INTERNATIONAL STANDARD

ISO 19439

First edition
2006-04-15

Enterprise integration — Framework for enterprise modelling

Entreprise intégrée — Cadre de modélisation d'entreprise

Reference number
ISO 19439:2006(E)

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Published in Switzerland

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Foreword

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The main task of technical committees is to prepare International Standards. 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.

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ISO 19439 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 310, *Advanced manufacturing technologies*, in collaboration with Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 5, *Architecture, communications and integration frameworks*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Introduction

This framework defines and specifies the generic concepts that are required to enable the creation of enterprise models for industrial businesses and to provide support for the use of frameworks by industrial enterprises.

Enterprise modelling consultancies and tool vendors have developed enterprise modelling methodologies and supporting tools that address phases of the enterprise life cycle and various aspects of enterprise modelling. These methodologies and tools support business decision-making (such as process visualization and simulation), enterprise process management, control and monitoring of operational processes (such as workflow) and performance monitoring (such as visualization of work in progress). This framework provides a unified conceptual basis for model-based enterprise engineering that enables consistency, convergence and interoperability of the various modelling methodologies and supporting tools. The framework does not encompass methodological processes; it is neutral in this regard.

ISO 15704:2000, 4.2.2 (see also A.3.1.2) places requirements on the description of the essential roles of humans. In this International Standard, these are described in terms of:

— organizational roles that are specified in the Organization View, which captures the various assigned responsibilities and required capabilities (skills);

— operational roles that are specified in the Resource View, which captures the operational capabilities (skills) and which are then matched to the ones identified in the Function View.

The Annex A contains a general description of the concepts of enterprise models, modelling frameworks and modelling language constructs (as defined in ENV 12204:1996) as background to the normative content of Clauses 5 and 6. Annex B describes with illustrative examples how the enterprise modelling framework can be used by both enterprise model developers and enterprise model tool developers.

Enterprise integration — Framework for enterprise modelling

1 Scope

This International Standard specifies a framework conforming to requirements of ISO 15704, which serves as a common basis to identify and coordinate standards development for modelling of enterprises, emphasising, but not restricted to, computer integrated manufacturing. This International Standard also serves as the basis for further standards for the development of models that will be computer-enactable and enable business process model-based decision support leading to model-based operation, monitoring and control.

In this International Standard, four enterprise model views are defined in this framework. Additional views for particular user concerns can be generated but these additional views are not part of this International Standard. Possible additional views are identified in ISO 15704.

2 Normative references

The following referenced documents are indispensable for the application 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 15704:2000, *Industrial automation systems — Requirements for enterprise-reference architectures and methodologies*

3 Terms and definitions

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

NOTE Definitions copied verbatim from other standards are followed by a reference in brackets to the source standard. Definitions that have been adapted from other standards are followed by an explanatory note.

3.1
abstraction
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

[ISO 14258:1998]

3.2
attribute
piece of information stating a property of an entity

[ISO 15704:2000]

3.3
behaviour
manner in which the whole or part of a system acts and reacts to perform a function

NOTE Adapted from ISO 15704:2000.

3.4
business process
partially ordered set of enterprise activities that can be executed to achieve some desired end-result in pursuit of a given objective of an enterprise or a part of an enterprise

NOTE Adapted from ISO 15704:2000, ENV 12204:1996.

3.5
capability
quality of being able to perform a given activity

[ISO 15531-1]

3.6
component
⟨system⟩ entity, with discrete structure within a system, which interacts with other components of the system, thereby contributing at its lowest level to the system properties and characteristics

[ISO/IEC 15288:2002]

3.7
concept definition
enterprise model phase that defines the business concepts of an enterprise domain to be employed in realizing its business objectives and its operation, including the necessary enterprise domain inputs and outputs

3.8
constraint
restriction or limitation or condition placed upon a system that originates from inside or outside the system under consideration

NOTE Adapted from ISO 14258:1998.

3.9
decision
result of choosing between different courses of action

3.10
decisional
relating to those processes that are concerned with making choices

3.11
decommission definition
enterprise model phase that defines the final state of a decommissioned operational system, all its components for a particular enterprise domain and the processes employed to conduct the decommissioning, so enabling re-use or disposition of those components

3.12
decomposition
breaking an entity into its constituent parts as appropriate to the purpose of the modeller

3.13
design specification
enterprise model phase that specifies the business processes, together with capabilities and rules, that are to be performed to achieve the requirements

3.14
detailing
addition of content, attributes and operations, that more precisely identify the intent of modelling language constructs and partial models

3.15
domain identification
enterprise model phase that identifies the enterprise domain to be modelled with respect to its business objectives, the enterprise domain inputs and outputs and their respective origins and destinations

3.16
domain operation
enterprise model phase that encompasses the operational use of the domain model

3.17
enactment
computer processing of models to facilitate the development of more responsive and coherent enterprises, in particular the use of a model to monitor and control the execution of the business processes of the enterprise

NOTE Adapted from Vernadat [23].

3.18
enterprise
one or more organizations sharing a definite mission, goals and objectives to offer an output such as a product or service

[ISO 15704:2000]

NOTE In this International Standard, a goal is the target resulting from the intention of the enterprise to achieve its mission and objective.

3.19
enterprise activity
all, or part, of process functionality that consists of elementary tasks performed in the enterprise that consume inputs and allocate time and resources to produce outputs

NOTE Adapted from ISO 15704:2000.

3.20
enterprise domain
domain
part of the enterprise considered relevant to a given set of business objectives and constraints for which an enterprise model is to be created

NOTE In this International Standard, *enterprise domain* is abbreviated to *domain* whenever it is used as a qualifier in such terms as *domain identification phase* and *domain model*. Other usages of *domain* have the normal dictionary meaning.

3.21
enterprise engineering
discipline applied in carrying out any efforts to establish, modify or reorganize any enterprise

[ISO 15704:2000]

3.22
enterprise integration
process of ensuring the interaction between enterprise entities necessary to achieve enterprise domain objectives

3.23
enterprise model
abstraction of an enterprise domain that represents enterprise entities, their interrelationships, their decomposition and detailing to the extent necessary to convey what it intends to accomplish and how it operates

3.24
enterprise model phase
life cycle phase of an enterprise model

3.25
enterprise model view
selective perception or representation of an enterprise model that emphasizes some particular aspect and disregards others

NOTE Adapted from ENV 40003:1990.

3.26
enterprise modelling
act of developing an enterprise model

3.27
enterprise object
piece of information in the enterprise domain that describes a generalized or a real or an abstract entity, which can be conceptualized as being a whole

3.28
enterprise operation
execution of business processes to achieve enterprise objectives

3.29
entity
any concrete or abstract thing in the domain under consideration

3.30
environment
surroundings external to the enterprise domain which influence its development and behaviour, and which are not controllable by the enterprise itself

3.31
framework
structure expressed in diagrams, text and formal rules which relates the components of a conceptual entity to each other

NOTE Adapted from ISO 15704:2000.

3.32
function view
enterprise model view that enables the representation and modification of the processes of the enterprise, their functionalities, behaviours, inputs and outputs

3.33
functionality
qualities of a process that enable it to achieve the purpose for which the process exists

3.34
generalization
specific concept modified for a more general extent, use or purpose or:
act of removing or modifying detail from a specific concept to produce a generalization thereof

NOTE Generalization is the inverse of specialization.

3.35
generic
property of being a generalization from a number of distinguishable entities based on their shared characteristics

3.36
generic level
collection of generic modelling language constructs for expressing descriptions that can be used to generate models at the partial and particular levels

3.37
genericity
extent to which a concept is generic

3.38
implementation description
enterprise model phase that describes the final set of processes, resources and rules implemented to achieve the desired operational performance for execution of the business processes and enterprise activities specified in the design specification phase

3.39
information technology component
component that is required to collect, process, distribute, store and verify data for enterprise activities in the enterprise

3.40
information view
enterprise model view that enables the representation and modification of the enterprise information as identified in the function view

NOTE It is organized as a structure containing enterprise objects that represent the information-related entities of the enterprise (material and information).

3.41
instantiation
creation of instances of modelling language constructs or partial models and the possible assignment of values to some or all attributes

NOTE A fully instantiated modelling language construct or model is one for which values have been assigned to all attributes.

3.42
life cycle
set of distinguishable phases and steps within phases which an entity goes through from its creation until it ceases to exist

3.43
life cycle phase
stage of development in the life cycle of an entity

3.44
manufacturing technology component
component that is required to control, transform, transport, store and verify raw materials, parts, (sub-)assemblies and end-products

3.45
methodology
set of instructions (e.g. provided through text, computer programs, tools) that is a step-by-step aid to the user

NOTE This formal definition is from ISO 15704:2000. More generally a methodology can be regarded as a systematic procedure for achieving some desired end-result.

3.46
mission
characterization of the business in which an enterprise describes the customer product or service function that it intends to fulfil

3.47
model
abstract description of reality in any form (including mathematical, physical, symbolic, graphical or descriptive) that presents a certain aspect of that reality

NOTE Adapted from ISO 15704:2000.

3.48
model development process
process of deriving and instantiating models at the different enterprise model phases

NOTE This is done by:

a) deriving and instantiating models for implemented components from the domain identification, concept definition, requirements definition, design specification and implementation description phases of enterprise modelling;

b) releasing the implementation description model as a domain operation model;

c) developing decommission definition models from domain operation models.

3.49
modelling language construct
textual or graphical part of a modelling language devised to represent, in an orderly way, the diverse information on common properties and elements of a collection of phenomena

NOTE Adapted from ENV 12204:1996. A modelling language construct is a basic architectural entity at the generic level that is designed to be re-used in a wide range of applications. As a part of a modelling language, it models common features of structure and/or behaviour in a modelled domain.

3.50
objective
statement of preference about possible and achievable future situations that influences the choices within some behaviour

NOTE Adapted from ISO/IEC 15414:2002.

