GUIDE 77-2

Guide for specification of product properties and classes

Part 2:
Technical principles and guidance

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Foreword

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Draft Guides adopted by the responsible Committee or Group are circulated to the member bodies for voting. Publication as a Guide requires approval by at least 75 % of the member bodies casting a vote.

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ISO/IEC Guide 77-2 was prepared by the Joint Technical Advisory Group of the ISO Technical Management Board and the IEC Standardization Management Board on product properties and families.

ISO/IEC Guide 77 consists of the following parts, under the general title *Guide for specification of product properties and classes*:

— *Part 1: Fundamental benefits*

— *Part 2: Technical principles and guidance*

— *Part 3: Experience gained*

Introduction

The capability to characterize products in an abstract way, independently of any particular manufacturer, is a fundamental aspect of engineering knowledge. Such a characterization is done by the name of a category of products that fulfils the same function, e.g. ball bearing, screw, capacitor. Such a category is called a characterization class. This first level of characterization is further detailed by means of some property-value pairs, which describe more precisely the target product within its characterization class. Examples of such properties are inner diameter, threaded length and capacitance.

Depending upon the context, products need to be characterized at various levels of accuracy. For example, in a preliminary engineering design phase, the need for a bearing with a particular inner diameter could be defined, with other properties of the bearing left unspecified. At a latter stage, it could be decided to use a ball bearing with a particular outside diameter and ball diameter; finally, a thrust angular contact ball bearing could be selected with contact angle equal to 80.

Consequently, characterization classes need to be defined at various levels of generality. A specialized class makes it possible to refine a requirement described in terms of a more general class. This generalization/specialization relationship between characterization classes builds up a hierarchy of characterization classes where each general class is refined into more specialized classes. The most specialized classes, called the leaf classes, are at the bottom of the hierarchy. In such a hierarchy, each class is associated with properties that can be used to characterize all the products belonging to this class. Note that a ball bearing being a bearing, all the properties applying to a bearing also apply to a ball bearing. Properties defined for more general classes can therefore also be used for all their specialized classes. Applicability of properties to classes is said to be inherited over the hierarchy.

Neither product characterization classes nor product properties are single words. They are concepts that belong to the engineering knowledge of specific engineering domains. These concepts exist independently of any particular language, and they can be referenced in various languages and technical jargons using various words. Usual word dictionaries are therefore inappropriate for describing such multilingual knowledge and for making it computer interpretable.

The goal of ISO/IEC Guide 77 is to describe how this knowledge can be modelled in a language-independent and computer interpretable way.

For each technical domain, the target result essentially consists of:

— a hierarchy (or a set of hierarchies) of characterization classes, each associated with a language-independent identifier and with a number of information elements, called attributes, that describe the corresponding concept, and

— a set of properties, each associated with a characterization class, that are inherited over the class hierarchy, and that have also language-independent identifier and descriptive attributes (name in various languages, domain of allowed values, etc.).

Such a structure is called a **product ontology** (see 2.17), to emphasize that it is a knowledge model that defines concepts and not words. In ISO/IEC Guide 77, each particular product ontology addressing a particular product domain that is designed in compliance with the common ISO 13584/IEC 61360 dictionary model for product ontology is called a **reference dictionary** (see 2.20) for that domain, keeping in mind that it is not a dictionary of words but a dictionary of concepts.

When an attempt is made to design or to use a reference dictionary for a particular domain (e.g. fasteners), a number of issues appear, notably including the following:

— which data to use for modelling characterization classes and product properties;

- how to represent characterization class hierarchies and relationships between classes and properties;
- how to avoid redefining properties that are already defined in other reference dictionaries;
- how to avoid a combinatorial blow-up when one tries to describe all the various categories of, for example, bolts and screws;
- how to extract from a standard reference dictionary only those properties that are useful for a particular company.

To answer these questions, a common information model for product ontologies, called the **common ISO 13584/IEC 61360 dictionary model** (see 2.6), has been developed as a joint effort of ISO/TC 184, *Automation systems and integration*, SC 4, *Industrial data*, WG 2, *Standard for the neutral representation of standard parts*, and of IEC/TC 3, *Information structures, documentation and graphical symbols*, SC 3D, *Data sets for libraries*.

This model has been defined in a formal data modelling language called EXPRESS. Thus, a number of software tools have been developed that support all the concepts of this model. These tools can be used by domain experts for building their own reference dictionaries without any knowledge about EXPRESS, while ensuring that the data representation of these reference dictionaries will be exchangeable in a standard way. The only prerequisite is to understand the concepts and mechanisms defined in the model: this part of ISO/IEC Guide 77 aims to provide this background.

