The Classification of Standards

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ABSTRACT: Many classifications of standards exist. These are often inconsistent, which may lead to confusion in standardization practice. This article includes an inventory of current classifications and a discussion of their applicability. Based on the new insights, gained from this examination, other possible classifications of standards are suggested. These classifications may be related to the entities the standards refer to or to the users of the standards.

1. Need for Classification of Standards

The standardization literature offers many possible classifications of standards. Most of them, however, lack systematic underpinning, and many of them are unsystematic,[1] as is demonstrated in the following example:

Example of Unsystematic Classification: DIN 820-3

The German standard DIN 820 part 3 *Normungsarbeit - Begriffe* (Standardization - concepts) presents two ways to classify standards. The second one concerns the standard's contents:

1 *Dienstleistungsnorm* [service standard]: specifies requirements to be fulfilled by a service to establish its fitness for purpose;
2 *Gebrauchstauglichkeitsnorm* [fitness for purpose standard]: specifies properties of entities that can be determined objectively to be able to judge the entity's ability to serve a defined purpose under specific conditions;
3 *Liefernorm* [supply standard]: specifies technical and contractual requirements for deliveries;
4 *Maßnorm* [measurement standard]: specifies sizes and tolerances of material objects;
5 *Planungsnorm* [planning standard]: specifies planning fundamentals and basic principles for design, calculation, construction, realization, and functioning of machines, structures, and achievements;
6 *Prüfnorm* [testing standard]: specifies methods, sometimes supplemented with other provisions related to testing, such as sampling, use of statistical methods, sequence of tests;
7 *Qualitätsnorm* [quality standard]: specifies properties of a material object that are essential for its use and specifies related assessment criteria;
8 *Sicherheitsnorm* [safety standard]: specifies requirements to prevent unacceptable risk or harm for people, animals, and material objects;
9 *Stoffnorm* [material standard]: specifies physical, chemical, and technological properties of materials;
10 *Verfahrensnorm* [process standard]: specifies requirements to be fulfilled by a process to establish its fitness for purpose;
11 *Verständigungsnorm* [comprehensibility standard]: specifies terminology, symbols, or systems to provide unambiguous understanding.

This classification combines apples and oranges, the apples being entities (services, material objects, materials, transactions, production processes, other processes or entities in general, the oranges being aspects to standardize: linguistic aspects (terminology, symbols, systems), (process-, technical, contractual or safety) requirements, requirements for use, sizes and tolerances, test methods, and properties in general. The aspects, moreover, could be divided into aspects that are intrinsic to the entity, such as size, chemical properties, and process speed and aspects related to the entity: linguistics, requirements, test methods.

A systematic classification could prevent such confusion. Standards Developing Organizations (SDOs) can use classifications

- to describe standardization projects;
- to develop criteria to determine whether or not certain standards are within their scope;
- to improve identification of standards.

This, in turn, may be of benefit to their customers.

This article includes an inventory of current classifications and a discussion of their applicability. Based on the new insights gained from this examination, other possible classifications of standards are suggested.

2. Subject Matter-Related Classifications

2.1 Introduction

As standards result from the process called standardization, systematic classification of standards must start with the definition of standardization. After inventorying and analyzing definitions in use, De Vries (1997b) arrived at the following definition:

Standardization is the activity of establishing and recording a limited set of solutions to actual or potential ***matching problems*** *directed at benefits for the party or parties involved, balancing their needs and intending and expecting that these solutions will be repeatedly or continuously used during a certain period by a substantial number of the parties for whom they are meant.*

Notes.

1 *A matching problem is a problem of interrelated* ***entities*** *that do not harmonize with each other. Solving it means determining one or more features of these* ***entities*** *in such a way that they do harmonize with each other, or of determining one or more features of an* ***entity*** *with a view to its relation(s) with one or more other* ***entities.***

2 *An entity is any concrete or abstract thing that exists, did exist, or might exist, including associations among these things. Example: A person, object, event, idea, process, etc.*

This definition consists of elements related to the subject matter (solutions, matching problems, entities, entity features), to the people and their activities and needs (establishing, recording, benefits, needs, the parties involved) and to the wider circle of interested parties and their activities (parties for whom they are meant or by whom they are used). Classifications of standards may relate to either the first, the second, or the third group of elements. The first will be discussed in the following two sections, the others in the next sections.

