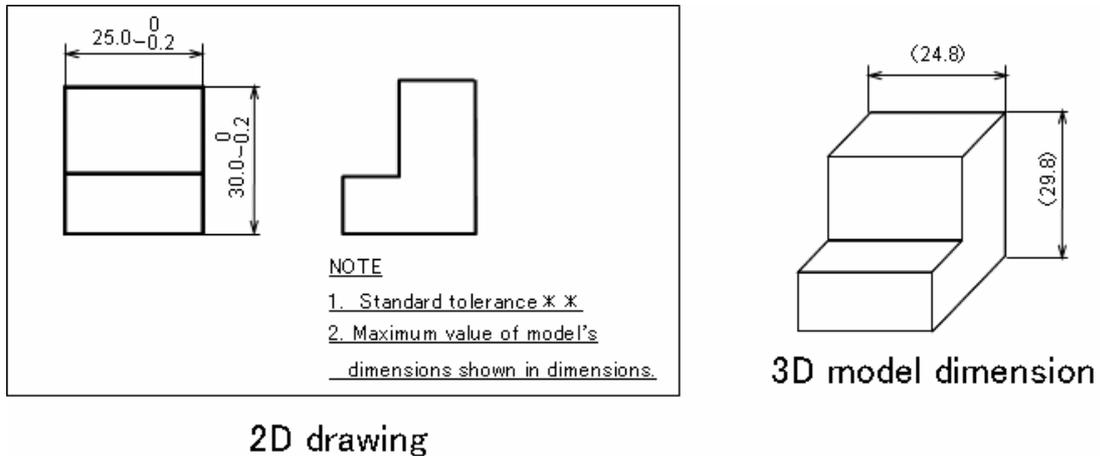


Figure 29 3D model created using the minimum value of standard tolerance (Example)

(g) If companies have their own regulations, those regulations shall prevail.

4.2.2 Geometrical Tolerance

Recommended methods

(a) For the dimensions of 3D models displaying geometrical tolerance, the median value shall be used. Figure 30 is an example of a 3D model created using the basic dimension value of standard tolerance.

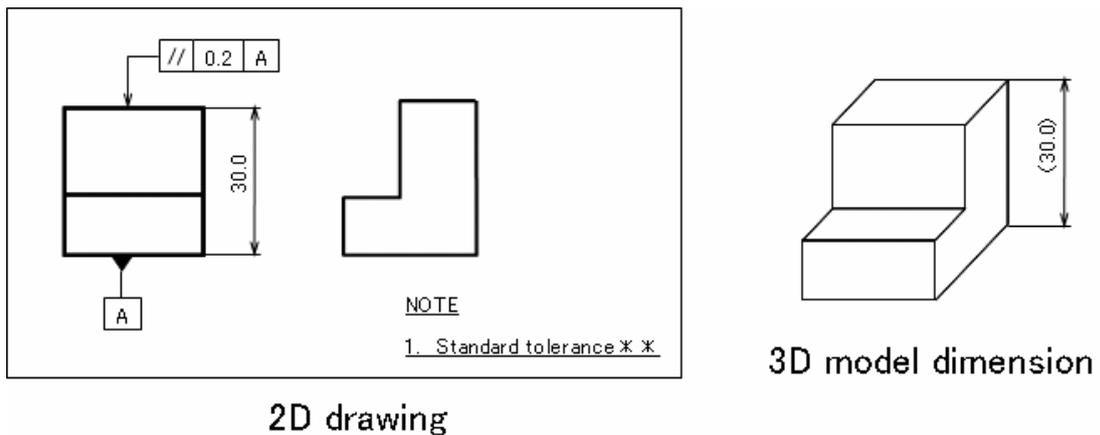


Figure 30 3D model created using the basic dimension value of standard tolerance (Example)

(b) If companies have their own regulations, those regulations shall prevail.

4.3 Notation Systems for 3D Model Design Change Locations

The following methods are to be used to indicate design change locations in a 3D model.

Requirements

For any form alteration of a 3D model, such design change locations should be reflected directly on the model. For annotations added to 3D models to indicate design changes, refer to the 3D annotated model standards for the indication method to be used.

Recommended methods

The following steps explain the process based on the diagrammed change being made.

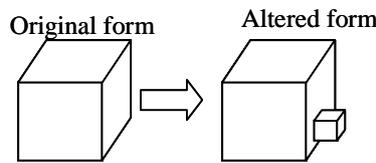


Figure 31 Original form and design change

(a) Change the color of the element with the design change in the model to an accentuated color (for example, red). See Figure 32.

