INTERNATIONAL STANDARD

ISO 17599

First edition
2015-01-15

Technical product documentation (TPD) — General requirements of digital mock-up for mechanical products

Documentation technique de produits (TPD) — Exigences générales de Digital mock-up pour les produits mécaniques

Reference number
ISO 17599:2015(E)

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Published in Switzerland

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Foreword

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 10, *Technical product documentation*, Subcommittee SC 6, *Mechanical engineering documentation*.

Technical product documentation (TPD) — General requirements of digital mock-up for mechanical products

1 Scope

This International Standard specifies the requirements for the classification, composition, modelling, review, application, and management of digital mock-up.

This International Standard for mechanical products is applicable to the building, management, review, and application of digital mock-up.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10007:2003, *Quality management systems — Guidelines for configuration management*

ISO 11442, *Technical product documentation — Document management*

ISO 16792:2006, *Technical product documentation — Digital product definition data practices*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
digital mock-up (DMU)
digital specification given to a complete mechanical product or sub-system with an independent function, not only of the geometric properties, but also of its function and/or performance in a particular field

Note 1 to entry: The digital mock-up of the product is built at a design stage and is applicable to the whole life cycle of the product, including design, manufacture, marketing, and aftermarket. The digital mock-up could realize interference check, motion analysis, simulation of performance and manufacturing, technical training, advertising, maintenance planning, etc.

3.2
complete digital mock-up
digital specification given to all the information of a complete mechanical product or its systems

Note 1 to entry: The complete description pertains to mechanical components, system devices, function components, accessories, etc.

3.3
sub-system digital mock-up
digital specification of all the information of sub-systems based on the different functional divisions of mechanical products

EXAMPLE DMU of power, transmission, and control systems

3.4
scheme digital mock-up
part of the complete DMU, which includes the digital specification of product plan design

3.5
detailed digital mock-up
part of the complete DMU, which includes the digital specification of elaborate product design

3.6
manufacturing digital mock-up
part of the complete DMU, which includes the digital specification of product machining and assembling

3.7
geometry digital mock-up
subset of the complete DMU, providing digital information specification, geometrically emphasized, extracted from officially released DMU

3.8
function digital mock-up
subset of the complete DMU, providing a digital information specification, functionally emphasized, extracted from officially released DMU

3.9
performance digital mock-up
subset of the complete DMU, providing a digital information specification, based on performance, extracted from officially released DMU

3.10
special-purpose digital mock-up
description extracted or simplified from a complete product model of a digital mock-up for special purposes, such as simulation, technical training, and marketing

3.11
retrofit digital mock-up
DMU of a new product, built on the basis of an existing one

3.12
simplification
method which allows some features built without modelling or some parts (or components) without assembling during the modelling process

Note 1 to entry: Through simplification, the geometric detailed representation can be simplified and the model loading efficiency can be improved provided that the simplification does not incur ambiguous understanding or bring about inconvenience to the use of a model.

3.13
lightweight
method to extract patches from the product geometry model

Note 1 to entry: It reduces resource expenditure in model loading, and it is suitable for large assembly, assembly simulation, advertising, technical training, etc.

3.14
annotation
dimension(s), tolerance(s), note(s), text, or symbol(s) visible without any manual or external manipulation

[SOURCE: ISO 16792:2006, 3.1]

3.15
configuration
interrelated functional and physical characteristics of a product defined in product configuration information

[SOURCE: ISO 10007:2003, 3.3]

3.16
product configuration information
requirements for product design, realization, verification, operation, and support

[SOURCE: ISO 10007:2003, 3.9]

3.17
configuration management
coordinated activities to direct and control configuration

[SOURCE: ISO 10007:2003, 3.6]

4 Abbreviations

BOM bill of materials

CAD computer-aided design

CAE computer-aided engineering

CAM computer-aided manufacturing

CAPP computer-aided process planning

DMU digital mock-up

EBOM engineering bill of materials

FMEA failure mode and effects analysis

MBOM manufacturing bill of materials

PBOM process bill of materials

PDM product data management

QC quality control

TED theoretically exact dimension

5 Classification of digital mock-up

5.1 Development stage

According to the development or life cycle stage, digital mock-up is generally divided into scheme digital mock-up, detailed digital mock-up, manufacturing digital mock-up, etc.

5.2 Purposes

Digital mock-up can be established according to various special purposes, such as simulation, manufacture, technical training, marketing, and advertising. This classification is done in line with purposes.

5.3 Data format

Digital mock-up can be classified according to the software type or data format.

6 Composition of digital mock-up

6.1 Geometric information

The geometric information of DMU includes point, line, surface, body, and other relevant geometric information.

6.2 Constraint information

The constraint information of DMU includes the constraints between parts or components and between the internal and/or external reference information of DMU.

6.3 Engineering attributes

The engineering attributes of DMU include BOM, material properties, boundary conditions, loads, failure criteria, lifetime performance, rigidity, strength, reliability, maintainability, safety, and other information.

7 Requirements of a digital mock-up model

7.1 General principles

Digital mock-up is the digital specification produced on a computer of a physical prototype, while the physical prototype is the materialized object of digital mock-up. The digital mock-up model shall

a) reflect the geometric attributes, functional characteristics, and performance properties of the physical prototype,

b) provide information representation required in the whole life cycle of a product with stability and completeness,

c) truly reflect the content of product characteristics where its forms may be various, and

d) be derivative, which can generate corresponding models depending on the different purposes.

7.2 Relationship between all kinds of digital mock-up

For relationships between all kinds of digital mock-up, see Figure 1.

