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Industrial automation systems — Concepts and rules for enterprise models

Systèmes d'automatisation industrielle — Concepts et règles pour modèles d'entreprise

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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 14258 was prepared by Technical Committee ISO/TC 184, *Industrial automation*, Subcommittee SC 5, *Architecture and communications*.

Annex A of this International Standard is for information only.

Introduction

The major objective of this International Standard is to define concepts and rules for enterprise models (see clause 3) with the intent to guide and constrain other standards or implementations that do or will exist on the topic. It accomplishes this by defining the elements to use when producing an enterprise model (see 3.2), concepts for life-cycle phases (see 3.3), and how these models describe hierarchy (see 3.4), structure (see 3.5), and behavior (see 3.6). This International Standard provides guidelines and constraints for enterprise models to anyone attempting to model an enterprise or to model processes (see 3.7).

The users of this International Standard are primarily the standards bodies making more detailed standards about a part of the integration and modeling domain. Systems implementers may also find value in the structure developed in this International Standard so that their developments parallel the concepts outlined herein. If conforming implementation designs have the same technology areas and nomenclature, or are able to map to them readily, the information of one enterprise or process can be more readily shared with information of another enterprise or process (see 3.8).

The rationale for this International Standard is that other well-designed standards in the domain of enterprise integration and modeling are needed to provide a known environment to enterprise designers. Thus, the risk of investing in islands of integration can be significantly reduced. Where an island does exist, then these standards assist the designer to create the translation required for the island to interact with the known environment. A standard for enterprise models should enhance interoperability by establishing the elements that must be present in an enterprise model. These elements will come into play when there is need for one process to communicate with another.

Industrial automation systems — Concepts and rules for enterprise models

1 Scope

This International Standard specifies concepts and rules for computer-understandable models of a manufacturing enterprise to better enable enterprise processes to interoperate.

This International Standard does not define standard enterprise processes, standard enterprises, standard organizational structures, or standard enterprise data. In addition, this International Standard does not specify the enterprise-modeling process, but forms the basis by which enterprise-modeling standards can be developed where they are needed.

2 Definitions

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

2.1 Definitions of enterprise concepts

2.1.1
enterprise
a group of organizations sharing a set of goals and objectives to offer products, services or both

2.1.2
environment
the uncontrollable part of a system which is widened to the extent that a decision-taking procedure cannot be conceived for the control of such a system

2.1.3
factors of production
that which is required to transform, transport, store, and verify raw materials, parts, (sub-) assemblies, and end products

2.1.4
user of standard
one who applies the requirements of this International Standard for whatever purpose

EXAMPLE 1 Enterprise planners, builders, modifiers, and analyzers using the requirements to check completeness of their activity.

EXAMPLE 2 Enterprise-model builders using the requirements to assure consistency between models to enable model interoperability.

EXAMPLE 3 Developers of standards for enterprise representation using the requirements to assure consistency between their standards and this International Standard.

2.2 Definitions of model concepts

2.2.1
abstraction
a shortening in duration or extent with no sacrifice of sense, used to differentiate between a real-world system and a model of the real world

2.2.2
behavior
how an element acts and reacts

2.2.3
constraint
restrictions and limitations on the system which can come from inside or outside the system under consideration

2.2.4
element
a basic system part that has the characteristics of state, behavior, and identification

2.2.5
enterprise model
a representation of what an enterprise intends to accomplish, how it operates and possibly how it is organized, which is used to improve the effectiveness and efficiency of the enterprise

NOTE – An enterprise model is an abstraction that represents the basic elements of an enterprise and their decomposition to any necessary degree. It also specifies the information requirements of these elements, and provides the information needed to define the requirements for integrated information systems.

2.2.6
model
a representation of something else expressed in mathematics, symbols, or words

NOTE – A model is an abstraction that represents one's understanding of a system or situation, and of the relevant elements and relationships. It represents the system elements and the connectivity between the elements.

3 Concepts and rules

3.1 Purpose of enterprise models (informative)

Enterprise models are used as tools to describe and represent an enterprise in the context of a given purpose. Enterprises are systems that can be analyzed and modeled using systems theory. These models can be constructed to analyze, guide the engineering of, and manage the operation of enterprises.

The rules presented in clause 3 are designed to support these usages and to allow information transfer between enterprise models.

3.2 Systems theory as a basis for enterprise models

Enterprise models conforming to this International Standard shall be constructed to conform to the relevant elements of systems theory. The normative concepts and rules presented in clause 3 describe these relevant elements of systems theory and relate them to model content and characteristics.

