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STEP geometry visualization services

Services de visualisation de la géométrie STEP

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

There is a confirmed opportunity for industries to have a structured approach on 3D product visualization and to enable integration of product data in visualization applications across the life cycle of the product in all areas of a company.

The integrated standard for the exchange of product model data (STEP) in the enterprise processes has great value to contribute to this goal.

Business scenarios exist related to the visualization of product data other than geometry (e.g. metadata, production data, financial data).

The ability to trustfully share, distribute, collect, store, maintain, transfer, process and present product data associated with its geometry to support business processes distributed in enterprise networks is a key component of the digital transformation of our industries.

As long as data sets are managed by a single management system, we can ensure quality and traceability of the data set. However, when data is shared with partners in a supply chain, the data sets are usually copied and extracted from their initial management system and they lose all the traceability and links with the other product data. This document provides a solution to this problem.

This document is the first of a series of documents to provide an integrated framework using the ISO 10303 series to allow the consumption of product data in supply-chains and in companies using geometries as human-computer interface to access these product data through visualization applications. This is realized by using metadata to support the audit trail of the transformation of a geometry definition, and web services based on the utilisation of these metadata. This framework can also be used for automated product data consumption by software.

Annex A contains an identifier that unambiguously identifies this document in an open information system.

STEP geometry visualization services

1 Scope

This document defines a set of metadata to support the audit trail of the transformation of a geometry definition, while it is distributed and shared in supply-chains, to ensure the traceability of geometric model data. It also defines a set of web services based on the utilisation of these metadata.

The following are within the scope of this document:

— metadata definitions for geometry transformation audit trail:

 — syntax for storing these metadata in geometry data sets in various formats;

 — conformance level for implementers and business processes;

 — definitions of web services to query the geometric model data set and its associated metadata.

The following are outside the scope of this document:

— service specifications for CAD operations;

— specifications of a cybersecurity infrastructure to enable web services;

— the technical implementation of a STEP geometry services client or server;

— any geometric model definition;

— any product and manufacturing information (PMI) definition;

— archiving.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8601-1, *Date and time — Representations for information interchange — Part 1: Basic rules*

ISO 10303-21, *Industrial automation systems and integration — Product data representation and exchange — Part 21: Implementation methods: Clear text encoding of the exchange structure*

ISO 14306, *Industrial automation systems and integration — JT file format specification for 3D visualization*

ISO 16684-1, *Graphic technology — Extensible metadata platform (XMP) — Part 1: Data model, serialization and core properties*

ISO 16684-3, *Graphic technology — Extensible metadata platform (XMP) specification — Part 3: JSON-LD serialization of XMP*

ISO 17506:—[1)], *Industrial automation systems and integration — COLLADA digital asset schema specification for 3D visualization of industrial data*

ISO/IEC 19775-1, *Information technology — Computer graphics, image processing and environmental data representation — Extensible 3D (X3D) — Part 1: Architecture and base components*

1) Under preparation. Stage at the time of publication: ISO/FDIS 17506:2021.

ECMA-404, *The JSON data interchange syntax*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
boundary representation solid model
B-rep
type of geometric model in which the size and shape of a solid is defined in terms of the faces, edges and vertices which make up its boundary

[SOURCE: ISO 10303-42:2019, 3.1.2.5]

3.2
constructive solid geometry
CSG
type of geometric modelling in which a solid is defined as the result of a sequence of regularized Boolean operations operating on solid models

[SOURCE: ISO 10303-42:2019, 3.1.2.12]

3.3
derived geometry
geometric representation generated from another representation

Note 1 to entry: The derivation is realized by actions such as using another representation method, another format, approximations, simplification

EXAMPLE A "6-face *B-rep*" (3.1) is derived from a CSG (3.2) "solid block".

3.4
converted geometry
result of changing the data format of a geometry

Note 1 to entry: The import and export operations in a CAD system produce converted geometry.

Note 2 to entry: Converted geometry is a kind of *derived geometry* (3.3).