Due to the diversity of industrial sectors and of engineering disciplines, creating reference dictionaries that cover the whole technical domain is a huge task that can only be performed by a number of parallel groups and projects. To ensure interoperability of the developed reference dictionaries, it is crucial that the same data model be used. It is also crucial that some mechanisms be used to connect the various reference dictionaries and to reuse in each reference dictionary the relevant properties that are already defined in some other reference dictionary. For these reasons, the ISO Technical Management Board and the IEC Standards Management Board decided to establish ISO/IEC/JWG 1. Its role has been to produce a guide for specification of product properties and families on the basis of the common ISO 13584/IEC 61360 dictionary model, and to produce recommendations and guidelines on how to monitor consistency of the work items produced in accordance with the guide across all ISO/IEC Technical Committees. These guidelines are documented in this multi-part ISO/IEC Guide 77. ISO/IEC Guide 77 is not only of interest to ISO and IEC Technical Committees for developing standard reference dictionaries, it can also be useful to any group, consortium or industrial organization that needs to develop interoperable reference dictionaries.

Developing reference dictionaries is a design task. It is based on a number of design choices and decisions that need to be agreed upon in a consensual way to ensure acceptability of the developed reference dictionary. These choices are largely domain-dependent, therefore no universal and systematic methodology can be built. To help domain experts in the process, ISO/IEC Guide 77-3 provides some reports of previous experience in the use of the common ISO 13584/IEC 61360 dictionary model in reference dictionary design.

Guide for specification of product properties and classes

Part 2:
Technical principles and guidance

1 Scope

ISO/IEC Guide 77 provides general advice and guidance for the description of products and their characteristics by the use of the ISO 13584 and IEC 61360 series of standards for the creation of computer-processable reference dictionaries. This description will provide the details of the products and their properties in an unambiguous manner capable of computer communication, in a form that is independent from any proprietary application software.

NOTE 1 The term “product” is taken to include devices, processes, systems, installations, etc.

ISO/IEC Guide 77 is intended to assist the objective of enabling the flow of technical information between internal and external business partners in a cost-effective and timely manner.

The guidance given in this part of ISO/IEC Guide 77 contains technical recommendations intended to assist standardization committees and technical experts contributing their knowledge to the development of standard reference dictionaries compliant with the common ISO 13584/IEC 61360 dictionary model.

It might also be useful for information experts responsible for the exchange of technical information between business partners or for the generation of applications of ISO 13584 and IEC 61360.

This part of ISO/IEC Guide 77 is intended to support the achievement of industrial benefits of applications of the common ISO 13584/IEC 61360 dictionary model. The following are within the scope of this part of ISO/IEC Guide 77:

— general principles of product description and characterization;

— presentation of the concepts of product characterization classes, product properties, product ontology and reference dictionaries for products;

— universal identification of classes and properties;

— presentation of the modelling constructs that can be used for building reference dictionaries conforming to the common ISO 13584/IEC 61360 dictionary model;

— rules and principles for developing standard reference dictionaries;

— rules and principles for connecting standard reference dictionaries to avoid duplication and overlap;

— rules and principles for developing user-defined reference dictionaries and for connecting user-defined reference dictionaries to standard reference dictionaries;

— formats and mechanisms for exchanging reference dictionaries;

— mechanisms for connecting reference dictionaries to classification systems.

The following are outside the scope of this part of ISO/IEC Guide 77:

— an overview for ISO and IEC Technical Committees and industrial managers for the development of computer-processable product libraries, reference dictionaries and catalogues;

NOTE 2 An overview of the development of computer-processable product libraries, reference dictionaries and catalogues is provided in ISO/IEC Guide 77-1.

— case studies from experiences in the creation of reference dictionaries of product information in industrial practice;

NOTE 3 Experience gained in the creation of reference dictionaries of product information in industrial practice is provided in ISO/IEC Guide 77-3.

— categorization of products for purposes other than product characterization.

2 Terms and definitions

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

2.1
applicable property of a class
property relevant for any product belonging to a product characterization class and that can be used for characterizing it

NOTE 1 All the applicable properties of a superclass are also applicable properties for its subclasses.

NOTE 2 Only properties defined or inherited as visible and imported properties of a class can become applicable properties.

2.2
attribute
data element for the computer-sensible description of a property, a relation or a class

NOTE An attribute describes only one single detail of a property, of a class or of a relation.

EXAMPLE The name of a property, the code of a class, the measure unit in which values of a property are provided are examples of attributes.