3.51
operational
pertaining to the execution of the set of processes used to achieve enterprise objectives

3.52
organization view
enterprise model view that enables the representation and modification of the organizational and decisional structure of the enterprise and the responsibilities and authorities of the individuals and organizational units within the enterprise

3.53
partial level
collection of partial models

3.54
partial model
model used as a reference model in a specific type of industry segment or industrial activity

NOTE A partial model is comprised of modelling language constructs and/or other partial models. Partial models also enable a modeller to re-use already existing models built for other enterprise domains.

3.55
particular level
level at which a model is described for a particular, specific enterprise domain

3.56
particular model
model of a particular, specific enterprise domain

3.57
particularization
process of specialization and instantiation by which more specific model components can be derived from more generic ones

3.58
process
partially ordered set of activities that can be executed to achieve some desired end-result in pursuit of a given objective

3.59
requirements definition
enterprise model phase that defines the operations needed to achieve enterprise objectives and the conditions necessary to enable those operations, both being without reference to implementation options or implementation decisions

3.60
resource
enterprise entity that provides some or all of the capabilities required to execute an enterprise activity

[ISO 15704:2000]

NOTE In this International Standard, resource is used in the system theory sense of entities that provide capabilities required by the system and are an essential part of the system itself. The resource description includes the identification and description of consumables (such as energy, air, coolant) that are required to be present in sufficient quantities to operate the resource. In contrast, material is reserved for process inputs that are required by the various processes such as raw materials, parts and assemblies. These inputs are identified in the function view, described in the information view, and have the associated management responsibilities identified in the organization view.

3.61
resource view
enterprise model view that enables the representation and modification of enterprise resources

3.62
specialization
general concept modified for a more limited extent, specific use or purpose, or the act of adding or modifying details to a general concept to produce a specialization thereof

NOTE Specialization is the inverse of generalization.

3.63
stakeholder
interested party having a right, share or claim in the system or in the system's possession of qualities that meets their needs

NOTE Adapted from ISO/IEC 15288:2002.

3.64
system
collection of real-world items organized for a given purpose

[ISO 15704:2000]

4 Symbols and abbreviations

GERAM Generalized Enterprise-Reference Architecture and Methodologies

IFAC International Federation of Automatic Control

IFIP International Federation for Information Processing

5 The framework

5.1 Underlying concepts

5.1.1 Dimensionality

The framework described in this International Standard is structured in terms of three dimensions for the reasons given in Clause A.2. The dimensions shall be:

— enterprise model phase;

— enterprise model view;

— genericity.

5.1.2, 5.1.3 and 5.1.4 introduce these dimensions, each of which is specified further in 5.2, 5.3 and 5.4.

5.1.2 Enterprise model phase — The concept of the model life cycle

Enterprise models have a life cycle that is related to the life cycle of the entity being modelled. The life cycle of an enterprise model is the result of the model development process by which models are created, made operational and finally discarded. The corresponding framework dimension shall be denoted by the term ‘enterprise model phase’ and is specified further in 5.2.

This dimension shall be divided into seven enterprise model phases defined in 5.2.2 to 5.2.8, which are distinguished by different intentional descriptions of the origin, existence and demise of an enterprise entity. Decomposition (3.12) and detailing (3.14) characterize the progression between model phases. The phases are:

— domain identification;

— concept definition;

— requirements definition;

— design specification;

— implementation description;

— domain operation;

— decommission definition.

5.1.3 Enterprise model views — Filtering model content

The enterprise model view dimension enables the enterprise modeller and enterprise model user to filter their observations of the real world and their various usages of the model within its lifecycle by emphasizing those aspects that are relevant to their particular interests and context.

In working with an enterprise model, an enterprise modeller shall use enterprise model views, as described in 5.3.1, to emphasize a particular aspect, and disregard others.

The user shall use the predefined views or generate additional views for particular purposes by selecting an appropriate subset of modelling language constructs.

The view dimension shall be denoted by the term “enterprise model view” and is further specified in 5.3.

The predefined views are defined in 5.3.2 to 5.3.5. They are:

- function view;
- information view;
- resource view;
- organization view.

5.1.4 Genericity — The concept of generalization and specialization

Generalization (3.34) is the progression from one or more particular concepts to a more general concept that represents their shared characteristics or essential qualities. Specialization (3.62) is the reverse process, which proceeds from a more general concept to something with a special purpose.

EXAMPLE Specialization, by adding attributes (3.2) such as the specification of density and temperature to a feedstock.

The dimension along which this generalization-specialization progression occurs shall be denoted by the term "genericity" and is specified further in 5.4.

The genericity dimension shall be divided into three levels defined in 5.4.2 to 5.4.4. They are:

- generic level;
- partial level;
- particular level.

5.1.5 Enterprise model consistency and completeness

The quality of enterprise models is determined by their semantic and syntactic consistency in terms of coexistence of compatible facts, and by their completeness in terms of describing all relevant aspects of the enterprise domain being modelled.

The modelling framework should provide a unification (common semantics) of the modelling contents and should assure model consistency in terms of valid in-context references to enterprise objects.

Extensions of the enterprise knowledge base (adding and deleting enterprise objects) should be done by modelling experts in order to ensure its continued consistency.

To cope with the complexity of enterprise model content, the unification shall be limited to the local content of an enterprise model with limited size. Modelling of larger areas in an organization, or even across organization boundaries, can be accomplished by providing links to the origins and destinations of enterprise domain inputs and outputs in the domain environment, and by providing common semantics only for those enterprise objects that can be exchanged between different enterprise domains, and only for the enterprise domains involved in the exchange.

Enterprise model completeness varies in terms of model content for the different enterprise model phases identified in 5.1.2. However, the syntactic completeness of the model shall be checked at each of the different modelling phases. The use of computer enactment, animation or simulation should ensure the availability of all inputs and the creation of all outputs identified in the enterprise model and the absence of any undefined or undetermined processes having endless loops and dead ends.

5.2 Dimension of enterprise model phase

5.2.1 Enterprise model phase

Enterprise model phases are manifestations of the life cycle phases of enterprise model development, which encompass all model development activities from identification to decommissioning (or end of useful life) of the domain model. The four enterprise model views (as described in 5.3) and three levels of genericity (as described in 5.4) shall be considered at each of the seven enterprise model phases.

The phases of enterprise model development identified in this framework correspond to life cycle phases of ISO 15704:2000, A.3.1.3.2.

NOTE 1 Because of the dependency constraints (3.8) between phases, corresponding to different extents of model decomposition and detailing, it is common usage to refer to different enterprise model phases as preceding phases or subsequent phases. However, this usage is not to be interpreted as implying a particular ordering in the execution of the phases.

The seven enterprise model phases are shown in Figure 1 and each phase is defined separately in 5.2.2 to 5.2.8.

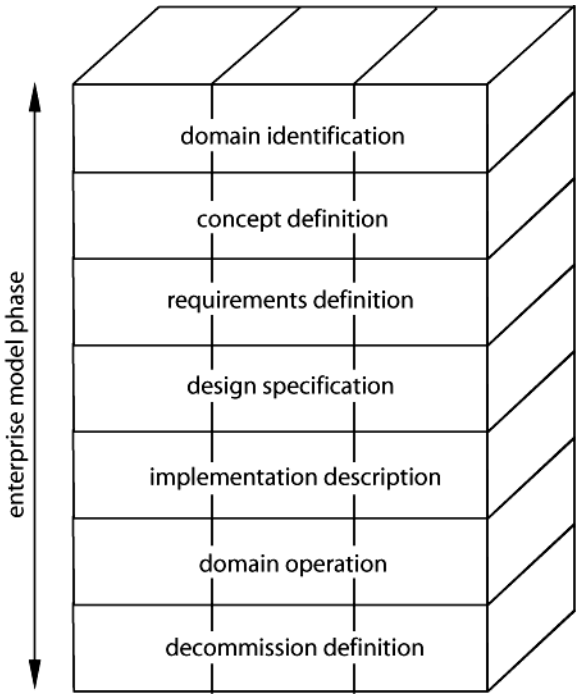

Figure 1 — Dimension of enterprise model phase

For each of the first five enterprise modelling phases, models elaborated at preceding phases shall be transformed into a new model, having an appropriate extent of decomposition and detail for that phase, to produce a more precise description of the particular enterprise under consideration. This transformation shall be performed by adding new modelling language constructs that are appropriate for the modelling purpose at that level, or adding new attributes to modelling language constructs already used in preceding modelling

phases. The sixth enterprise model phase represents the use of the enterprise model, and the last enterprise model phase expresses the activities necessary for the decommission of the system at its end-of-life.

At the generic level, a reference catalogue of generic modelling language constructs for expressing descriptions of the entity to be modelled shall be defined for each of the enterprise model phases (with the exception of domain operation). These modelling language constructs shall then be used to create models at each of the partial and particular levels.

At the partial level, sets of partial models shall be described for each of the enterprise model phases (with the exception of domain operation), which express typical functionalities, information, resources and organization belonging to particular industry segments. These models can generate models at the particular level by further instantiation and specialization.

NOTE 2 The definition of partial models may depend on enough requirements having been defined or sufficient experience gained with implemented model components to identify appropriate concepts.

At the particular level, the corresponding particular mode of a particular enterprise domain shall be described for each of the enterprise model phases.

The content for each modelling phase after the domain identification phase depends upon the content of the preceding phases. The activities in each phase shall be those necessary to generate the model of that phase and confirm the model as suitable for controlled release to subsequent phases.

While there is no presumption in this International Standard that the model development process is necessarily sequential, the phases of modelling are ordered in the sense that there is a progression towards greater detailing and concreteness in moving from domain identification to domain operation. The model development process involves a progression from both the abstract to the concrete, and from the general to the specific. However the flow of information between phases is not necessarily one-way, i.e. from domain identification, concept definition, etc., to implementation description and domain operation. In practice it can be necessary, in considering individual enterprise operations (3.28), to reconsider a preceding enterprise model phase [e.g. implementation constraints (3.8) can cause a rework of requirements specification or a statutory requirement can even require the identification and definition of new concepts].