3.5
design intent
intentions of the designer of a model with regard to how it may be instantiated or modified

Note 1 to entry: The aspects of design intent relevant to ISO 10303-108 are concerned with the information represented in the parameters and constraints associated with a model. More generally, design intent also includes the procedural or construction history of a model, which is the subject of ISO 10303-55. All aspects of design intent influence the behaviour of a model under editing operations.

[SOURCE: ISO 10303-108, 3.7.10, modified — Changed "this part of ISO 10303" to "ISO 10303-108" in Note 1 to entry].

3.6
geometry data set
serialized representation of geometry data which can be exchanged between two systems

Note 1 to entry: The geometry data set can be instantiated into a single file, a set of files, a web service payload or the result of a database query.

3.7
geometry service
web-service supporting retrieval of geometry-related data

Note 1 to entry: Geometry related data can be:

— a *geometry data set* (3.6) or one of its subsets;

— geometric properties of a geometry data;

— metadata related to a geometry data set;

— non-geometric product data related to a geometry identifier.

3.8
level of detail
LOD
description of detail and extent of geometric model information

3.9
native geometry
native CAD
data format used to write to memory using the authoring CAD application's CAD kernel

Note 1 to entry: This capability is used in order to save the *original geometry* (3.10) model as data and to reuse it without any loss with the original authoring tool.

Original geometry is often considered to be replicated only by reading the *native geometry* from memory into the CAD / modelling application using the same system, version or installation, used to initially author the *original geometry*, although even this is not guaranteed.

3.10
original geometry
geometry as defined by a modeler (human being) in a CAD tool using CAD authoring functions based on mathematical constructs

Note 1 to entry: The *original geometry* is the first initial geometry construction that holds the design intent.

Note 2 to entry: This is also often referred to as *native CAD* (3.9). However, a *native CAD* is in fact referring to the native CAD kernel and CAD format of the CAD tool manipulating the geometry. It therefore can also be any geometry derived from another CAD format.

Note 3 to entry: Geometry as initially authored in a CAD / modelling application using that tool's geometric modelling system, operations, and database. The author's design intent (3.5) as well as the characteristics and artefacts of the application's implementation of geometric and solid modelling algorithms, are present in the original geometry, thus distinguishing it from "exact geometry". *Original geometry* can take on many forms, e.g. *B-rep* (3.1), CSG (3.2), hybrid, tessellated, and be modelled using many modelling paradigms, e.g. procedural, explicit, dual, parametric features with construction history.

Note 4 to entry: While often misused and interchanged for each other, *original geometry* is distinguished from *native geometry* (3.9).

3.11
procedural model
generative model
history-based model
model described in terms of the operation of a sequence of procedures (which may include the solution of constraint sets), as opposed to an explicit or evaluated model which captures the end result of applying those procedures

Note 1 to entry: Although procedural models are outside the scope of ISO 10303-108, they are defined here to make an important distinction between two fundamentally different modelling approaches. The present resource is intended to be compatible with ISO 10303-55, which provides representations for the exchange of procedurally defined models.

[SOURCE: ISO 10303-108, 3.7.28, modified — Changed "this part of ISO 10303" to "ISO 10303-108"].

3.12
product and manufacturing information
PMI
non-geometric attributes in 3D CAD and Collaborative Product Development systems necessary for manufacturing product components and assemblies

Note 1 to entry: PMI may include geometric dimensions and tolerances, symbols, notes, surface finish, and material specifications.

[SOURCE: ISO 10303-62, 3.1.3.2]

3.13
tessellated geometry
geometry composed of a large number of planar tiles, usually of triangular shape

Note 1 to entry: *Tessellated geometry* is frequently used as an approximation to the exact shape of an object.

[SOURCE: ISO 10303-42, 3.1.2.47]

3.14
3D visualization
visual presentation on a screen or another media of graphical and textual three-dimensional representations of a set of data representing an object, information or results of a computational process in order to facilitate capture of the understanding of the object, for visual information sharing with users and sometimes to promote decision process by a human looking at the data visualized in a medium

[SOURCE: ISO 14306:2017, 3.1.1]

4 High level business scenarios

4.1 General

Geometry services can be deployed in a large variety of business scenarios. Some of them are presented below.