2.2 Entities

Standards concern entities or relations between entities. Thus, standards can be classified according to these entities. An entity may be

- a person or group of persons;
- a "thing" such as an object, an event, an idea or a process. "Things" includes plants and animals;[2]
- a combination of the first two kinds of entities (for instance, a car with a driver, or a company).

It can be concluded that matching problems, because they concern interrelated entities or relations between entities, can concern:

- matching thing - thing (for instance: bolts and nuts);
- matching man - thing (for instance: safety or ergonomic requirements);
- matching man - man (for instance: procedures, management systems).

Current entity-related classifications generally concern only one of the entities and are, therefore, only partly satisfactory.[3] In defining the tasks to be carried out in a standardization project, the matching problems to be solved need to be described unambiguously. Defining the entities concerned should be part of this description.

It is often not one or two entities that are involved, but a system of interrelated entities. Hildebrandt (1995, pp. 34-35) related a hierarchic product structure, based on VDI 2222,[4] to standardization. IEC 61355 (IEC, 1997, p. 31) more generally relates documents to the structure and reference designation of a plant, system, or equipment.

2.3 Entity-Related Classifications

SDOs often distinguish between *horizontal* and *vertical* standards. Horizontal standards set general requirements for a collection of different entities, for instance, bio-compatibility criteria for medical devices. Vertical standards set several requirements for one kind of entity, for instance, a transfusion apparatus or medical gloves.

In information and communication technology, one[5] often distinguishes between classic standards, functional standards, and standards for testing.

- *Classic standards* provide general descriptions. Although these mostly are called *basic standards*, they are not basic and *classic standards* is a better designation (De Vries & Simons, 1997, p. 13).
- *Functional standards* (or *profiles*) provide a selection out of the options offered in classic standards.
- *Standards for testing* specify a technical procedure for performing a test (CEN/CENELEC, 1993, clause 12.2).

A distinction can be made between basic standards, requiring standards, and measurement standards.

- *Basic standards* provide structured descriptions of (aspects of) interrelated entities to facilitate human communication about these entities[6], and/or to be used in other standards. Examples are terminology

standards, standards providing quantities and units,[7] standards providing classifications and/or codes,[8] and standards providing systematic data[9] or reference models.

- *Requiring standards* set requirements for entities or relations between entities. These can include specifications of the extent to which deviations from the basic requirements are allowed.
  There are two sub-categories: performance standards and standards that describe solutions.
  Performance standards set performance criteria for the solution of matching problems. They do not prescribe solutions. Performance standards can include specifications of the extent to which deviations from the basic requirements are permissible.
  Solution- describing standards describe solutions for matching problems.[10]
- *Measurement standards* provide methods to be used to check whether requiring standards criteria have been met.

Example: Acoustic Standards in Housing

If the entity is a wall separating two houses, one performance criterion might be its soundproofing effect (in DbA). This could be laid down in a performance standard. A descriptive criterion could be that to get this effect when using sand-lime bricks, the wall should be 22 cm thick. Such a standard provides an example of a solution that meets the requirements set and would be of practical help when designing a row of houses. Another standard might describe a method to measure the soundproofing characteristics once the houses have been built.

Simons (1994; elucidated in De Vries & Simons, 1997, pp. 14-15) distinguishes between interference standards, compatibility standards, and quality standards.

- *Interference standards* set requirements concerning the influence of an entity on other entities. Examples are safety, health, environmental, and EMC[11] standards. Companies often have to use interference standards because of governmental requirements. They, therefore, have no choice: they must use them.
- *Compatibility standards* concern fitting of interrelated entities to one other, in order to enable them to function together, for example, specifications for films and cameras, GSM telephone specifications. Choices regarding compatibility standards are often commercial decisions that can have direct impact on market share. Thus, while the choices are up to the company, it is often the market situation which strongly influences these choices.
- *Quality standards* set requirements for entity properties to assure a certain level of quality. ISO 9000 quality management standards, a film having a standard film sensitivity (to enable standard film processing), measurement standards, and company procedures are examples of quality standards. Quality standards are often related to the company's operations, and, in many cases, the company is free to set or choose them.