2.3
class
class of products
abstraction of a set of similar products

NOTE 1 A product that complies with the abstraction defined by a class is called a **class member** (see 2.5).

NOTE 2 A class is an intentional concept that can take different extensional meanings in different contexts.

EXAMPLE The set of parts used by a particular enterprise and the set of all ISO-standardized parts are two examples of contexts. In these two contexts, the set of products that are considered as members of the single ball bearing class might be different, notably because employees of each enterprise ignore a number of existing single ball bearing products.

NOTE 3 Classes are structured by class inclusion relationships.

NOTE 4 A class of product is a general concept as defined in ISO 1087-1. It is therefore advisable that the rule defined in ISO 704 be used for defining the designation and definition attributes of classes of product.

NOTE 5 In the context of this part of ISO/IEC Guide 77, a class is either a product characterization class, associated with properties and usable for characterizing products, or a product categorization class, not associated with properties and not usable for characterizing products.

2.4
class inclusion relationship
relationship between classes that means inclusion of class members

NOTE 1 Therefore, if A is a superclass of A1, this means that, in any context, any member of A1 is also member of A.

EXAMPLE 1 The set of parts used by a particular enterprise and the set of all ISO-standardized parts are two examples of contexts.

EXAMPLE 2 In any context, the class capacitor includes the class electrolytic capacitor.

NOTE 2 Class inclusion defines a hierarchical structure between classes.

NOTE 3 Class inclusion is a conceptual relationship that does not prescribe anything at the data representation level; consequently, it does not prescribe any particular database schema or data model.

NOTE 4 In the common ISO 13584/IEC 61360 dictionary model, the **is-a relationship** (see 2.9) ensures class inclusion. This part of ISO/IEC Guide 77 also recommends that the **case-of** (see 2.10) relationship also ensure class inclusion.

NOTE 5 Class inclusion relationship is a case of generic relation as defined in ISO 1087-1.

NOTE 6 Class inclusion relationship is also called subsumption.

2.5
class member
product that complies with the abstraction defined by a class

2.6
common ISO 13584/IEC 61360 dictionary model
data model for product ontology, using the information modelling language EXPRESS, resulting from a joint effort between ISO/TC 184/SC 4/WG 2 and IEC/SC 3D

NOTE 1 In ISO/IEC Guide 77, a product ontology that addresses a particular product domain, based on the common ISO 13584/IEC 61360 dictionary model, is called a **reference dictionary** (see 2.20) for that domain.

NOTE 2 The current version of the common ISO 13584/IEC 61360 dictionary model recommended by ISO/IEC Guide 77 is documented in EXPRESS in both IEC 61360-5 and ISO 13584-25 (conformance classes 1,2, 3 and 4). It is also documented in UML, together with its XML exchange format, in ISO 13584-32, OntoML.

NOTE 3 The common ISO 13584/IEC 61360 dictionary model is used in a number of ISO and IEC standards, including IEC 61360-4-DB, ISO 13584-501, ISO 13399, ISO 13584-511, ISO 23584, IEC 61987-2, ISO/TS 23768.

2.7
feature
aspect of a product that can be described by a characterization class and a set of property-value pairs

NOTE In the common ISO 13584/IEC 61360 dictionary model, features and products are both represented by product characterization classes. The concept of feature is only a useful design concept to be considered when designing the class hierarchy and the associated properties of a reference dictionary.

EXAMPLE Screws can be described as consisting of different features, such as screw head, screw thread, screw shank, and screw end. Such a description, used in ISO 13584-511:2006, makes it possible to describe a huge number of different screws by a smaller number of screw classes that reference a small number of feature classes.

2.8
imported property
property defined in a class that is selected by another class of the same or of a different reference dictionary, by means of the case-of relationship, to become applicable to the latter class

NOTE 1 Only properties that are visible and/or applicable in a class can be imported from this class.

NOTE 2 Importation between classes of different reference dictionaries enables properties, e.g. properties defined for example in a standard reference dictionary, to be reused without having to be redefined.

NOTE 3 Importation between classes of the same reference dictionary acknowledges the fact that some products can perform several functions, requiring the capability to import properties from several higher level classes.

NOTE 4 When a property is imported in a new class, it keeps its original identifier; consequently, it is not necessary to duplicate all the attributes.

2.9
is-a relationship
class inclusion relationship associated with inheritance

NOTE 1 Therefore, if A1 is-a A, then each product belonging to A1 belongs to A, and all class properties described in the context of A are also automatically described in the context of A1.

NOTE 2 This mechanism is usually called inheritance.