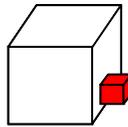


Figure 32 Design change indicated in an accentuated color (red)

(b) Change the color of the altered edge of the model to an accentuated color (red), increasing thickness as needed. See Figure 33.

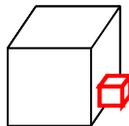


Figure 33 Altered edge indicated in an accentuated color (red), with increased thickness

(c) Add an annotation to the element containing the design change. The element with the design change is highlighted when the annotation or the creation history is selected, making it even more distinct. See Figure 34.

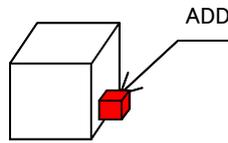


Figure 34 Annotation added to the design change

(d) Create a surface that matches the altered element, make it an accentuated color (red), and superimpose it on the area of the model. *Or* save the surface as a separate layer. To ensure that the surface model is not treated as an unnecessary element, create it in accordance with the PDQ guidelines. See Figure 35.

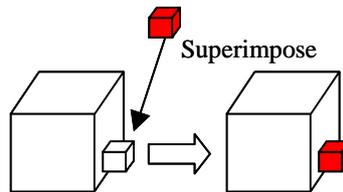


Figure 35 Additional steps to highlight the design change

(e) Mark the element with the design change in the 3D model by placing an identifying number and indicate the change in itemized notes on the simplified 2D drawings, etc.

(f) Save the element with the design change in the 3D model as a special layer.

(g) When transferring data to a different CAD system, color data may be lost during the transfer, so use caution.

4.4 3D Model Creation History Management Methods

This section describes the methods for managing 3D model creation history data at the point of creation.

3D CAD systems have functions for saving the creation history data for 3D models. The information contained in creation history data, may be proprietary to the company. To preserve confidentiality, methods for handling such data have been defined.

Requirements

(a) In order to reuse data regarding model amendment, design changes, and the like, creation history data must be maintained.

(b) Maintenance of the creation histories of 3D models provided to other parties is discretionary.

Figure 36 shows an example of a 3D model and its creation history data.



Figure 36 3D model and creation history data (Example)

4.5 Plate Thickness Indication Methods

This section describes methods for indicating plate thickness when displaying surface models in 3D drawings.

For surface models, indication of thickness orientation and thickness indication methods must be clear; therefore, the following standards have been defined.

Recommended methods

(a) The orientation of thickness should be indicated on the surface(s) of the 3D model using arrows. When the reference surface is a median surface, arrows should be placed on both sides. See Figure 37.

(b) Board thickness should be indicated using the methods given below.

(1) An annotation, note, or management information should be used to indicate thickness for 3D models. See Figure 37 a.

(2) In cases where each face's thickness must be clearly indicated--for example, when there are adjacent faces of contrasting thickness--color-coding should be used. Thickness should be indicated as in Figure 37 b.

(3) When indication of thickness orientation is unnecessary, explanatory notes, itemized notes of simplified 2D drawings, etc. should be used.

(c) If the application of methods (a) and/or (b) is difficult, a conventional 2D cross-section is acceptable.

(d) When transferring data to a different CAD system, color data may be lost during the transfer, so use caution.

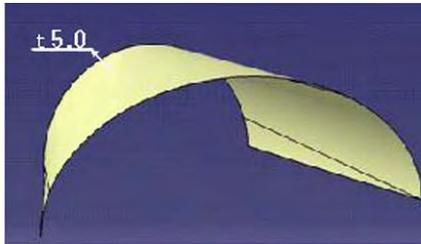


Figure 37 a Indicating thickness

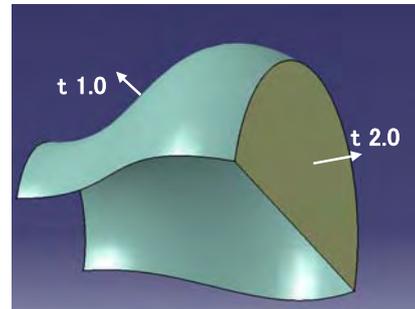


Figure 37 b Color-coding to indicate area of varying thickness

4.6 Indication Methods for Fillet Surfaces and Chamfering

The following indication methods describe the annotation of fillet surfaces and chamfering on 3D models.