Basic standards are missing in Simons' classification. His interface, compatibility, and quality standards are particularizations of requiring standards. Compatibility standards are always descriptive; interface and quality standards can be performance standards as well as solution-describing standards. Measurement standards are included in Simons' quality standards. In fact, they are a particular kind of requiring standards, namely, standards that describe a solution for measuring. In a research project on standardization in the service sectors, however, it proved fruitful to distinguish between requiring and measuring standards (De Vries 1997a).

Wiese (1998, p. 286) distinguishes between horizontal compatibility and vertical compatibility.

- *Horizontal compatibility* concerns the fit between functionally equivalent objects. Examples: two Lego bricks, two telephones.
- *Vertical compatibility* concerns the fit between functionally different things. Examples: hardware and software, tracks and trains.

Indirect horizontal compatibility results from the common fit of functionally equivalent objects to functionally different objects (Wiese, 1998, p. 288). Example: telephone A - telephone system - telephone B.

The above classifications can be combined as follows:

1 Basic standards
2 Requiring standards
2.1 Performance standards
  - Interference standards
  - Quality standards
2.2 Solution-describing standards
  - Interference standards
  - Compatibility standards
    . Horizontal compatibility
    . Vertical compatibility
  - Quality standards
3 Measurement standards.

By combining this standards classification to the above entity classification, it can be concluded that basic standards include descriptions of entity architectures and the related standards architecture. Such a standards architecture can, subsequently, include horizontal and vertical standards. All categories of

standards can, in principle, concern all categories of interrelated entities including men.[12]

3. Actor-Related Classifications

3.1 Actors

The definition of standardization indicates that two groups of actors are relevant: those interested in the standard and those involved in standardization. The second is a subset of the first.

The set of potentially interested actors can be determined by identifying which (groups of) people have a direct or indirect relation to the entities involved during the entities' life cycle. In a system of interrelated entities, this life cycle may differ per kind of entity. The actors are usually producers and customers, and some other stakeholders such as governmental agencies, pressure groups, consultancies, scientists, and organizations involved in testing and certification.

As many of the standards are mainly used in a particular business sector and/or professional discipline, many standards classifications refer to such stakeholder groups.[13] In practice, these classifications are not unambiguous:

- A professional discipline may be developed around aspects, such as environmental aspects, from which a separate business sector may subsequently emerge.
- As most standards relate to two or more stakeholder groups, most of them fit into two or more categories, unless all the stakeholder groups share the same general category.
- Standards are sometimes used by groups for which they have not been developed.[14]

It appears that such classifications are not really fundamental, though they may be practical for bibliographic reasons.

The geographic spread of the actors may lead to another classification, often called *level of standardization* (Verman, 1973). In most cases, a distinction is made between the international, regional, national, and company level. In formal standardization, this classification corresponds to the geographic spread of the parties that *are able to get involved*. The standards can be *used* by actors in other geographic areas too,[15] whereas, conversely, actors within the geographic area will not always use the standards.[16] In de facto standardization, it is more difficult to use a geographic classification: the *actors involved* in preparing the standard may even be limited to one company.[17] *Interested actors* will often have a different geographic spread. Moreover, this, may change over time.[18]

Thus, it appears that *level of standardization* is too inconvenient to be a common classification criterion.

3.2 Functional Classifications

Functional classifications connect standards to actors. Kienzle (1943; English version in Hesser & Inklaar, 1997, pp. 39-45) provides a functional classification. According to him, a standards function is *the inevitable link between a standard as independent variable and the consequences that depend upon its content.* So, the standard itself and its functions are at the centre. In another functional approach, developed by Susanto (1988, p. 36), it is not the standard but its use that is the focal point: *Standardization functions are taken to mean the relationship between the actual state before standardization (input variable) and the results of standardization (output variable) of a set of circumstances (system).*

We will speak about *intrinsic functions* of a standard when we use Kienzle's definition. The functions of standards according to Susanto's definition will be called standards' *extrinsic functions.* A third category is subjective functions, which indicate actor-specific interests related to a standard.

Though their definitions of the functions are clear, Kienzle and Susanto confuse these three different functions. Combining Kienzle, Susanto, and Bouma (1989), *intrinsic standards' functions* can be concluded to be:

- describing a set of agreed solutions to a matching problem
- recording these
- freezing them during a certain period
- providing elucidation to them.