The following two kinds of model development activity exist within enterprise model phases.

a) **Model structure decomposition**. The extent of model structure decomposition is determined by the need for activities to be controlled or decisions to be made by the relevant stakeholders at some stage during the anticipated use of the model, such as when the activities start, and the scope of the activities. Decomposition is therefore concerned with matching the granularity of description to the appropriate decisional or control responsibilities and time horizons.

b) **Model contents detailing**. The extent of model contents detailing corresponds to a progression through the phases of model development, such as from requirements to design. Content detailing is concerned with the addition of new attributes to modelling language constructs and/or partial models, and the addition of more detailed functionality.

Each of the resulting models may be revised in the model development process to comply with design constraints and implementation issues arising from subsequent enterprise model phases. Such revisions can be accomplished through any number of necessary iterations.

NOTE 3 In 5.2.2 to 5.2.8, the enterprise model phase is used as a qualifier to denote the form of the enterprise model that is the output of that phase, such as domain identification model, concept definition model. However, they are all manifestations of the same underlying enterprise model as described in 5.1.5.

5.2.2 Domain identification

The domain identification phase shall identify the enterprise domain to be modelled in terms of its business objectives, its inputs and outputs, their respective origins and destinations and the domain's basic functionalities and capabilities (3.5).

NOTE In general, the model produced in the domain identification phase is described by end-users.

Modelling language constructs at the domain identification phase shall support the expression of business objectives of an enterprise in terms of enterprise domains and domain relationships, domain inputs and outputs, and their respective origins and destinations. Modelling language constructs at this phase shall be independent of any implementation details.

At the generic level, the reference catalogue shall provide generic modelling language constructs to describe domain objectives and the enterprise domain's relationships to its environment.

At the partial level, the sets of partial models shall describe typical enterprise domains belonging to particular industry segments in terms of their domains' objectives and relationships.

At the particular level, a domain identification model shall be described, being composed of fully instantiated modelling language constructs defining the business objectives of a particular enterprise domain and its relations to the environment.

5.2.3 Concept definition

The concept definition phase shall define the business concepts that facilitate the realization of the business objectives and the domain operations, including the domain mission, vision, values, strategies, operational concepts, policies, business plans, etc. necessary to achieve the basic functionalities and capabilities of the enterprise domain. The concept definition model is derived from the domain identification model.

NOTE In general, the model produced in the concept definition phase is described by end-users.

Modelling language constructs at the concept definition phase shall support the expression of the business concepts of an enterprise domain in terms relating to the identified domain and domain relationships. Modelling language constructs at this phase shall be independent of any implementation details.

At the generic level, the reference catalogue shall provide generic modelling language constructs for expressing general concepts of the enterprise domain.

At the partial level, the sets of partial models shall describe typical business concepts of enterprise domains belonging to particular industry segments.

At the particular level, a concept definition model shall be described, being composed of fully instantiated modelling language constructs defining the business concepts of a particular enterprise domain.

5.2.4 Requirements definition

The requirements definition phase shall define the business functionality of an enterprise domain in terms of business processes, enterprise activities and their inputs and outputs. This encompasses the collection of all the functional, behavioural, informational and capability needs including service, manufacturing, management and control.

The model produced in the requirements definition phase is derived from the concept definition model and shall identify the business needs of the enterprise domain.

To ensure necessary and sufficient description, end-users, with the assistance of enterprise engineers, should develop the requirements definition.

Modelling language constructs at this phase shall be independent of any implementation details.

At the generic level, the reference catalogue shall provide generic modelling language constructs for expressing enterprise domain requirements in terms of business processes, their enterprise activities, inputs and outputs.

At the partial level, the sets of partial models shall describe typical business requirements and enterprise activities in enterprise domains belonging to particular industry segments.

At the particular level, a requirements definition model shall be described, being composed of fully instantiated modelling language constructs defining the business requirements of a particular enterprise domain.

5.2.5 Design specification

The design specification phase shall specify the detailed manner in which the domain operations are performed. This design specification model shall be derived from the requirements definition model and shall capture the specification of domain processes with all of their components to satisfy the domain requirements.

The model produced in the design specification phase should be developed by enterprise engineers with the help of the user.

The design of human and machine tasks concerned with services and products as well as related management and control functions shall be included in the specification. The design of the operational processes includes identification of the necessary information and resources (including manufacturing, information, communication, control or any other technology).

During model development, production capacity, information technology components, manufacturing technology components and the roles of humans shall be specified, and the constraints of the environment shall be determined.

NOTE Verification of the design can be achieved by animation and simulation of the design specification model.

The design specification phase shall also serve to isolate the requirements definition phase from the implementation description phase.

The design specification phase may be further subdivided into preliminary and detailed design, reflecting different extents of design detail.

At the generic level, the reference catalogue shall provide generic modelling language constructs for specifying business processes, their enterprise activities, inputs and outputs.

At the partial level, the sets of partial models shall describe designs for typical business processes and enterprise activities in enterprise domains belonging to particular industry segments.

At the particular level, a design specification model shall be described, being composed of fully instantiated modelling language constructs specifying the business processes of a particular enterprise domain.

5.2.6 Implementation description

The implementation description phase shall describe the information needed for all of the tasks that are to be carried out by the domain operational system. The implementation description model shall be derived from the design specification model.

Selecting the means for the domain operation from available components can lead to deviations from the design specification by either exceeding or missing required capabilities of the information technology components and manufacturing technology components, such as role of humans, machines and programs. Therefore the implementation description shall start from the design specification model and shall modify the design specification contents in all cases where the implementation of real system components deviates from the specification.

The model produced in the implementation description phase should be developed in cooperation between systems implementers, users and enterprise engineers.

After satisfactory verification to ensure availability of the necessary inputs and outputs, the implementation description model at the particular level can be released for operation and made available for the daily

execution and control of the enterprise. This shall include verification of physical and personnel safety and satisfactory economic capabilities of the enterprise.

At the generic level, the reference catalogue of generic modelling language constructs shall provide modelling language constructs for implementing business processes, their enterprise activities, inputs and outputs.

At the partial level, the sets of partial models shall describe implementations of typical business processes and enterprise activities in enterprise domains belonging to particular industry segments.

At the particular level, an implementation description model shall be described, being composed of a fully implemented set of business processes of a particular enterprise domain that is released for operation.

5.2.7 Domain operation

The domain operation phase constitutes the operational usage of the model that represents the operation of the enterprise domain. This model is the released implementation description model. The model used in the domain operation phase shall be capable of facilitating monitoring and controlling of the domain operation as well as supporting all decision-making activities. Domain resources shall be managed and controlled to carry out the processes necessary for mission fulfilment.

Domain operation models shall reside only at the particular level of the domain operation phase (generic and partial levels of the modelling framework are not defined for this phase) and shall be represented by modelling language constructs used at the implementation description phase.

5.2.8 Decommission definition

The decommission definition phase shall define the final state of the operational system for a particular enterprise domain at the end of its useful life. The decommission definition model is derived from the domain operation model.

The model produced in the decommission definition phase shall identify the different tasks and resource requirements envisioned in the decommissioning of the domain operational system. These tasks include retraining, redesign, recycling, preservation, transfer, disbanding, disassembly, or disposal for all or part of the operational system at the end of its useful life.

At the generic level, the reference catalogue shall provide generic modelling language constructs for specifying decommissioning business processes, their enterprise activities, inputs and outputs.

At the partial level, the sets of partial models shall describe typical business decommissioning processes and resources for enterprise domains belonging to particular industry segments.

At the particular level, the decommission definition model shall be described, being composed of a fully implemented set of business processes for the decommissioning of the particular enterprise domain.

5.3 Dimension of enterprise model view

5.3.1 Enterprise model view

The concept of enterprise model view provides a means for the various aspects of the enterprise that are described within a unified model to be presented to the user or model developer in different subsets (enterprise model views). Each enterprise model view shall contain a subset of facts present in the unified model, enabling the user to concentrate on relevant questions that the respective stakeholders might wish to consider whilst using enterprise modelling. The set enumerating the different kinds of enterprise model view forms the dimension of enterprise model view.

Different enterprise model views may be made available, highlighting certain aspects of the model and hiding all others.

The enterprise model view concept shall be applicable throughout the entire enterprise model development life cycle. Any manipulation of an enterprise model view (any change of the contents of a particular view) shall be reflected in the unified model and thereby in all relevant enterprise model views.

NOTE 1 Enterprise model views have no natural ordering.

This framework specifies four enterprise model views (see Figure 2) that allow model content to be grouped and expressed in different ways. Each view focuses on one important enterprise aspect within the selected enterprise domain. The four enterprise model views are:

— function view (see 5.3.2) to represent the functions of the enterprise;

— information view (see 5.3.3) to represent the enterprise information used and obtained during the operation;

— resource view (see 5.3.4) to represent the enterprise assets needed for carrying out the enterprise operations;

— organization view (see 5.3.5) to represent the organization, organizational relationships and the decision-making responsibilities in the enterprise operation.

NOTE 2 In addition to these four views, any other model views such as economic, decision or others, could be developed from the underlying model and its content as expressed in these four views.