3.2.1 Methodologies derived from systems theory (informative)

In literature[1)] there are various methodologies derived from general systems theory which emphasize different aspects. The three most frequently used aspects are the structural aspect, behavioral aspect, and hierarchical aspect.

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1) *An Approach to General Systems Theory*, George J. Klir (1969); *An Introduction to General Systems Thinking*, Gerald M. Weinberg (1975).

The structural aspect is based on the principle that elements are not isolated but have multiple interdependencies with other elements of the system. The interdependencies are the explanation why the whole (system) exhibits properties different from the properties of its parts (elements).

The behavioral aspect is based on the identification of variables and their functional or other relationships. If the variables are restricted to input and output variables the system is considered as a black box.

The hierarchical aspect is based on the principle that an element of a system can itself be regarded as a system, which is then called a subsystem. Similarly the system under consideration can be regarded as an element of another system, which is then called a supersystem. This implies the assignment of levels of abstraction to systems. Because of interdependence new properties can emerge at a higher level in the hierarchy.

Steps to lower levels allow one to obtain more detailed description of the system under consideration and how it achieves its purpose. Steps to higher levels allow one to understand the role of the system within its environment.

Each level is describable in terms of structure and behavior. Depending on the desired purpose particular methodologies are applicable. Steps downward expose the inner structure of the subsystem. This could be achieved by observation, by logical conclusion, or by design in the case of systems under development. Steps upward expose the behavior of the system in its environment. Similarly this could be achieved by observation, by logical conclusion, or by making assumptions in the case of systems under development.

3.2.2 Factors of production

Enterprise models shall address what happens to the factors of production (such as people, capital, material, information, energy, and tools) during the phases of the enterprise or product life cycle.

3.2.3 Scope of enterprise models

Enterprise models shall define relevant aspects of the enterprise necessary to

— conceive, design, procure for, and construct an enterprise consisting of any set of related chosen processes,

— manage and operate an enterprise so that it can meet its objectives,

— support an enterprise to design, modify, operate, or dismantle it.

3.2.4 Availability and format of model information

In an operating scenario the information captured by an enterprise model shall be available to humans or machines responsible for successful operations. The information shall be either in a neutral format (preferable) or as specified by the using application.

3.2.5 Semantics and syntax of an enterprise model

Models, as representations of enterprises, shall carry syntax and semantics. The syntax of a model refers to the permissible arrangements of the representations of the elements and to the permissible kinds of relations. The semantics of a model encompass the meanings of the elements and relations with respect to enterprise-model concepts. The syntactic form and semantic content of a model will be different depending, for example, on the purpose of the model and on the boundary and the environment of the enterprise.

3.2.6 Management of constituent parts

Enterprise models shall be designed in such a way as to allow their constituent parts to be managed by an automated configuration-management system.

3.3 Concepts for life-cycle phases (informative)

Products, processes, projects, and enterprises are systems. Systems have a life cycle that can be partitioned into phases such as plan/build, use/operate, and recycle/ dispose.

3.3.1 Issue-solving activities

Three activities are required to solve issues found within each high-level system life-cycle phase (plan/build, use/operate, recycle/dispose). These activities are

— find out what to do (activity W),

— find out how to do it (activity H),

— do it (activity D).

Figure 1 illustrates a mapping between common names for system life-cycle phases and the what, how, and do activities.

The activities W, H, and D may be represented by different types of models. These models shall have the capability to interoperate where it has been determined that these activities need to communicate with each other.

	"What" activities	**"How" activities**	**"Do" activities**
Plan and build phase (e.g. before sell/buy title transfer)	• Develop goals • Define strategy • Define product needs	• Develop requirements • Define concept • Design product • Plan to produce product • Plan to support product	• Procure parts • Produce product • Test product • Ship product
Use and operate phase (e.g. after sell/buy title transfer)	• Define support needs • Define use	• Define use requirements • Define support requirements	• Use the product • Support product
Dispose and recycle phase (e.g. after product is no longer useful)	• Define recycle/ dispose needs	• Define recycle/ dispose requirements	• Recycle product • Dispose product

Figure 1 — Mapping between system life-cycle phases and system activities W, H, and D

3.3.2 Life cycle of systems

Different life-cycle phases may have different models. These models shall have the capability to interoperate where it has been determined that processes need to communicate with each other.

Feeding model information forward and backward in life-cycle activities enables value-added iteration of enterprise processes that improves product quality.

3.3.3 Recursion

Activities W, H, and D are recursive and, thus, decomposable. Therefore, each activity can be divided into subactivities, and these subactivities will consist of another set of W, H, and D activities (see Figure 2).

These subactivities may be represented by different types of models. These models shall be able to interoperate where it has been determined that these subactivities need to communicate with each other.