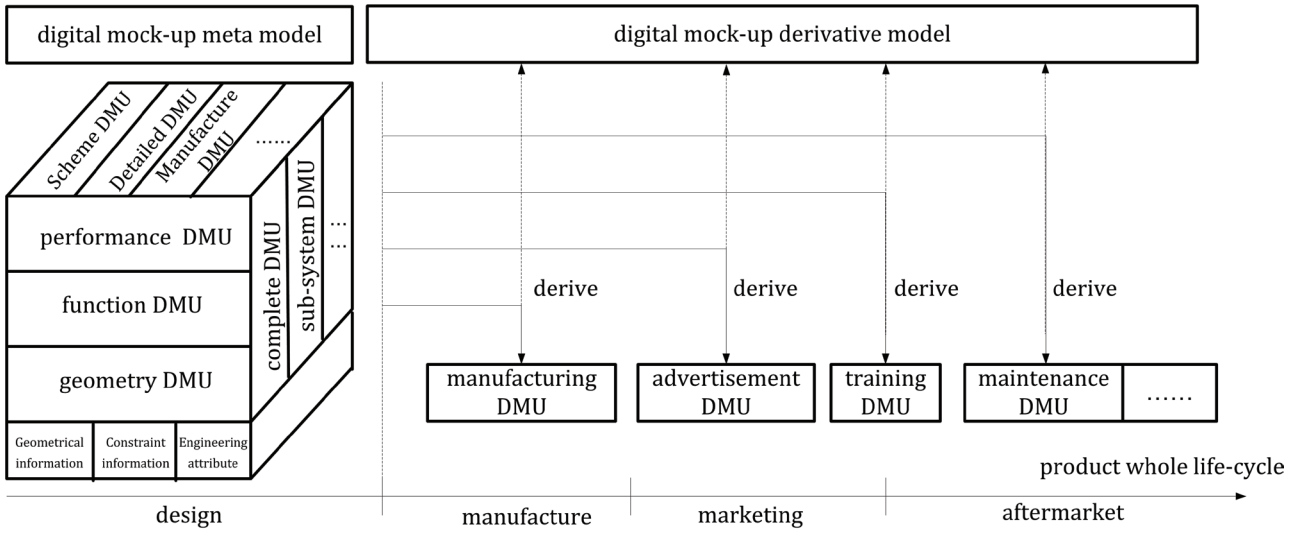

Figure 1 — Relationship between all types of digital mock-up

7.3 Requirements of complete digital mock-up

A complete digital mock-up shall be formed after the general assembly of each sub-system with each function modular included. It is a collective body involving information of a complete product in each field. It is also a system description of a product object in the computer. The complete DMU shall include, but not be limited to,

a) information which shall completely reflect product structure, layout, and position of each sub-system on the digital mock-up,

b) information which shall reflect the compatibility and maintainability on structure and system between a complete product and its sub-system,

c) information which shall reflect the working principles and the performance characteristics of one or each field concerned, and

d) complete information necessary for manufacturing, when the digital mock-up is transformed to physical prototype.

7.4 Requirements of sub-system digital mock-up

The sub-system digital mock-up is a description of the sub-system with a given function. It shall include, but not be limited to,

a) information which shall completely show the distribution and location of geometry, structure, and components,

b) information which shall reflect the working principles and performance characteristics in a certain field, and

c) information which shall contain complete manufacturing information to transform sub-system digital mock-up into a physical prototype.

7.5 Requirements of scheme digital mock-up

The scheme digital mock-up is formed at the scheme design stage. The definition and result of the scheme digital mock-up shall include, but not be limited to,

a) describing primary overall indicators of products and defining the primary product structural composition,

b) describing the product outline and carrying out industrial design evaluation,

c) establishment of basic parameters for each sub-system and enveloping space,

d) initial selection of standardized, purchased, finished parts, and equipment,

e) optimization of the scheme parameters and mechanism test models, and

f) carrying out overall layout design and scheme digital mock-up.

7.6 Requirements of detailed digital mock-up

Detailed digital mock-up is formed at the detailed design stage. The definition and result of the detailed digital mock-up shall include, but not be limited to,

a) carrying out the overall design of system and mechanism, primary simulation and optimization of system through CAE calculation, and getting a detailed design scheme,

b) carrying out calculations of detailed mass, performance, and load of the product and generally evaluating system reliability, maintainability, etc.,

c) carrying out the detailed assembly hierarchy division, space split, connection method, and interface definition of each sub-system and component model, and the calculation of envelope space of moving parts,

d) carrying out detailed product analysis,

e) verifying the parameters of overall design, including product function and performance, and modifying and optimizing partially if necessary, and

f) producing the assembly diagrams and engineering drawings of components and parts.

7.7 Requirements of manufacturing digital mock-up

Manufacturing digital mock-up is formed at the technological design stage. The definition and result of the manufacturing digital mock-up shall include, but not be limited to,

a) design of tools, clamps, and gauges,

b) simulation of the technological process of the product, including virtual machining, assembly, workshop (factory), etc., and

c) technological documents generation.

7.8 Requirements of geometry digital mock-up

The geometry digital mock-up of mechanical products shall include, but not be limited to,

a) information which can reflect each sub-system position in the digital mock-up,

b) information which can find the shape, dimension information, and geometric constraints of parts and components, and

c) product coordination, assembly, and fitting relations.

7.9 Requirements of function digital mock-up

Function digital mock-up of mechanical products shall include the following information, but not be limited to,

a) product working principles,

b) product hierarchical tree,

c) composition of parts and components, their state, and manual instructions,

d) coordinative harmony in the mechanical and function between sub-systems, and

e) information of product operation and maintenance.

7.10 Requirements of performance digital mock-up

Performance digital mock-up of mechanical products shall include the following information, but not be limited to,

a) performance indicators of product,

b) working characteristics of input and output,

c) sub-system indicators and performance coupling relations between sub-systems,

d) the safety factor and the stress and strain for the critical and important parts, and