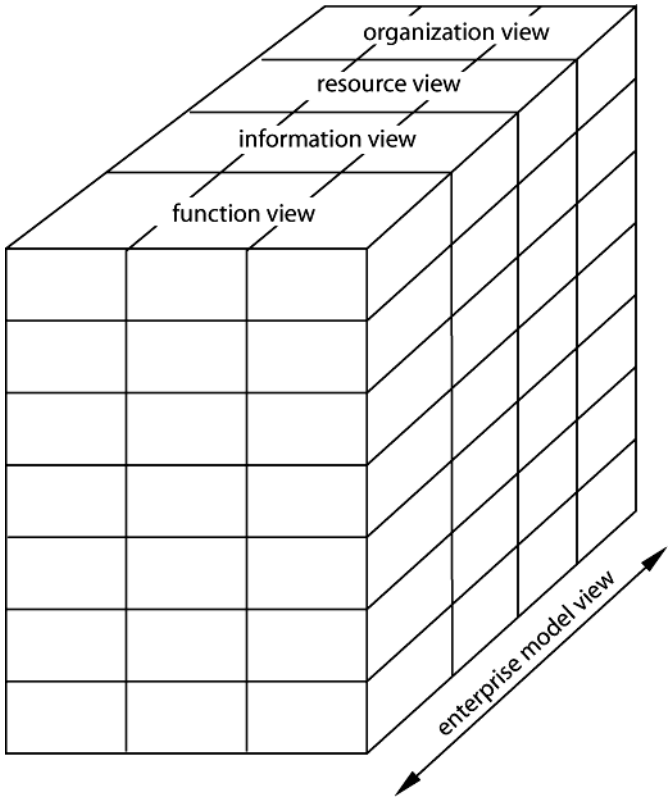

Figure 2 — Dimension of enterprise model view

The concept of enterprise model view shall be applicable at all enterprise model phases. Similarly, the levels of genericity (see 5.4.1) shall be considered at each of the four enterprise model views.

Although the four enterprise model views are described in 5.3.2, 5.3.3, 5.3.4 and 5.3.5, their generation and utilization is determined entirely by the modeller or model user. It is not the purpose of this International Standard to specify the internals or sequencing of the generation or utilization processes.

In addition to the four enterprise model views defined in this framework, model developers may generate additional views for particular user concerns, and these can then be used by any concerned stakeholder.

NOTE 3 These additional views are not part of this International Standard. Possible additional views are identified in ISO 15704 and elsewhere.

5.3.2 Function view

The function view shall represent the business processes of the enterprise domain, their functionality, behaviour, inputs and outputs. The function view shall describe the assembly of single processing steps as a collection of processes (business processes and enterprise activities) structured as a network of activities reflecting their logical connection and interdependencies. The function view shall emphasize the representation of system behaviour, mutual dependencies, and influences of elements during function execution in the enterprise.

Decisional activities of the management-related operations shall be represented, as well as transformational and support activities.

The function view shall present relationships to the enterprise environment since it reflects constraints and takes account of relevant inputs and outputs. The function view shall also identify all entities of the enterprise (material [1)], information, resource and control) required for function execution as enterprise objects.

The processes shall be described by use of the relevant modelling language constructs defined at the generic level. The described processes can be embodied in partial models as well as in models for particular enterprises.

5.3.3 Information view

The information view shall describe the information-related enterprise objects (both material and information) of the enterprise as they are used and produced in the course of enterprise operations.

The enterprise objects in the information view shall be described using the relevant modelling language constructs defined at the generic level. The described objects can be organized as partial models representing typical information models of enterprise domains belonging to particular industry segments, as well as providing models for particular enterprises.

5.3.4 Resource view

The resource view shall describe resource assets of the enterprise (human as well as technological components) as they are used in the course of the enterprise operations. Resource instances shall later be assigned to enterprise activities according to required capabilities. Resources can also be structured into resource models, for applications such as asset management.

The enterprise objects in the resource view shall be described using the relevant modelling language constructs defined at the generic level. The described objects can be organized as partial models, representing typical resource models of enterprise domains belonging to particular industry segments, as well as providing models for particular enterprises.

5.3.5 Organization view

The organization view shall describe the responsibilities and authorities within the enterprise domain. This view shall allow for the gathering and structuring of the different responsibilities (for processes, material, information, resource and control) in the enterprise, and include the mapping of those responsibilities onto the organizational entities and/or organizational groupings such as departments, divisions and sections. The organization view shall also provide for representation of responsibilities for decisional activities into a decisional structure for the verification of consistency and completeness.

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1) See 3.60 for the distinction made between material and resource.

The enterprise objects in the organization view shall be described using the relevant modelling language constructs defined at the generic level. The described objects can be organized as partial models, representing typical organization models of enterprise domains belonging to particular industry segments, as well as providing models for particular enterprises.

5.4 Dimension of genericity

5.4.1 Level of genericity

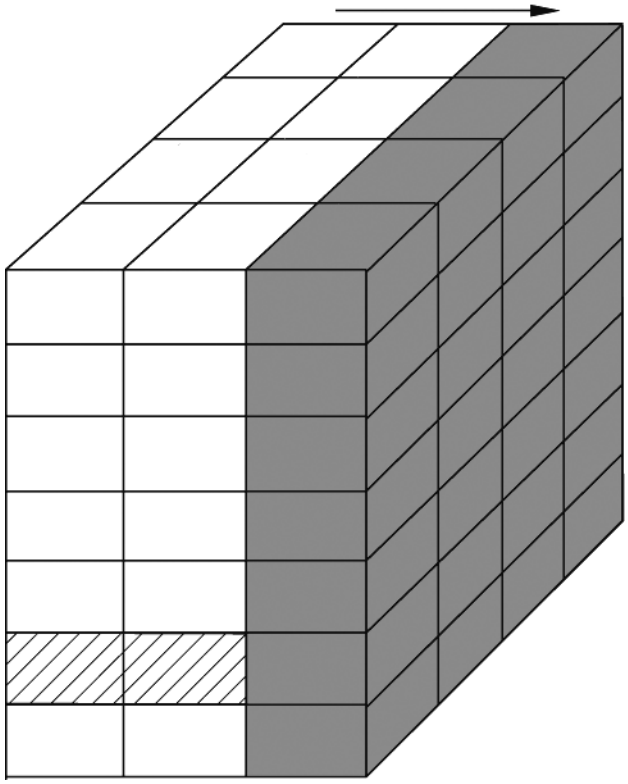
The concept of genericity supports the establishment of a reference catalogue of re-usable generic modelling language constructs that can be specialized and aggregated into industry- and sector-specific models (partial models) to represent and satisfy common patterns. These generic modelling language constructs and partial models can be used (instantiated and specialized) in the development of models for particular enterprises.

As described below, three levels of genericity are defined (see Figure 3) as:

— generic level;

— partial level;

— particular level.



Key

reference part

particular part

not defined at the domain operation phase

Figure 3 — Dimension of genericity

These levels of genericity shall be ordered, in the sense that the partial level is a specialization of the generic level, and the particular level is a specialization of the partial one. The concept of genericity is applicable for all enterprise model phases and across all enterprise model views.

The reference part of the modelling framework shall consist of the generic and partial levels only. These two levels provide a structure for the definition of modelling language constructs and partial models that shall be utilized for the description of an identified enterprise domain. The particular level represents the results of the modelling process, which shall be the models of the particular enterprise domain at the different enterprise model phases.

The particularization process shall support the progression from the generic level to the particular level, via intermediate partial models based on industry experience. Particularization is achieved by a process of specializing and instantiating generic modelling language constructs, for example, by restricting selected attributes of those modelling language constructs to particular values.

A specialized modelling language construct inherits the properties of one or more generic modelling language constructs: some properties are made more specific and/or new properties are added.

NOTE It is not the purpose of this International Standard to specify the internals or sequencing of this particularization process. However, the methodology is intended to enable the orderly progression from generic or abstract modelling language constructs and partial models to a particular model for a specific enterprise. The use of partial models as an intermediate step is an ideal that can be achieved only by highly experienced enterprise modellers operating in limited enterprise domains. Initially particular models will be developed using generic concepts and only when a sufficient body of knowledge has been acquired will useful partial models be developed for faster reuse, such as in specific sectors, or across a number of similar plants in a large company.

5.4.2 Generic level

The generic level shall comprise a collection of modelling language constructs that can be used to build partial models as specified in 5.4.3, and particular models for specific enterprises as specified in 5.4.4. Modelling language constructs described at this level have the widest application in the representation of enterprise domains.

5.4.3 Partial level

The partial level shall contain sets of partial models, each one being applicable to a specific kind of industry segment or industrial activity. A partial model is a re-usable reference model that allows the user to capture and re-use concepts common to many enterprises, and thereby to increase the efficiency of modelling. Partial models still need adaptation to the requirements of the specific enterprise.

Partial models shall be constructed from the modelling language constructs provided by the generic level and/or other partial models, and can be further instantiated to generate models at the particular level representing processes and system components, constraints, rules, services, functions and protocols.

NOTE 1 It is foreseen that partial models will be the prime means by which the modelling language constructs encapsulate industry needs, and so provide a more realistic and usable tool for a particular enterprise. They are incomplete models for particular enterprises (see 5.4.5) and are generally applicable to a wide range of industry sectors, company organizations and/or manufacturing strategies.

A partial model shall consist of typical structures for a variety of categories such as industry sector types (e.g. aerospace, automotive, electronics), company size, national variations or typical structures for prototypical enterprise operations such as enterprise procurement or computer-assisted product design. Partial models can also be defined in a hierarchy (see Figure 4) and can cover all or part of enterprise model phases (with the exception of domain operation) and all enterprise model views as specified in 5.2 and 5.3.

NOTE 2 A set of partial models, such as “automotive suppliers”, can be further particularized in a subset according to enterprise size, and even in a further subset according to type of business. Partial models may also be created and re-used within an enterprise for common enterprise processes. Another kind of a partial model is a set of functions, information or resource structures (depending on the enterprise model view considered). Requirements for such partial structures will grow with time.