EXAMPLE — In a manufacturing enterprise, the activity "Produce" can be, in turn, separated into lower-level activities W, H, and D. Activity W is user-needs driven and comprises any activities finally resulting in a request for what is to be produced.

Activity H is technology-requirements driven and comprises any activities finally resulting in how the product/system has to be produced in terms of a release statement. Activity D is task driven and comprises any activities finally resulting in the shipment of the product.

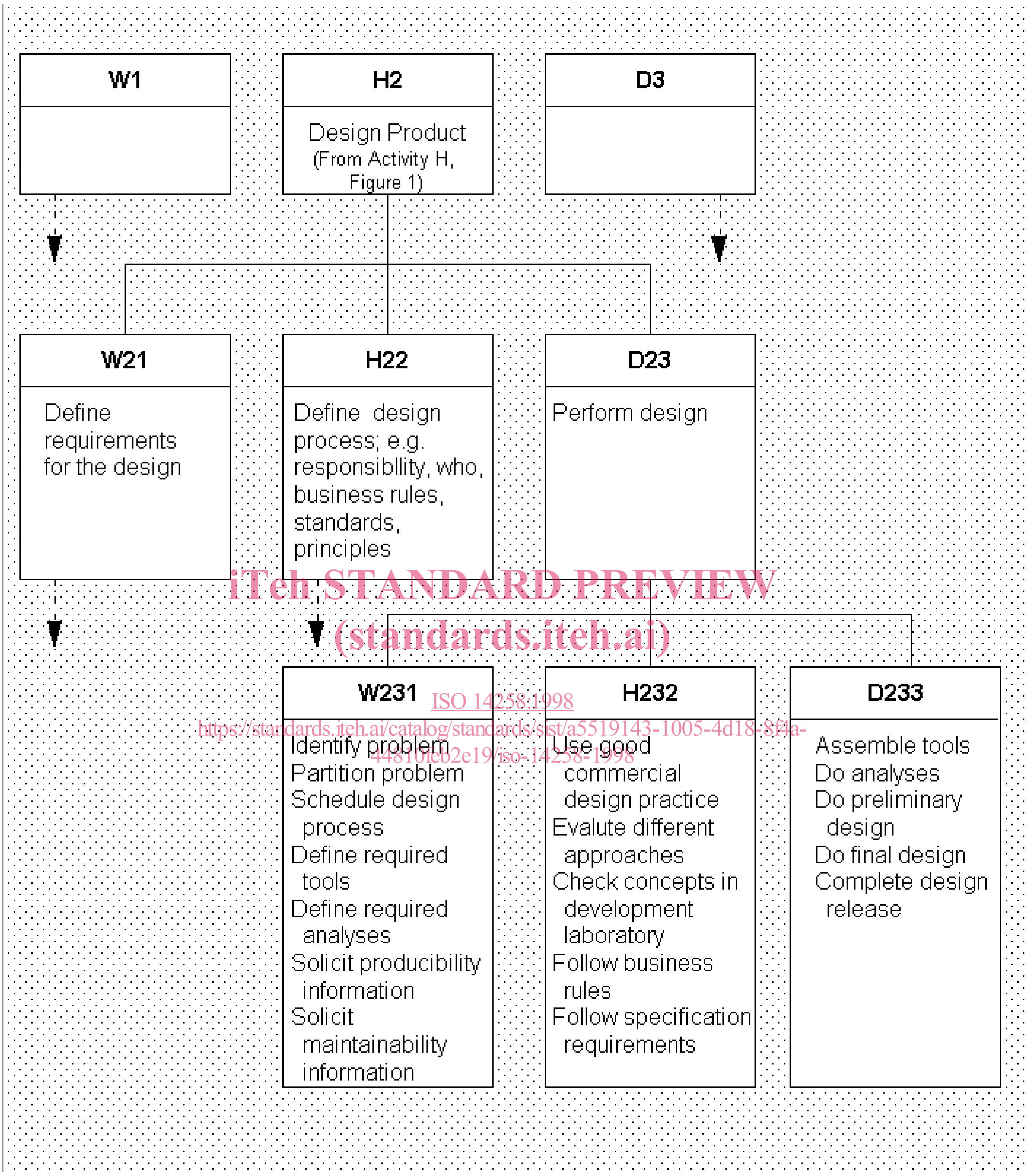

Figure 2 — Decompose "Design Product" activity to show recursiveness of activities W, H, and D

3.3.4 Iteration

Activities W, H and D are iterative; therefore, there is no fixed sequence of these activities, but it is possible to return to previous activities to repeat them with updated input (see Figure 3).

Each performance of each activity may result in a different model. Every one of these different models shall be subject to both change and version management.