The first three apply to all standards.

Extrinsic functions differ per standard and can include:

- assortment control
- providing transparency (by laying down unambiguous descriptions)
- facilitating information exchange between people and/or institutions
- storing know-how, and keeping it accessible
- enabling repetition of the solution laid down in the standard
- enabling dissemination of the solution laid down in the standard
- enabling economies of scale
- serving as a benchmark (for instance, in process management, to be able to decide between approval and disapproval)
- assuring performance (by setting, for instance, certain quality or safety characteristics)
- enabling interchangeability
- enabling interoperability
- creating an *installed base*[19]
- matching the life cycle of different entities.[20]

Apart from these, there are *subjective functions*,

related to the interests of specific actors, for instance:
- cost reduction
- enabling a company to continue selling its products
- creating barriers to new entrants and/or cometitors
- stimulating price competition between suppliers
- enabling customization at acceptable costs (by assembling standardized modules in products, methods and marketing tools)[21]
- eliminating barriers to trade (for instance, by harmonizing national requirements)
- creating barriers to trade (for instance, by creating a regional standard different from an existing international standard)
- stock control
- providing transparency in the supply of products or services (by means of standardized descriptions of them)
- facilitating technological innovations (by using a standards architecture that permits changes in parts of the entity systems without affecting other parts of these systems, or by describing good R&D practice)
- enabling and interworking and portability of entity systems (making use of interconnection and interoperability)
- enabling justification
- contributing to quality management
- enlarging consumer safety
- avoiding extra legal safety requirements
- facilitating processes (for instance, by using standardized data exchange)
- making processes more difficult (by laying down high-level process requirements)
- environmental care
- facilitating meeting legal requirements
- contributing to knowledge management
- providing reliable testing
- enabling re-use
- improving maintainability of products or systems.

Although this list is longer than other existing lists, it is not complete. This is virtually impossible, since certain actors may have particular interests, including irrational ones.

3.3 Classifications Related to the Installed Base

Standardization freezes solutions for matching problems. Three typical situations can apply: [22]

1 *Anticipatory (or prospective) standardization*
In anticipation of an expected future matching problem, a standard is developed so that the matching problem can be solved from the out-set.[23]
2 *Concurrent standardization*
Matching problems are solved as soon as they occur.
3 *Retrospective standardization*
Standardization to solve present matching problems.

IEC 61355 (IEC, 1997, p. 31) relates documents to the product's 'life cycle,' such as engineering, manufacturing, installation, commissioning, operation, and maintenance. This may be applied to standards, but does not add a useful classification.[24]

Another distinction[25] concerns:

1 *Designing standardization*
Standardization directed at creating a limited set of *new solutions* to solve matching problems;
2 *Selecting standardization*
Standardization directed at establishing a set of preferred solutions out of already available solutions to the matching problems.

In anticipatory standardization, solutions have often not yet been developed. In that case, standardization includes designing solutions. In retrospective standardization, there are often several solutions, and standardization entails selection of one or some of these. Development of new solutions is also an option in retrospective standardization. The combination of existing solutions and the modification of existing solutions are in-between options.

3.4 Time-Related Classifications

Standardization freezes matching problem solutions until the standard is revised or withdrawn. Afterwards, a standard's life span can be calculated exactly. Life span calculation for implementation in company practice is more difficult, because this differs per company or even within a company.[26] In sectors with rapid technological changes, standards can quickly become outdated. Therefore, Simons (1994, p. 10) states that the life span of a standard meant for producers should exceed the life span of their investments; for customers, it should exceed the economic or technical life span of the products; and for governments, it should correspond to the life span of the laws that refer to it. Thus, standards can be classified in accordance with the expected life span of the entities they relate to.

The life span of standards should be more than the time needed to develop a new standard, so the expected life span can be a criterion whether standardization makes any sense or not. For SDOs as well as for big companies preparing company standards, the present minimum life span for standards is three years (De Vries & Simons, 1997, pp. 7-8).