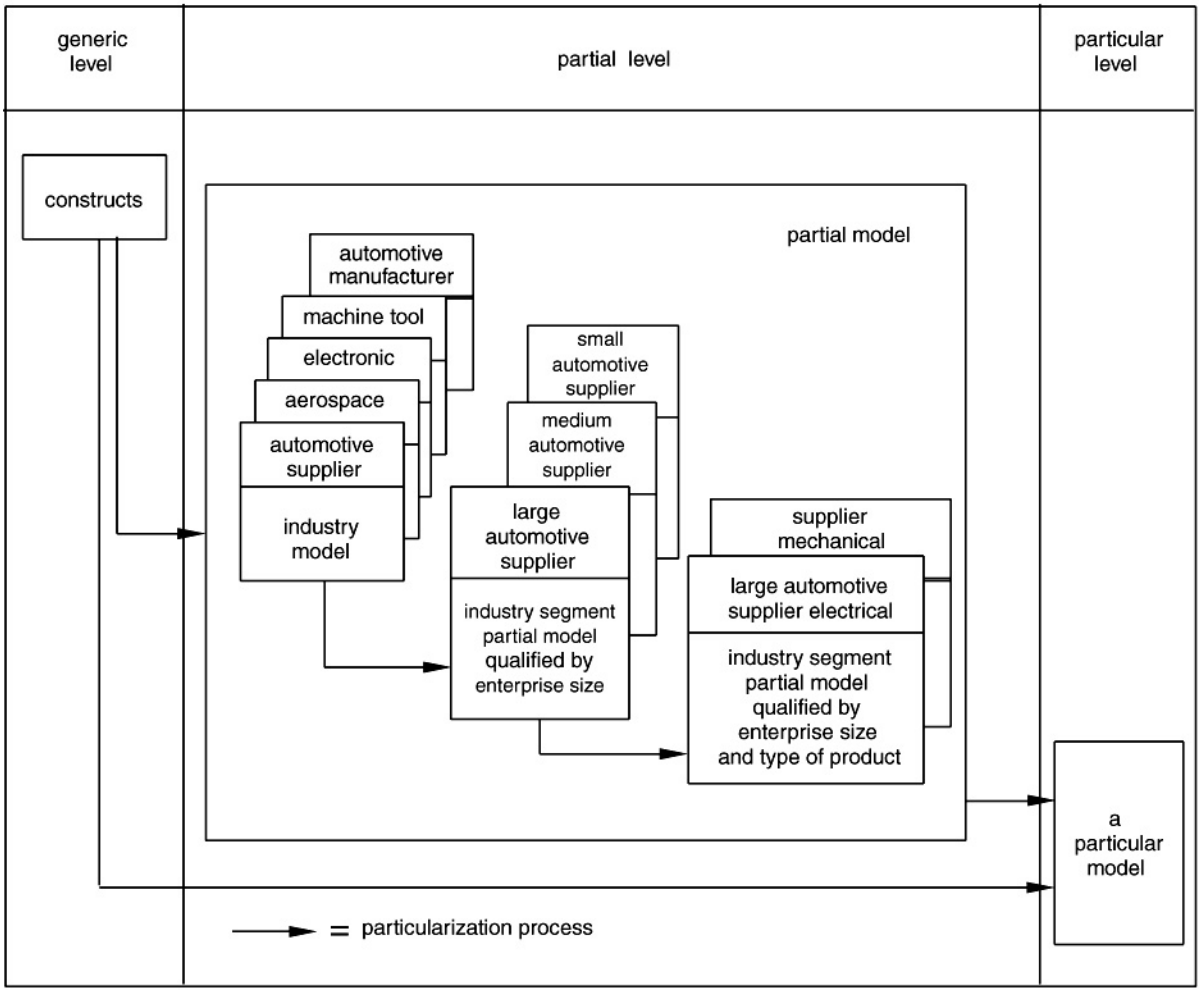


Figure 4 — The role of partial models (an example)

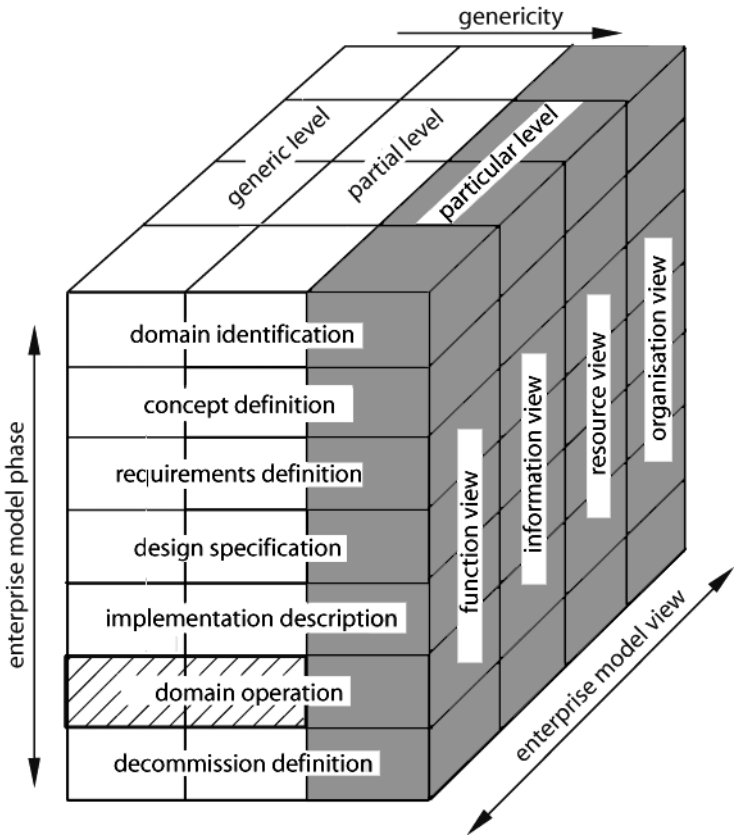
5.4.4 Particular level

The particular level shall be concerned solely with one particular enterprise domain. It shall embody all necessary knowledge of that enterprise in a way that can be used directly for the identification, specification, implementation, operation and later decommissioning of its enterprise operation.

NOTE Particular models can be generated from existing partial models, which can be modified to meet the needs of a particular enterprise and can be complemented by use of generic modelling language constructs provided at the generic level. Particular models can also be generated by the sole use of modelling language constructs provided at the generic level where such partial models are not yet developed.

5.5 Graphical representation of the framework

Each dimension described in 5.2, 5.3 and 5.4 (see Figures 1 to 3) is illustrated by an accompanying figure. Figure 5 provides an overview of the complete framework. It follows the approach, introduced in Clause A.2, of presenting different dimensions as independent axes.



Key

reference part

particular part

not defined at the domain operation phase

Figure 5 — Overview of the framework for enterprise modelling

6 Requirements on enterprise models and modelling methodologies

A model shall conform to the framework specified in this International Standard if

a) the enterprise model contains the function view and the information view,

b) the enterprise model contains the resource view, or the necessary information to derive the resource view and

c) the enterprise model contains the organization view, or the necessary information to derive the organization view.

A modelling methodology shall conform to this framework if

d) the enterprise models developed by the modelling methodology themselves conform,

e) the modelling methodology encompasses enterprise model phases and it is possible to distinguish different manifestations of the model corresponding to each phase,

f) the modelling methodology provides for the derivation of partial and particular models from generic modelling language constructs, and for the controlled addition of generic modelling language constructs to its reference catalogue and

g) the modelling methodology reflects changes in model contents on to all relevant enterprise model views.

Conformance statements shall include either a statement of total conformance to the requirements of Clause 5, or a statement of partial conformance that explicitly identifies areas of non-conformance.

It is recommended that an enterprise model also include a statement of completeness and compliance or otherwise to ISO 15704 and a demonstration of this compliance such as a case study of the development of a particular large enterprise. This study should include all phases as exemplified by the model content, purpose and implementation view of Figure A.9, of ISO 15704:2000, including emphasis on role of humans, safety and economic aspects, to the satisfaction of the customer.

Annex A
(informative)

Enterprise models, frameworks and modelling languages

A.1 Models

Models are descriptions of essential and relevant parts of the domain that do not duplicate reality, but are scope-limited approximations of the reality under consideration. The appropriate extent of detail for a model is determined by its intended use, i.e. the purpose of the model. The real world in the context of this International Standard is therefore restricted to the domain selected by the modeller, and is usually a portion of the entire enterprise, including as components: people, capital, equipment, processes, policies and links (relations) to the external environment. A full description of any model includes statements of its purpose, assumptions and constraints.

Enterprise models are models about enterprises or parts thereof. They are related to the real world (the enterprise) through the perception of observers who can be model creators (enterprise modellers) or model users. The purpose of the observer within the life cycle context determines the appropriate level of abstraction, the extent of decomposition and detailing, and the aspects of the enterprise model that are significant to the observer. Therefore, for each life cycle phase, it might be necessary to consider different concepts, different extents of detail and different views of the enterprise model.

NOTE Methodological processes beyond those imposed by the framework structure itself are not the subject of this International Standard. However, Annex A of ISO 15704:2000 notes that enterprise engineering methodology decides, on the basis of some pragmatic purpose, which model to produce and which modelling language or formalism to use to describe that model.

To ensure proper use of models during enterprise operation, enterprise models have to be complete, consistent and allow for a proper separation of concerns. Therefore, it is useful to structure enterprise models into different viewpoints, aspects and details within a framework that encompasses the relevant conceptual space. Viewpoints correspond to a perspective adopted by an observer in attributing a certain meaning and significance to what is observed.

A.2 Framework dimensions

A framework for enterprise modelling can be organized in terms of aspects and viewpoints, so that the complexity of the entities under consideration is reduced. There are many aspects and viewpoints to be considered for the representation of businesses, and the organization and management of these requires a multi-dimensional modelling framework. Possible dimensions of a framework for industrial applications could be, among others, dimensions of genericity, of industry type, of product type, of enterprise function. Any of these dimensions may stand alone, however, most of the potential dimensions are interrelated and the modelling is not complete without those interrelations. Practical experience with ENV 40003:1990, as supported by ISO 15704, has shown that three dimensions can be sufficient for the modelling of manufacturing enterprises, and this is the approach adopted in this International Standard.