4.2 Check for updates

A supplier receives, from an original equipment manufacturer (OEM), a 3D Model of a part that the company has to manufacture.

During the development process, the supplier and the OEM can access the version information that the supplier has and confirm that it is the appropriate version through web services.

The following metadata shall be available: creator, name, ID and URI of the 3D Model, from the 3D model owner and from the 3D Model provider. It also needs the level of detail (LOD) of the data set to confirm that it can execute its task with the available information.

4.3 Visualization #1

A user shall perform a review and receives a metadata file.

The user queries the repository with the product Id/version in the metadata file to get the data set to load and visualize.

The query specifies the format and LOD to review.

The following metadata shall be available: ID and URI of the 3D Model from the 3D Model provider.

4.4 Visualization #2

From a large assembly data set already loaded for fast visualization, query the repository for a more detailed representation of a part with special concern [exact boundary representation (B-rep) with PMI].

The following metadata shall be available: ID and URI of the 3D Model from the 3D Model provider.

4.5 Retrieve product lifecycle management (PLM) data of a product

A user is viewing a part in visualizer software. The current data set contains only geometry.

Query the repository with the product Id/version to get PLM attributes of this product and display them in the viewer.

The following metadata shall be available: ID and URI of the 3D Model from the 3D Model owner.

4.6 Archiving

Ensure traceability from the original geometry data set in a Product Data Management (PDM) system and the geometry data set in an archiving system.

Following metadata shall be available: ID, URI, creation date, name, creator of the 3D Model from the 3D Model owner

5 Information requirements

5.1 Review of geometry, topology and shape definitions

The concepts defined below are extracted from ISO 10303-41, ISO 10303-42, ISO 10303-43.

This document considers a geometry data set as a collection of geometric models as defined in ISO 10303-42.

The geometric models in ISO 10303-42 provide data specifications describing the precise size and shape of three-dimensional solid objects. The geometric shape models provide a complete representation of the shape, which in many cases includes both geometric and topological data. Included here are the two classical types of solid model, constructive solid geometry (CSG) and B-rep. Tesselation is another common representation for geometry which provides light-weight data sets but is less accurate than the two previous solid model types but which other entities, providing a rather less complete description of the geometry of a product, and with less consistency constraints, are also included.

The geometric models are composed of geometric and topological data. Their primary application is for explicit representation of the shape or geometric form of a product model. The shape representation has been designed to facilitate stable and efficient communication when mapped to a physical file.

The geometry is exclusively the geometry of parametric curves and surfaces. It includes the point, curve and surface entities and other entities, functions and data types necessary for their definition. A common scheme has been used for the definition of both two-dimensional and three-dimensional geometry. All geometry is defined in a coordinate system which is established as part of the context of the item which it represents.

The topology is concerned with connectivity relationships between objects rather than with the precise geometric form of objects. ISO 10303-42 defines the basic topological entities and specialized subtypes of these. In some cases, the subtypes have geometric associations. Also included are functions, particularly constraint functions, and data types necessary for the definitions of the topological entities.

In addition to the geometric models, other product related information can be instantiated in a geometry data set, e.g. saved view and display attributes, e.g. colour, transparency, texture, PMI represented as graphical geometry helpers or semantic metadata, links to product metadata.

5.2 Geometry data set definition

The geometry data set (3.6) is a collection of models as defined in ISO 10303-42 with or without assembly structure. In addition to the geometric models, other product related information can be instantiated in a geometry data set, e.g. PMI represented as graphical geometry helpers or semantic metadata, links to product metadata.

The geometry data set can be instantiated into a single file, a set of files (see Figure 1), a web service payload or by the result of a database query.

EXAMPLES Simple shape CSG, simple shape B-rep, complex part without PMI, complex part with PMI, assembly of parts with tessellated shapes and PMI.