Most SDOs (and many companies) have a procedure that should guarantee a review of all standards every five years. The responsible committee then has to decide on confirmation, revision, or withdrawal of the standard. In SDO (and company) practice, this

review is often postponed or skipped, so that many standards collections contain obsolete standards.[27]

Many SDOs have introduced *pre-standards*: standards that follow the normal drafting and voting procedure, but have a shorter period of review, for instance, three years. These standards are used for rapidly changing technologies or when there already is a need for a standard though there is not yet enough experience and/or consensus to set a definitive standard.[28]

Standards can also be classified by the stage they are in the process of their development. Annex H of the ISO/IEC[29] Directives provides two examples (ISO and IEC respectively) of this (ISO/IEC, 1995, p.119-120).

ISO/IEC's Stages in Standards' Development

The ISO/IEC stages are: preliminary stage, proposal stage, preparatory stage, committee stage, approval stage, and publication stage. Other stages are: review stage, and withdrawal stage. Per stage substages are distinguished: registration, start of main action, completion of main action, and decision. Codes related to this classification make it possible to indicate what stage in its development process a standard is in.

Such classifications are useful for standards' project management. Moreover, they indicate the status of the document: a *Working Draft*, for instance, has less status than a published *International Standard*. All SDOs use such classifications, which usually resemble the ISO/IEC classification. As far as the author knows, these classifications are satisfactory, and there is no need for further improvements.

3.5 Classification by Rate of Obligation

Many authors classify standards by the rate of obligation. Galinski,[30] for instance, distinguishes between six classes of regulation: information, indication, recommendation, case-by-case, obligatory regulation, and legally enforced regulation. In practice, the difference between regulatory standards and voluntary ones is not strict.[31] Moreover, the same standard can be voluntary for one actor and obligatory for another party.[32] Therefore, this is not a fundamental classification, although it may be of help to describe the interests of different stakeholders.

3.6 Classifications Related to the Process of Developing Standards

Standards issued by official standardization institutes are the result of a conscious process of drafting and decision making by interested parties. This, however, does not always apply. Simons (in: De Vries & Simons, 1997, p. 12) distinguishes two other categories of standards development processes: historical and factual standardization processes.

- In *historical standardization*, the choice of one man or a few people finds broader application and gradually becomes broadly based. The QWERTY keyboard, many quantities and units, and musical notes and symbols are examples of this.
- In *factual standardization*, circumstances determine the standard. There is no conscious process of balancing needs. Many company-created standards are factual ones: most procedures and forms used by personnel departments, for instance, are highly determined by governmental requirements.

Conscious standardization is restricted by historical and factual standardization: a standard for keyboards cannot ignore QWERTY and a standard test method for steel can not ignore factual steel properties.

Within conscious standardization, a distinction can be made between formal standardization and de facto standardization.

- *Formal standardization* is standardization carried out in committees of official standardization institutes.
- *De facto standardization* is standardization carried out by other parties, for instance, companies, consortia, or governments.

For a clear distinction, it is necessary to define 'official.' Does this mean 'recognized,' for instance, by governments or by the international SDOs such as the ISO and the IEC? Or does 'official' refer to a more or less democratic, consensus-based decision-making process and openness to all interested parties? The literature provides no clear answers to this question.

According to Stuurman (1995, pp. 22-24), 'formal' refers to the SDO's recognition. He also distinguishes between

- *one-sided standards*, originating from one dominant organization, and *common standards*, meeting common interest;
- *open standards*, where all interested parties have been welcome to participate, and *closed standards*, where participation has been restricted;
- *non-public standards*, accessible only to parties involved in drafting them, and *public standards*, accessible to all third parties.

Standards issued by national standardization institutes are formal, common, open, and public.

SDOs can be *private* or *governmental* organizations. In most industrial countries, national standardization organizations are private organizations; in many developing countries and former state eco-

nomies, they are part of the governmental administration.[33]

3.7 Classifications Related to Business Models

A French classic publication on standardization is *La normalisation dans l'entreprise* (Association Française de Normalisation, 1967). It includes a classification of objectives of standardization based on a business typology.[34] The typology is obsolete, but it illustrates the possibility of relating a standards' classification to a company model.

For companies in service sectors, such a model is presented by De Vries (1997a). The standards' classification for service companies was applicable in all service sectors investigated. The services standards' architecture is related to the architecture of the entities concerned and offers the possibility for a systematic description of the need for standards in service sectors.