It is usual to present different dimensions of a subject on different axes, as in 5.2, 5.3 and 5.4, so that the different axes can be analysed separately and the dependencies can be indicated in the space defined by the combination of axes used. This presentation also allows for partitioning a dimension into meaningful segments, thus providing conceptual categories within a dimension.

NOTE Framework dimensions do not normally have properties corresponding to geometrical dimensions. Using terms adapted from statistics, they can be nominal scales (just distinguished by their categorical names), or ordinal scales (ordered/sorted), but interval and ratio scales are not used.

The axes are independent in the sense that (with the exceptions listed below) for any combination of the three conceptual dimensions which define some set of modelling entities, it is valid to consider related modelling entities that:

— are at a preceding phase (with the exception of domain identification) or a subsequent phase (with the exception of decommission definition) of the model development process, corresponding to particular life cycle phases (see 5.2);

— have different modelling viewpoints corresponding to different criteria or viewpoints (see 5.3);

— are more or less generalized or specialized (with the exception of domain operation) so determining the extent of genericity (see 5.4).

However, the conceptual space defined by the union of these three dimensions need not be completely populated.

EXAMPLE Generic and partial levels are not defined at the domain operation enterprise model phase (see 5.2.7).

A.3 Modelling languages and modelling language constructs

Standard enterprise modelling languages developed in accordance with this framework will provide unification of the modelling contents and thereby improve model understanding across organizations and even across industries. These languages will simplify the creation of business process models and increase modelling efficiency.

Modelling languages will consist of a set of modelling language constructs providing the common semantics and facilitating the unification of model contents mentioned above. The adaptation of these common modelling language constructs to different stakeholder languages appropriate to each phase of the model development might require different representations at some enterprise model phases, but without changing the underlying semantics.

The modelling language constructs can be specialized and/or organized into structures for a specific purpose (as partial models, see 5.4.3), such as for an industry sector, or for a particular kind of enterprise concern such as maintenance. In turn such structures and/or the generic modelling language constructs can be used for developing particular models for a particular enterprise.

Annex B
(informative)

Using the enterprise modelling framework

B.1 Introduction

B.1.1 General

The enterprise modelling framework (Figure 5) guides both model developers and tool developers. It guides the former through the different model phases of the process of modelling enterprise domains and guides the latter in creating the modelling tool architecture needed to support the model developers in the creation of domain models.

B.1.2 Support for enterprise model developers

For the guidance of the model developers the modelling framework provides:

a) up to seven enterprise model phases that support the modelling of the entire life of the entity (enterprise domain) to be modelled, from its identification to its end-of-life or decommission phase;

b) a minimum of four enterprise model views that allow the user to view only the part of the model of particular concern to his or her particular work area and thereby to reduce the complexity of the overall model;

c) identification of means to express the model content (modelling language, including partial models and modelling methodology, all implemented in supporting modelling tools).

B.1.3 Support for enterprise model tool developers

For the guidance of the tool developers the modelling framework provides:

a) up to seven enterprise model phases that allow tools to be aligned to the interests and concerns of the various stakeholders involved in each phase of the modelling of the entire life of the entity, from its identification to its end-of-life or decommission phase;

b) a minimum of four enterprise model views to be supported by tools, so allowing the user to view only the part of the model of particular concern to his or her particular work area and thereby to reduce the complexity of the overall model;

c) an overall structure (the dimension of genericity) for both tool support (reference architecture with modelling language and methodology) and the resulting enterprise model.

A compatible modelling tool should provide a means of supporting the modelling framework and its repository should be structured according to the reference architecture (generic and partial level) as well as providing for the particular model level. All levels of genericity and enterprise model phase should allow for enterprise model view representation. This means that modelling language constructs have to be identified for selected representation (see Figures B.2 to B.6).

B.2 Using the enterprise model phases

B.2.1 Relations between enterprise model phases

The general content of the enterprise modelling phases is defined in 5.2. However, the relations between enterprise model phases are defined according to general model development rules.

The model development process is a set of activities to be carried out in the course of modelling and may be the subject of model engineering specialists (such as tool builders) and/or model users. These activities are concerned with establishing some or all of the development relations defined below.

a) Relations between modelling language constructs at the generic levels:
modelling language constructs at each enterprise modelling phase are re-used at successive phases; all modelling language constructs inherit preceding modelling phase contents and are enhanced at successive modelling phases according to the needs of those successive modelling phases (defined by specialists).

b) Relations between models at the partial levels:
partial models at each enterprise modelling phase become partial models at successive phases by enhancing their individual modelling language constructs according to the content of the related modelling language constructs and/or construct types defined at the generic level (done by users and specialists).

c) Relations between models at the particular levels:
particular models at each enterprise modelling phase become particular models at successive phases by enhancing their individual particular models and/or modelling language constructs according to the related content of the partial and generic level (done by users).

B.2.2 Using the enterprise model phases – An example

The following example (identical to Figure 2-3 of [24]) illustrates the enterprise model phases of the framework in use. It identifies some of the information to be used and created in the tasks to be carried out in the different model phases of preparing the “Master Plan” of the Purdue Enterprise Reference Architecture (PERA). Figure B.1 shows the preliminary part of the modelling framework focusing on the particular level.

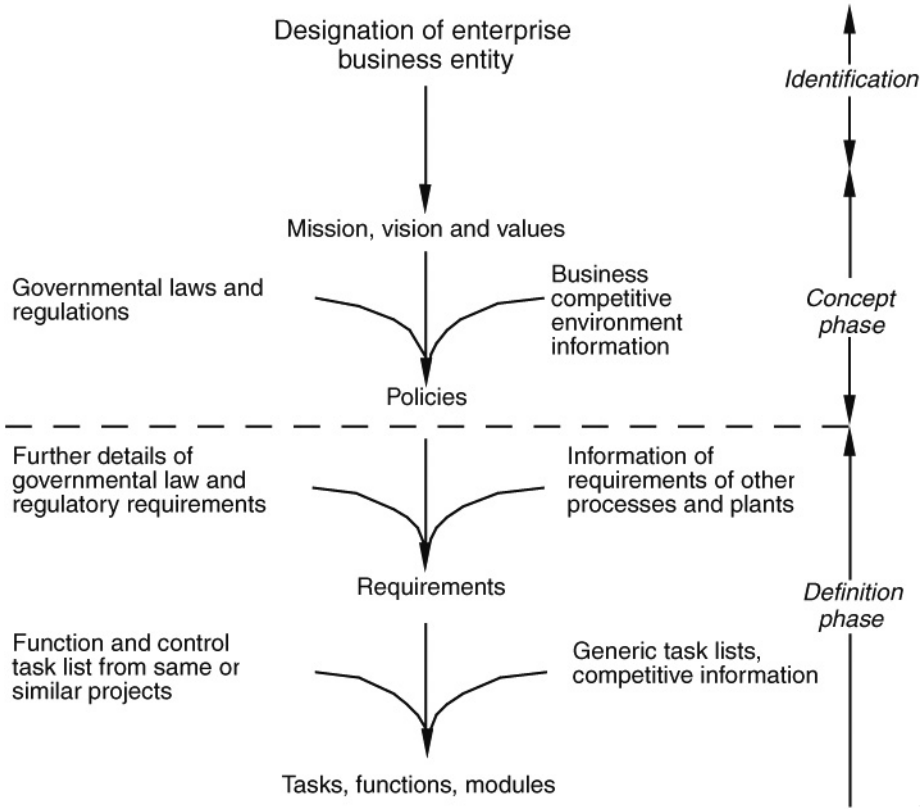


Figure B.1 — Development of enterprise requirements

The figure demonstrates (with some changes of terminology):

— in the domain identification phase (called “identification” in the figure), the designation of the enterprise domain (called ‘enterprise business entity’ in the figure);

— in the concept definition phase (called “concept phase” in the figure), the identification of the domain mission, vision and value for the identified enterprise domain and the use of governmental and business information to establish the domain policies;

— in the requirements definition phase (called “definition phase” in the figure), the use of those policies augmented with other information to define the domain requirements at both a preliminary and a more detailed level.

A description of the model phases from a user’s point of view is provided in Table B.1. Column 2 identifies the content of the different model phases relating to Figures B.2 to B.6 (see B.2.3) as appropriate.

Table B.1 also illustrates the difference between requirement definition and design specification. Whereas required capabilities are defined for the different activities in the requirement definition model, corresponding resources are specified in the design specification model. In addition the object views [2)] identified in the different activity inputs and outputs will be enhanced at the design specification phase; in particular time and cost information are mainly the subject of the design specification model. Also status information will become relevant only for this latter model.

In general particular models at each enterprise modelling phase become lower level particular models at successive phases by enhancing their individual partial models and/or modelling language constructs according to the related content of the partial and generic level.

2) The term object view describes a sub-set of object attributes valid for a temporal interval.