NOTE 3 In the common ISO 13584/IEC 61360 dictionary model, the is-a relationship can only be defined between characterization classes. It is advisable that it defines a single hierarchy, and it ensures that both visible and applicable properties are inherited.

2.10
is-case-of relationship
case-of
property importation mechanism

NOTE 1 Therefore, if A1 is-case-of A, then the definition of A products also covers A1 products, thus A1 can import any property from A.

NOTE 2 The goal of the is-case-of relationship is to allow the connecting together of several class inclusion hierarchies, while ensuring that referenced hierarchies may be updated independently.

NOTE 3 There is no constraint that the is-case-of relationship define a single hierarchy.

NOTE 4 In the common ISO 13584/IEC 61360 dictionary model, the is-case-of relationship can notably be used in four cases:

a) to link a characterization class to a product characterization,

b) to import, in the context of some standardized reference dictionaries some properties already defined in other standardized reference dictionaries,

c) to connect a user reference dictionary to one or several standardized reference dictionaries, and

d) to describe a part using the properties of different classes.

When parts of class A1 fulfil two different functions, and thus are logically described by properties associated with two different classes, A and B, A1 can be connected by is-a to A, and by is-case-of to B.

2.11
leaf characterization class
leaf class
characterization class that is not further subdivided into more precise characterization classes

EXAMPLE Countersunk flat head screw with cross recess (type Y) and hexagon socket head cap screw with metric fine pitch thread are leaf characterization classes defined in ISO 13584-511.

NOTE A characterization class that is further subdivided into more precise characterization classes is called a “non-leaf characterization class” (e.g. externally-threaded component and metric threaded bolt/screw are non-leaf characterization classes defined in ISO 13584-511).

2.12
product
thing or substance produced by a natural or artificial process

NOTE In ISO/IEC Guide 77, the term “product” is taken in its broadest sense to include devices, systems and installations, as well as material, software and services.

2.13
product categorization
recursive partition of a collection of products into subsets for a specific purpose

NOTE 1 Subsets which appear in a product categorization are called **product categorization classes**, or **product categories** (see 2.14).

NOTE 2 A product categorization is not a product ontology. It cannot be used for characterizing products.

NOTE 3 No property is associated with categorizations.

NOTE 4 Several categorizations of the same set of parts are possible, depending on their target usage.

EXAMPLE The United Nations Standard Products and Services Code (UNSPSC) classification, defined by the United Nations, is an example of product categorization that has been developed for spend analysis.

NOTE 5 Using the is-case-of relationship, several product characterization class hierarchies can be connected to a categorization hierarchy to generate a single structure.

2.14
product categorization class
product category
class of products that constitutes an element of a classification

EXAMPLE Manufacturing Components and Supplies, and Industrial Optics are examples of product categories defined in the UNSPSC.

NOTE 1 No rule is given in this part of ISO/IEC Guide 77 about how to select categorization classes. This concept is introduced both to clarify its difference from characterization class, and to explain that the same characterization class can be connected to any number of categorizations.

NOTE 2 There is no property associated with a product category.

2.15
product characterization
description of a product by means of a product characterization class, to which it belongs, and a set of property value pairs

EXAMPLE Hexagon_head_bolts_ISO_4014 (product grades = A, thread type = M, length = 50, diameter = 8) is an example of product characterization.

NOTE In the above example, Hexagon_head_bolts_ISO_4014 stands for the identifier of the Hexagon head bolts product characterization class defined by ISO 4014. The names in italics between parentheses stand for the bolt properties defined in ISO 4014.

2.16
product characterization class
class of products that fulfil the same function and that share common properties

NOTE Product characterization classes can be defined at various levels of details, thus defining a class inclusion hierarchy.

EXAMPLE Metric threaded bolt/screw and hexagon head bolt are examples of product characterization classes defined in ISO 13584-511. The first characterization class is included in the second one. Transistor and bipolar power

transistor are examples of product characterization classes defined in IEC 61360-4-DB. The second one is included in the first one.

2.17
product ontology

model of product knowledge, made by a formal and consensual representation of the concepts of a product domain in terms of characterization classes, class relations and properties

NOTE 1 Product ontologies are based on a class-instance model that makes it possible to recognize and to designate the sets of products, called characterization classes, that have a similar function (e.g. ball bearing, capacitor), but also to discriminate within a class the various subsets of products, called instances, that are considered as identical. It is advisable that the rules defined in ISO 1087-1 be used for formulating designation and definitions of characterization classes. Instances have no definitions. They are designated by the class to which they belong, and a set of property-value pairs.