Cargill (1990) offers a combination of two standards classifications that try to relate standards classifications to company's practice. His second classification distinguishes between

- *regulatory standards*: standards having some form of statutory enforcement behind them;
- *business/marketing standards*: standards to gain a business or marketing advantage or to avoid a business or marketing disadvantage;
- *operational standards*: standards to structure day-to-day operations of an organization.[35]

In the case of regulatory standards and operational standards, the company can obtain the standards needed from outside and/or make company standards. The only reason to get other parties involved is that they might be facing the same problems so they could co-operate in finding solutions. In the case of business/marketing standards, a strategy is needed to handle the situation of different parties having different interests. Consequently, three different situations are possible:

1 the party making its own (company) standard;
2 the party co-operating with other parties having the same interests;
3 the party trying to find its way in an arena with different parties having different interests.

Although it provides some insight into actors' interests, Cargill's classification is not unambiguous and again mixes apples and oranges.

One may try to relate standards to accepted business models, such as Porter's value chain. Without explicitly talking about business models, Enjeux (1992) and De Vries & Simons (1997, pp. 87-96) group standards into areas of business activities. Feier (1995) links standards to hierarchical levels within a company. However, a standard that sets requirements for a pump sold by company A, for example, may also be applied by company B that uses this pump in its installation. For A, the entity is a product; for B, it is a part of an installation. This demonstrates that the same standard may be placed into different classes in business-model-related standards classifications, depending on the party using them. Therefore, we have not tried to develop such a classification. In describing the interests of different actors, however, it would be useful to relate a standard to their business processes.

3.8 Property Rights

According to Crawford (1991, p. 44), a *licensed standard* is created *when a company (or group of companies or agencies) establishes a new design, gains patent or copyright protection for it, and explicitly sets out to persuade other companies to use the same one.* Such de facto standards are sometimes offered to formal SDOs to include them in their standards' collections. In general, SDOs have the intellectual property rights to standards developed in their committees. This may cause problems when a standardization committee wishes to include patented matters in standards.[36] Formal SDOs only allow this when the patent holder declares that he is *willing to negotiate licences under patent and like rights with applicants throughout the world on reasonable terms and conditions.*[37] The market mechanism determines what is 'reasonable.' A standards classification can specify whether or not such intellectual property rights apply.[38]

4. Conclusions

4.1 Entity-Related Classifications

Standards' classifications can be divided into entity-related and actor-related classifications. Additional to a classification of entities themselves, the major entity-related classification distinguishes between:

1 Basic standards
2 Requiring standards
2.1 Performance standards
  - Interference standards
  - Quality standards
2.2 Solution describing standards
  - Interference standards
  - Compatibility standards
    . Horizontal compatibility
    . Vertical compatibility
  - Quality standards
3 Measurement standards.

Sets of requiring standards can also often be divided into:

- *horizontal* versus *vertical* standards
- classic versus functional standards.

4.2 *Actor-Related Classifications*

Fundamental actor-related classifications are the functional ones, relating to *intrinsic functions* of standardization, *extrinsic functions*, or *subjective functions*.

Classifications related to the *installed base* are:
- anticipatory, concurrent, and retrospective standardization;
- designing and selecting standardization.

Time-related classifications can concern:
- life expectancy of standards
- stages in the development of standards.

Processes of standards' development can be:
- conscious / historical / factual
- formal / de facto
- common / one-sided
- open / closed.

The resulting standards can be public or non-public. SDOs can be private or governmental.

Finally, it can be important whether or not *intellectual property rights* relate to the standard.

4.3 *Applicability of Standards' Classifications*

In general, classifications can be of help in human communication, in searching for information, and in organizing data. They are the means to make matters clear. Many current standardization classifications mix apples and oranges. Others appear to be irrelevant or inconsistent, such as
- classification related to the *level of standardization* (company, national, regional, international)
- business-oriented classifications
- classifications by rate of obligation of the standards.

In this article some new classifications have been introduced and relevant ones from the literature have been sorted out. SDOs can use them as a help
- to define criteria for inclusion of proposed work items in their work program;
- to describe proposed and current standardization projects. Entity-related classifications can be used to describe a standard's scope, actor-related classifications can be used to describe their field of application;[39]
- to create coherent sets of standards that correspond to relevant entity structures, matching problems therein, and actors and their interests.