Table B.1 — Modelling framework phases — Example of the enterprise domain life cycle

Model phase	Relations to Figures B.2 to B.6 or short content description
1 Domain Identification	Figure B.2: Enterprise Domain: Order Processing Boundary: - Domain Inputs: Customer Order, Parts; - Domain Outputs: Product, Purchase Order; I/O Origins and Destinations: - Customer, Supplier
2 Concept Definition	Domain Mission, Vision and Values, Operational Policies Not part of Figures B.2 to B.6
3 Requirement Definition	Figures B.2 and B.3: Process: Manufacturing Process, Administrative Process with all Activities Activity Inputs (EA4): - Function: Parts, Purchased Parts - Control: Shop Floor Order - Capability: Assembly Activity Outputs (EA4) - Function Product b - Control: not used - Capability: not used Figures B.2 and B.4: - Enterprise Object: Part, Product, Market, Order, Report - Object View: Part, Purchased Part, Product Figures B.2 and B.5: - Capability Set of Resource Object Shop Floor: Assembly Station, Buffer, Machining Centre, Supervisor, Operator - Object View: Assembly Station, Assembly Station Status Figures B.2 and B.6: - Organization Object: Enterprise, Department, Member, Decision Centre, Planning Horizon - Department: Shop Floor, Product Development, Production Planning, Purchasing, Sales - Member: Supervisor, Operator - Planning Horizon: Month, Week, Day
4 Design Specification	Figures B.2 and B.3: Process: Manufacturing Process, Administrative Process with all Activities Activity Inputs (EA4): - Function: Parts, Purchased Parts - Control: Shop Floor Order - Resource: Assembly Resource Activity Outputs (EA4) - Function Product b - Control: Activity Status - Resource: Resource Status Figures B.2 and B.4: - Enterprise Object: Part, Product, Market, Order, Report - Object View: Part, Purchased Part, Product Figures B.2 and B.5: - Resource Object Shop Floor: Assembly Station, Buffer, Machining Centre, Supervisor, Operator - Object View: Assembly Station, Assembly Station Status - Operator, Operator Status Figures B.2 and B.6: - Organization Object: Enterprise, Department, Member, Decision Centre, Planning Horizon - Department: Shop Floor, Product Development, Production Planning, Purchasing, Sales - Member: Supervisor, Operator - Planning Horizon: Month, Week, Day
5 Implementation Description	Design Specification Model modified by Implementation Deviations from Design Specification. Not part of Figures B.2 to B.6
6 Domain Operations	The operational use of the Domain Model (released Implementation Description Model). Not part of Figures B.2 to B.6
7 Decommissioning Definition	Domain Model remodelled for Definition of End-of Life State of the Domain Components. Not part of Figures B.2 to B.6

B.3 Using the model views in model development

B.3.1 An order processing example

This example of order processing demonstrates the use of the view concept for the four views defined in this International Standard — function, information, resource and organization (see 5.3).

NOTE The example is a draft version taken from the CIMOSA Technical Baseline [13].

The example is presented in the form of an entity-relation diagram representing an ordering process in a manufacturing enterprise (Figure B.2).

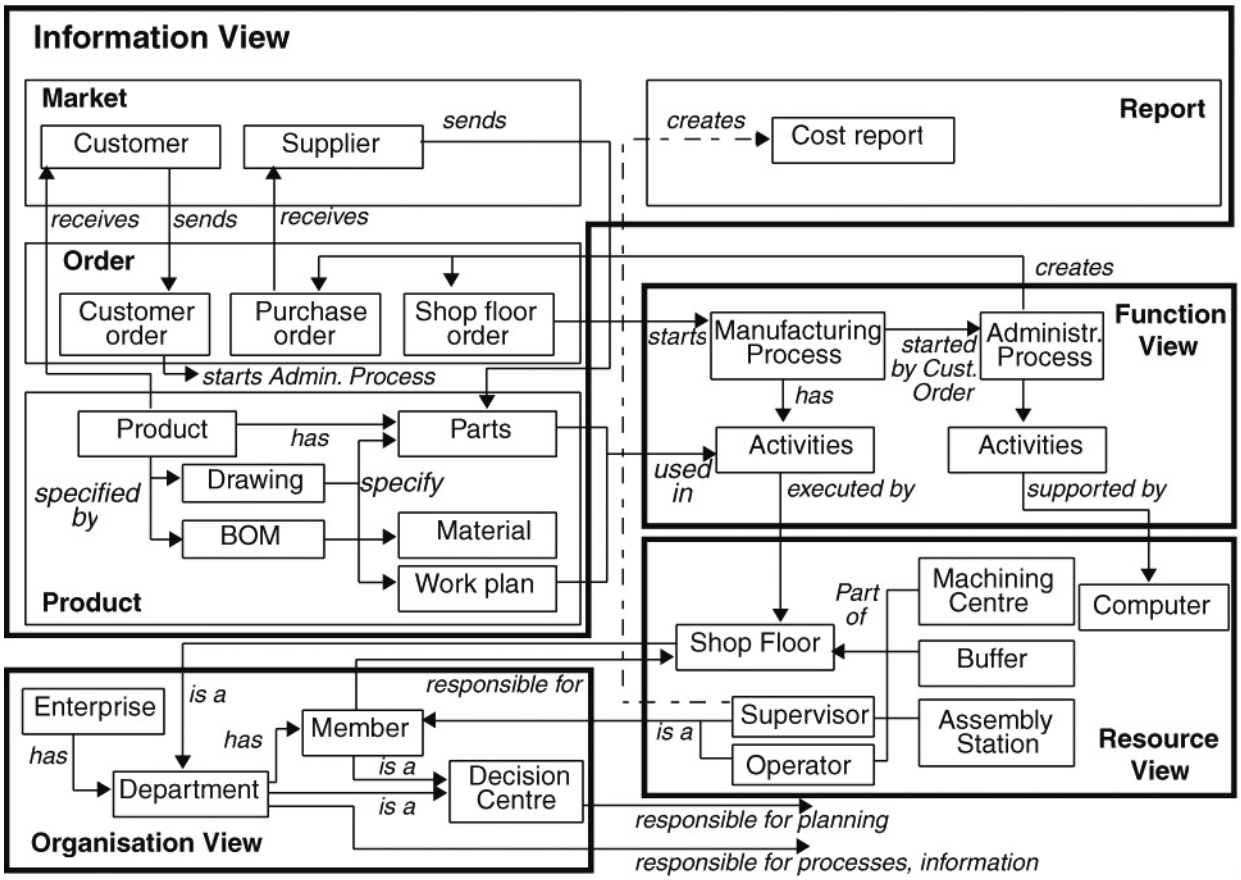


Figure B.2 — Model views for order processing

The function view represents the operational processes (Production and Administration) and the associated activities. The associated activities would usually be represented as networks of activities linked by the predefined control flow using behavioural rule sets. For reasons of simplicity these process networks are represented as boxes named “activities” (see Figures B.3 to B.6 for more details on individual views).

Activity inputs and outputs are represented and structured in the information view. The enterprise objects used in the order processing are organized in a set of objects (Market, Order, Product and Report), which in general are composed from other objects. The different enterprise objects and their constituents have relations to other objects in the same or other views. These relations are identified by the directed links between the different objects.

In the resource view, the required resources are identified and are also organized into composed structures (Shop Floor) that may follow the organization structure of the enterprise (Shop Floor is a department). Human resources (Supervisor and Operator) as members of a department (Shop Floor) also have relations to the organization view.

The organization view represents the relations between the different organizational entities in the enterprise and identifies their responsibilities. These responsibilities can be on different levels of the organization and are usually carried out by members of the organization entity authorized for the decision-making.

The GRAI concept [12] of decision centres addresses this decision-making aspect. Identifying the time horizons of the different decision centres that qualify the planning aspect of decision-making.

The representation of individual views is shown in B.3.2 to B.3.5 (Figures B.3 to B.6).

B.3.2 Function view

Figure B.3 shows the function view of the illustrative example for the order processing introduced in B.3.1. Two of the three identified enterprise domains (Customer and Supplier) are not further detailed, but provide inputs (Order, Parts) to and receive outputs (Product, Invoice, Supplier Order) from the Enterprise Domain under consideration. The latter consists of the two processes (Administration, Manufacturing) identified in the function view of the previous item.

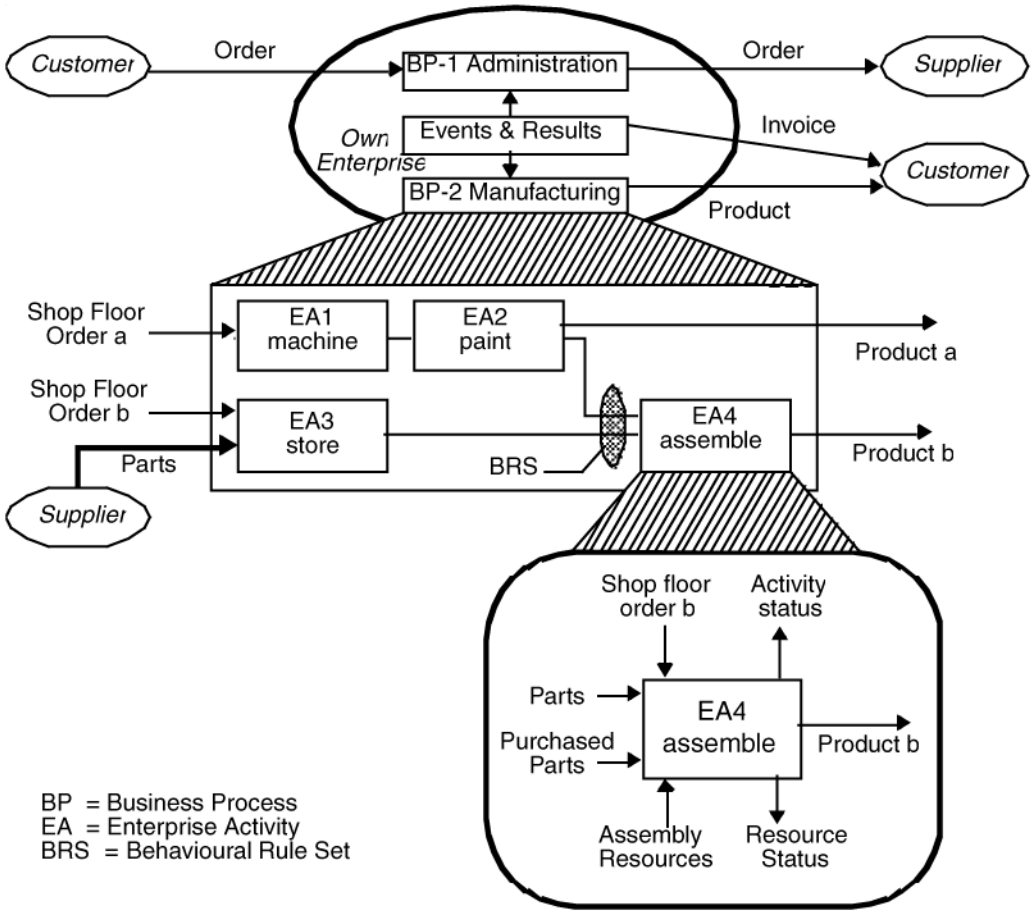


Figure B.3 — Function view for order processing

Decomposition of one of the two processes leads to the network of four enterprise activities shown in the centre part of Figure B.3. The lower part of Figure B.3 shows the links to the objects in the information and resource views that are identified as inputs and outputs of the enterprise activity. Not shown are links to the organization view made via responsibilities of human resources or identification of organizational aspects (Shop Floor, treated as a combination of Department and Decision Centre).