Recommended methods

- (a) Fillet surfaces and chamfering values of arbitrary tolerances shall be indicated in annotations. In the event that there are multiple faces involved, color-coding shall be used for indication. Marking colors shall be used for each respective tolerance value showing the relevant scope of application in the 3D model. The tolerance for each face and its color shall be indicated in annotation. See Figure 38.
- (b) Fillet surfaces and chamfering values given for reference shall be annotated on 3D models. For multiple faces, color-coding shall be used to indicate the area concerned. For each tolerance value, each relevant 3D model's scope of application shall be color-coded. The fillet values and colors shall be given in simplified 2D models or as management information entries.
- (c) When transferring data to a different CAD system, color data may be lost during the transfer. In such cases, use numbering or methods other than color-coding.

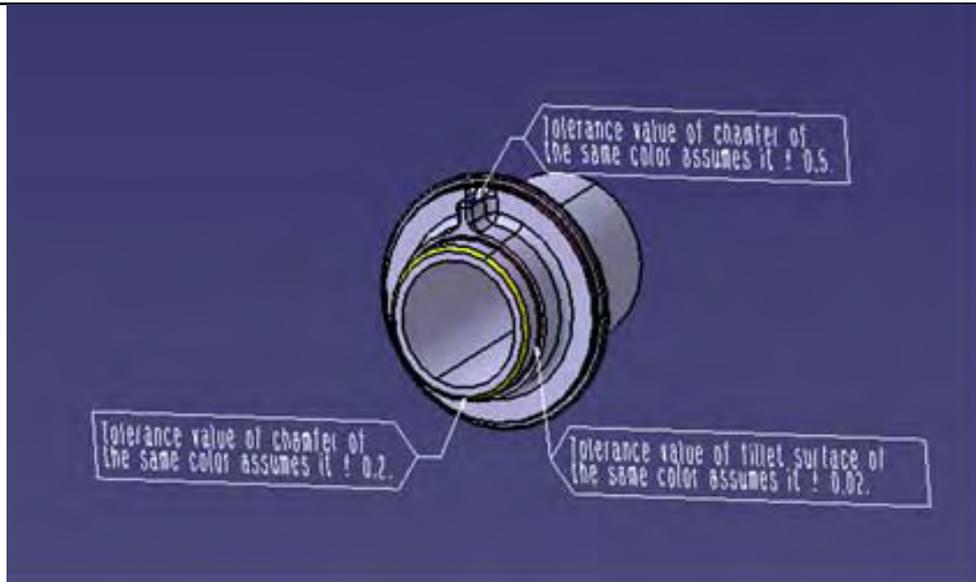


Figure 38 Annotations of tolerances

4.7 3D Model of a Part That Is Modified at Assembly

The following methods have been defined for drafting 3D models that have their shapes modified after assembly. See Figures 39 and 40.

Recommended methods

- (a) For 3D models of parts that have their shape modified after assembly, create a 3D model of the original form and another 3D model showing the assembled part.
- (b). Show the assembled shape on the assembly drawing. No 3D assembled shape would be created.
- (c) A 3D model showing the shape before assembly (without change) could be added to the assembly drawing.

When using (a), (b), or (c), if possible divide the part drawing or assembly drawing into layers, making the division clear, and attach 3D models showing before and after the change.

Using wiring as an example, Figure 39 shows the state before modification (single part), and Figure 40 shows the state after modification (before assembly).

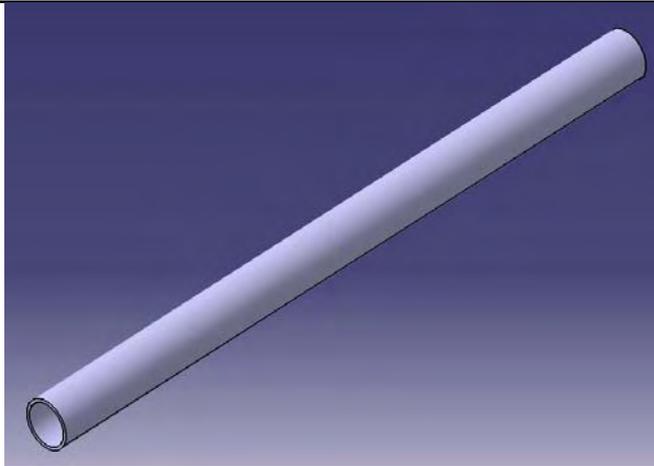


Figure 39 Single part (no modification)