Notes

1. This even applies to the most complete standards classification available, offered by Baynard (1982), which offers a *standard fingerprint* covering nine different aspects. Other examples are the classifications presented by Bonino & Spring (1991), Cargill (1990), Coles (1949, pp. 115-117), David (1995, pp. 211-217), and Le Lourd (1992, p.14).
2. Gaillard (1933, p. 33) provides a rather complete list of possible entities.
3. This also applies to the *International Classification of Standards (ICS)* (ISO, 1993), used by SDOs in their standards catalogues. ICS, moreover, concerns *fields of activity* rather than just entities; consequently, ICS mixes entities with the human use of them. Owing to these two factors, most standards have to be placed in two or more ICS categories.
4. *Richtlinie 2222 Konstruktionsmethodik* [Guideline 2222 Design Engineering Methodology] of the *Verein Deutscher Ingenieure* [Association of German Engineers].
5. For instance, Kampmann, 1993, p. 47. For *classic standards*, Kampmann used the term *basic standards*.
6. Descriptive standards to a large extent coincide with the *basic standards* defined in EN 45020 (CEN/CENELEC, 1993, clause 5.1). The definition there, however, is not accurate enough. David (1987, p. 215) uses the term *reference standards*. Writing about standards in information and communication technology, he obviously had the Open Systems Interconnection (OSI) standards in mind. The OSI reference model is an internationally recognized design template for information technology. A set of international OSI standards has been developed, of which ISO 7498 describes the basic reference model and the others provide requirements, to facilitate computer systems working together.
7. For instance, *SI: Système Internationale d'unités* [International System of Units].
8. For instance, the international standard ISO 7372 *Trade data interchange - Trade Data Elements Directory*.
9. Ergonomic standardization, for instance, includes standards describing man's characteristics and abilities, such as dimensions of the human body. These data are used in other standards (Schultetus, 1997).
10. The Agreement on Government Procurement (coming out of the Uruguay Round along with the World Trade Organization) advocates performance standards rather than standards that describe solutions (Schwamm, 1997, pp. 17-18). Companies and other stakeholders in standardization in general share this policy (for instance, the French National Standardization Organization AFNOR (Le Lourd, 1992, p. 14)), but most developing countries prefer descriptive standards with a large number of technical details (Hesser & Inklaar, 1997, p. 38). The percentage of performance standards is growing, at the expense of standards that prescribe certain solutions.