NOTE 2 Ontologies are not concerned with words, but with concepts, independent of any particular language.

NOTE 3 Consensual means that the conceptualization is agreed upon in some community.

NOTE 4 Formal means that it is advisable that the ontology be machine interpretable. It is advisable that some level of machine reasoning be possible over ontology, e.g. consistency checking.

NOTE 5 Identified means that each ontology characterization class and property is associated with a globally unique identifier, making it possible to reference this concept from any context.

NOTE 6 The data model for ontology recommended in this part of ISO/IEC Guide 77 is the common ISO 13584/IEC 61360 dictionary model, which is documented in ISO 13584-42 and IEC 61360-2 (conformance classes 1, 2, 3 and 4 of both documents).

NOTE 7 In ISO/IEC Guide 77, each product ontology addressing a particular product domain compliant with the common ISO 13584/IEC 61360 dictionary model is called a **reference dictionary** (see 2.20) for that domain.

EXAMPLE The reference dictionary for electric components, which is defined in IEC 61360-4-DB, is a product ontology for electric components compliant with the common ISO 13584/IEC 61360 dictionary model. A corporate reference dictionary is agreed upon by experts designated by management on behalf of the company.

2.18
property

defined parameter suitable for the description and differentiation of products

NOTE 1 A property describes one aspect of a given object.

NOTE 2 A property is defined by the totality of its associated attributes. The types and number of attributes that describe a property with high accuracy are defined in this part of ISO/IEC Guide 77.

NOTE 3 The term “property” used in this part of ISO/IEC Guide 77 and the term “data element type” used in IEC 61360 are synonyms.

NOTE 4 The term “property” used in this part of ISO/IEC Guide 77 and the term “property” used in ISO 704 are not synonyms. In ISO 704, a property is a statement about objects. In this part of ISO/IEC Guide 77, a property is used for differentiating the various products that are members of the same product characterization class. Thus, a property is associated with a domain of values, and it assigns a value in this domain for each member of a product characterization class.

2.19
property definition class

product characterization class in the context of which a product property is defined

NOTE In the common ISO 13584/IEC 61360 dictionary model, each product property has one property definition class that defines its domain of application. The property is only meaningful for this class, and all its subclasses, and it is said to be visible over this domain.

EXAMPLE In ISO 13584-511, wrenching height has nut as its property definition class, type of thread has thread as its property definition class, and major diameter of external thread has metric external thread as its property definition class.

2.20
reference dictionary
product ontology compliant with the common ISO 13584/IEC 61360 dictionary model

NOTE In ISO/IEC Guide 77, a product ontology that addresses a particular product domain, based on the common ISO 13584/IEC 61360 dictionary model, is called a “reference dictionary” for that domain.

2.21
subclass
class that is one step below another class in a class inclusion hierarchy

NOTE In the common ISO 13584/IEC 61360 dictionary model, class inclusion hierarchies are defined by the is-a relationship. They can also be established by is-case-of relationships.

2.22
superclass
class that is one step above another class in a class inclusion hierarchy

NOTE 1 In the common ISO 13584/IEC 61360 dictionary model, class inclusion hierarchies are defined by the is-a relationship. They can also be established by is-case-of relationships.

NOTE 2 In the common ISO 13584/IEC 61360 dictionary model, a class has at most one superclass specified by means of an is-a relationship.

2.23
visible property
property that has a definition meaningful in the scope of a given product characterization class, but that does not necessarily apply to the various products belonging to this class

NOTE 1 The concept of a visible property makes it possible to share the definition of a property among product characterization classes where this property does not necessarily apply.

EXAMPLE The non-threaded length property is meaningful for any class of screw, but it applies only to those screws that have a non-threaded part. It can be defined as visible at the screw level, while becoming applicable only in some subclasses.

NOTE 2 All the visible properties of a superclass that is a product characterization class are also visible properties for its subclasses.

3 General principles

3.1 The common ISO 13584/IEC 61360 dictionary model

ISO/IEC Guide 77 recommends that standard reference dictionaries be based on the common ISO 13584/IEC 61360 dictionary model. This clause outlines the origin of the common ISO 13584/IEC 61360 dictionary model. It defines the current reference documents for this model and the additional standard specifications documented either in the ISO 13584 series of standards or in the IEC 61360 series of standards.

The goal of the IEC 61360 series of standards is defined in IEC 61360-1:2004 as follows:

> “IEC 61360 provides a firm basis for the clear and unambiguous definition of characteristic properties (data element types) of all elements of electrotechnical systems from basic components to subassemblies and full systems.”