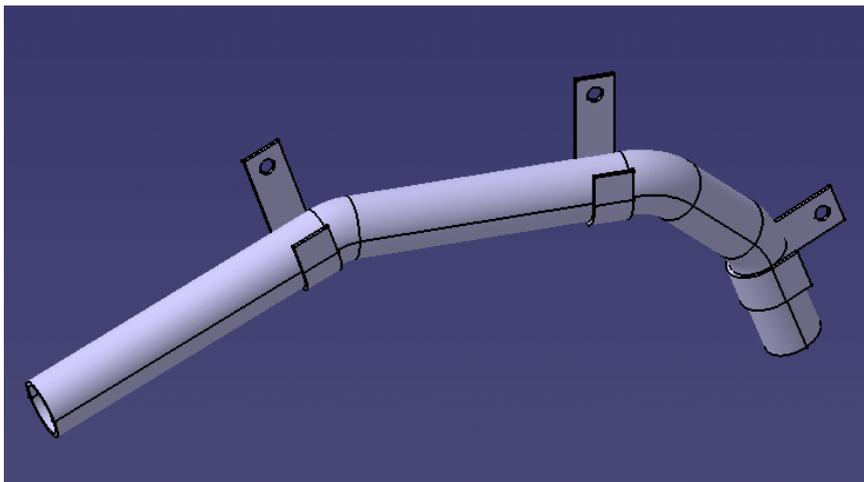


Figure 40 Grouped parts (after modification)

5 MANAGING CAD DATA

This chapter describes the methods of managing CAD and drawing data created with other software (hereafter called *CAD data*).

5.1 CAD Data Management Methods

This section presents the rules regarding CAD data management methods.

Requirements

Drawings must be maintained and accessible for the entire life cycle of the product. Therefore, rules regarding the management of such data have been defined.

(a) CAD data management standards

The parameters forming the basis for the rules regarding CAD data management are critical to efficient operation. Each company should develop and make available to all internal and external suppliers the following rules:

- For CAD data management requirements that are not outlined below, please refer to ISO16792.
- Rules for associating CAD data and part (drawing) numbers and part (drawing) names.
- Rules for associating the CAD or version of the software used to create models and the part (drawing) numbers for each drawing.
- Company names, approvers, the date of approval, and design change histories shall be included in CAD data.
- If layers are used in the models/drawings, data management rules regarding what information each layer should contain shall be defined. (In other words, information such as geometric models, drawing frame, title panel, item block, etc.)
- If corporate procedures require dividing CAD data in order to reduce the file size of CAD data, rules shall be defined regarding the division of CAD data files when necessary for release (transmission).
- When electronic data other than CAD data exists, reciprocal checks of the information shall be made.
- When distributing official CAD data, conformity with the original must be ensured.
- It is recommended that a company adopt a CAD data management system.
- When exchanging CAD data, the display of 3D models is not to change.

5.2 Methods for Presenting CAD Data Management Standards

This section defines the rules regarding the presentation of data management standards to OEMs and suppliers who are following this guideline.

For smooth business transactions and CAD data transfers between OEMs and suppliers, the involved parties must agree on the representation of data management standards. These rules address such agreements.

Requirements

The respective OEMs and their suppliers agree to abide by the data management standards outlined below in all dealings.

(a) Transfer of CAD data

- Transfer of CAD data from OEMs to suppliers
- Transfer of CAD data from suppliers to OEMs

(b) CAD data management standards

In accordance with the standards outlined in 5.1 “CAD Data Management Methods,” any CAD data required by either party for the performance of their business shall be provided by the other party.

(c) Regarding handling of CAD data supplied and received by both parties

- Appropriate steps shall be taken to maintain confidentiality of data.
- New and old CAD data shall be stored so that they are identifiable, and redundant data shall be deleted.
- Permission shall be obtained from the both the sender and the receiver of the data before disclosure to any third party.

5.3 Unnecessary Information

This section discusses deleting unneeded or redundant information from inside 3D models and annotated 3D models.

Requirements

All unneeded, redundant, or obsolete information should be deleted from 3D annotated models to reduce data file size to the minimum.

Some examples of unnecessary information are :

- peripheral part shapes
- jig and machine tool shapes
- elements external to the part shape
- design data irrelevant to the part in question
- unnecessary views