11. EMC = electromagnetic compatibility. These standards concern electrical disturbances.
12. Basic standards concerning people include data to be used for ergonomic requiring standards. Height requirements for pilots are an example of a requiring compatibility standard for people.
13. For instance, it is one of the three dimensions in the most often cited standards classification, the one developed by Verman (1973).
14. EAN (European Article Numbering Association) barcodes, for instance, were initially developed for the retail sector to be placed on consumer products, but have found their way to business-to business logistics too.
15. Example: American (national) ASTM standards are used in Europe; German DIN standards in the USA.
16. Example: the A and B series of paper sizes are laid down in international standards. In the North-American region, however, different sizes are used.
17. The *Windows* versions can be regarded as company standards of Microsoft.
18. For instance, a Scandinavian standard that provided a classification for technical aids for disabled persons got worldwide spread because of its adoption as international standard (ISO, 1992).
19. An *installed base* is a group of actors that use certain entities of which one or more aspects meet requirements set in a standard. Once created, an installed base forms a hindrance for conversion to another standard. Example: the non-metric system used in the Anglo-Saxon countries.
20. According to Bouma (1989), standardization is directed at matching the life cycles of entities having different speeds of change: *infrastructure*, which is rather stable in time, *components*, which are subject to rapid changes, and *man* in relation to these entities, who, in general, prefers a certain amount of stability.
21. Application of standardization in marketing is described by De Vries (1998).
22. Source: (1986) *Communications standards. State of the art report 14.3*. Maidenhead: Pergamon Infotech Ltd. p. 306; cited by Stuurman, 1995, p. 27).
23. Bonino and Spring (1991, p. 102) describe this for the Information Technology Industry.
24. The term 'product life cycle' is also often used to indicate a product's introduction, growth, maturity and decline stage. Seen from a company's point of view, standardization can play different roles in different stages. An initial impetus to this is provided by Pries (1995, pp. 11-13).
25. This distinction is lacking in the standardization literature.
26. Standards implementations, of course, may remain while a standard has been replaced. These may even cause withdrawn standards to be kept in use. An example of this is the Dutch standard NEN 1010 *Safety requirements for low voltage installations.* Dutch low voltage installations have to meet the requirements of the NEN 1010 edition in force at the moment the equipment was installed. So people involved in testing installations older than the present edition of NEN 1010 have to use an old edition. The International Federation for the Application of Standards (IFAN), therefore, asks SDOs to keep obsolete and withdrawn standards and to provide users access to them under the usual commercial terms (IFAN, 1997, p. 6).
27. Sometimes there is no committee that is able to decide on it, even when the SDO knows the standard is obsolete. This applies, for example, to the Dutch standard NEN 2296 *Handwriting for elementary schools - Letters and figures.* In 1985, NNI was informed that the standard, issued in 1958, was outdated. NNI tried to form a committee for revision of NEN 2296. There was, however, not enough support in the market. Twelve years later, the standard is still in NNI's catalogue.
28. For this reason, NNI issues pre-standards that describe methods for measuring pollution. Once these methods have proven their quality in practice, they become normal standards. When experience shows they are inconvenient, these standards are changed. An example of pre-standards at the European level are ENVs, developed by the European standardization organization CEN (Comité Européen de Normalisation). Differences with 'normal' European standards (ENs) are that they are reviewed after three instead of five years and that National Standardization Organizations in EC and EFTA countries are not obliged to include them in their national standards collection. Conflicting national standards may be maintained till the ENV is converted into an EN. CEN's Technical Board can decide to extend an ENV's life time for two years each time.
29. ISO = International Organization for Standardization; IEC = International Electrotechnical Commission, the international standardization organization in the area of electrotechnology.
30. Source: personal letter, 1995. Mr. C. Galinski is involved in the International Information Centre for Terminology (Infoterm) in Vienna and is chairman of ISO Technical Committee 37 *Terminology (principles and coordination).*
31. In the European *New Approach*, for instance, standards are developed that are related to European directives. A company that meets the relevant standards is assumed to meet the general requirements set in the directives. Thus, implementing

the standards is an efficient way to meet the legal requirements. The company, however, is allowed to meet these requirements in another way. Though principally voluntary, in practice, these standards are almost obligatory.

32. Example: company A may use standard ISO 9001 on quality assurance as a benchmark in its quality management policy. Company B may be forced by its customers to meet the requirements set in this standard.
33. Governmental national standardization organizations and voluntary standardization are not contradictory, as is demonstrated by, for instance, the Japanese Industrial Standards Committee (JISC), the National Standards Authority of Ireland (NSAI), and the Standards Council of Canada (SCC).
34. The dimensions of this typology are: 1) activity rhythm (seasonal fluctuations in production); 2) product complexity; 3) characterization of the added value; 4) production techniques; 5) production speed; 6) market and customer characteristics.
35. In practice, this classification resembles Simons' classification mentioned in Section 2.3: compatibility standards are often business/marketing standards; interference standards are often regulatory standards; and general quality standards are often operational standards.
36. Standards and patents both describe a mostly technical solution. A standard, however, is intended to be used by all parties for which it is meant, whereas a patent is only used by the patent-holder and, via licenses, by third parties chosen by him, who usually have to pay for this use.
37. Annex A *Reference to patented items* in ISO/IEC Directives Part 2 (ISO/IEC, 1992, p. 17).
38. The issue of standards and patents often arises in the field of telecommunication. The European Telecommunication Standards Institute (ETSI) faced problems relating to them. More information on standards and intellectual property rights is provided by, among others, Farrell (1989), Stuurman (1997, Chapter 8), and Weiss & Spring (1992).
39. These are ambiguously indicated in many current standards. Often the application field is missing. The Standards Engineering Society (1995, p. 7) advises distinguishing between scope, purpose, and application. 'Application' can be related to the above-mentioned intrinsic and extrinsic functions of standardization; 'purpose' to the subjective functions.

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