B.3.3 Information view

The example of order processing is also used in Figure B.4 as an illustrative example for the information view. Figure B.4 identifies the relations between the information view and the function view using only assemble activity function inputs (Parts and Purchased Parts) and outputs (Product b).

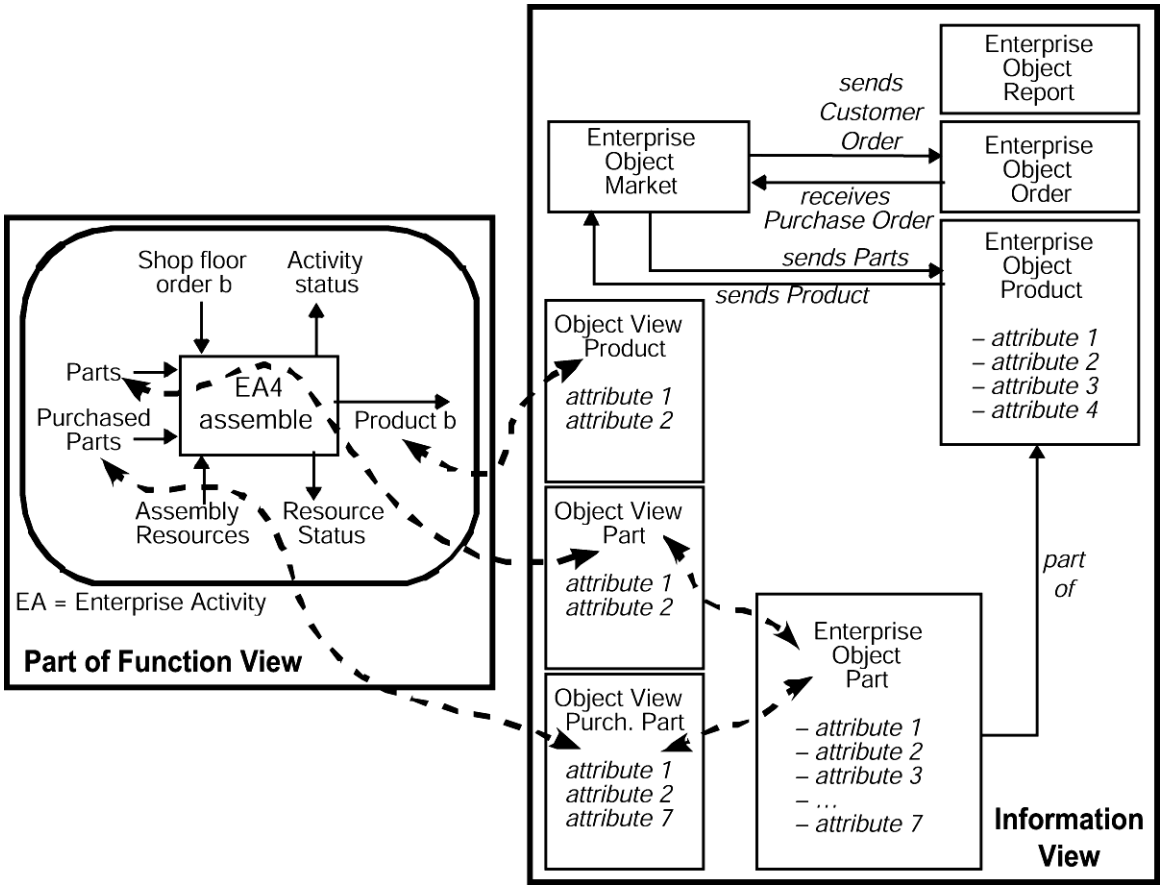


Figure B.4 — Information view for order processing

All the information used and produced by the activity is part of the set of enterprise objects. Parts and Product are represented in the information view as objects or projections of objects (CIMOSA [13] Object Views). As indicated already in Figure B.2, the enterprise object Part is part of the enterprise object Product. For the remainder of the information view, only the composed objects and their relations are shown in Figure B.4.

This concept of Object View requires multiple use of information as indicated in the two Object Views derived from the Enterprise Object Part (both object projections use attributes 1 and 2). However, all of these object projections are of a temporary nature, which means they only exist together with an enterprise activity instance and the information redundancy is of no consequence for the consistency of the overall information model.

The information view can be used in two different ways as indicated by the links with the two arrows.

a) The necessary object projections can be identified according to the needs of the operational activities and the enterprise objects are assembled from the multitude of object projections identified in the course of modelling.

b) The object projections are selected from the predefined enterprise objects.

Option b) is the preferred way of providing consistency of the enterprise model and the enterprise knowledge base.

B.3.4 Resource view

Using the same example of order processing the resource view is illustrated in Figure B.5. The Figure identifies the relations between the resource view and the function view using only assemble activity resources. Again, the concept of Object Views (CIMOSA [13]) is employed. As indicated already in Figure B.2, the Resource Object Assembly Station together with human and equipment resources is part of the Resource Object Shop Floor.

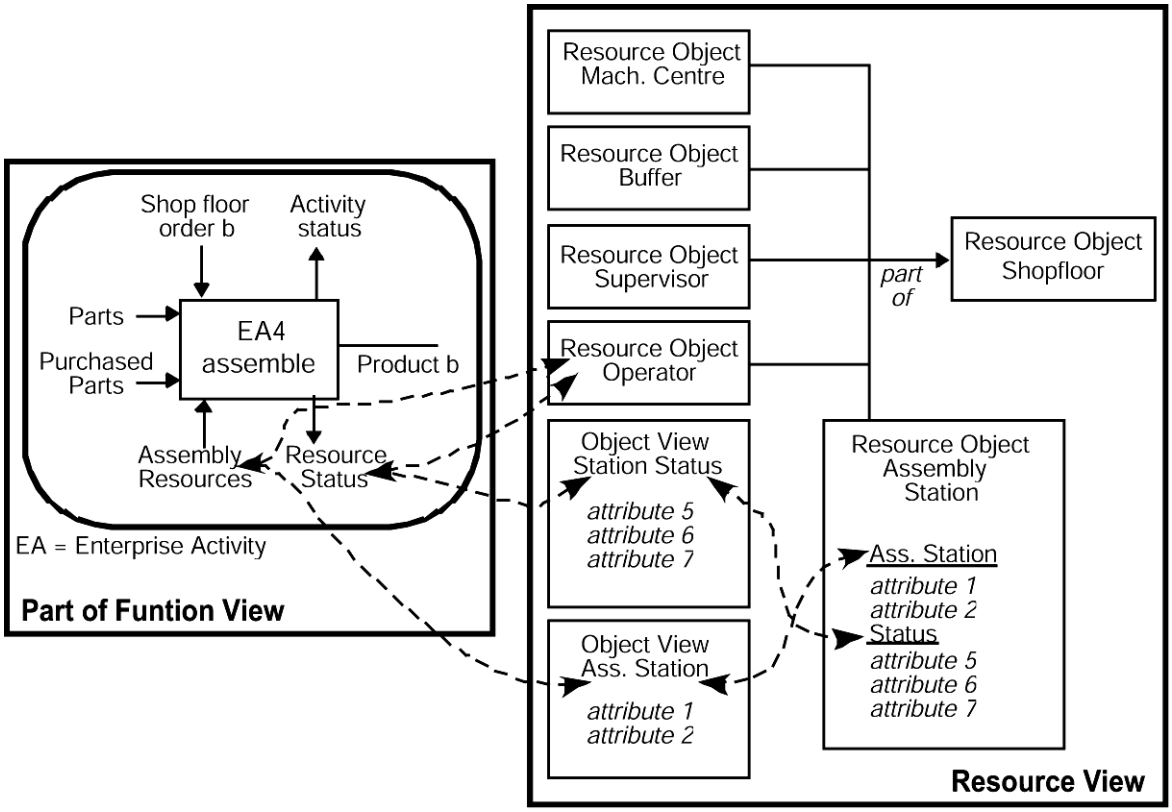


Figure B.5 — Resource view for order processing

Object Views of the Assembly Resources describe the capabilities of the station itself, one for the resources of the assembly resources, and one for the status of the station after completion of the assemble activity. The latter provides information such as operation duration, available lifetime of time critical components and identification of maintenance operations needed. The other resource object is the operator involved in the assemble activity. Again Object Views on the remaining resource capability and resource status are provided, but not shown in Figure B.5.

The resource view can also be used in two different ways as indicated by the various double-headed arrow links.

a) The necessary object projections can be identified according to the needs of the operational activities and the resource objects are assembled from the multitude of object projections identified in the course of modelling.

b) The object projections are selected from the predefined enterprise objects.

Option b) is the preferred way of providing consistency of the enterprise model and the enterprise knowledge base.

B.3.5 Organization view

Figure B.6 shows the organization view of the illustrative example of order processing. Starting from the general concept shown in the lower left corner of Figure B.2, the responsibilities of the different departments and its members are indicated for the objects or Object Views in the other CIMOSA [13] views (function, information and resource).

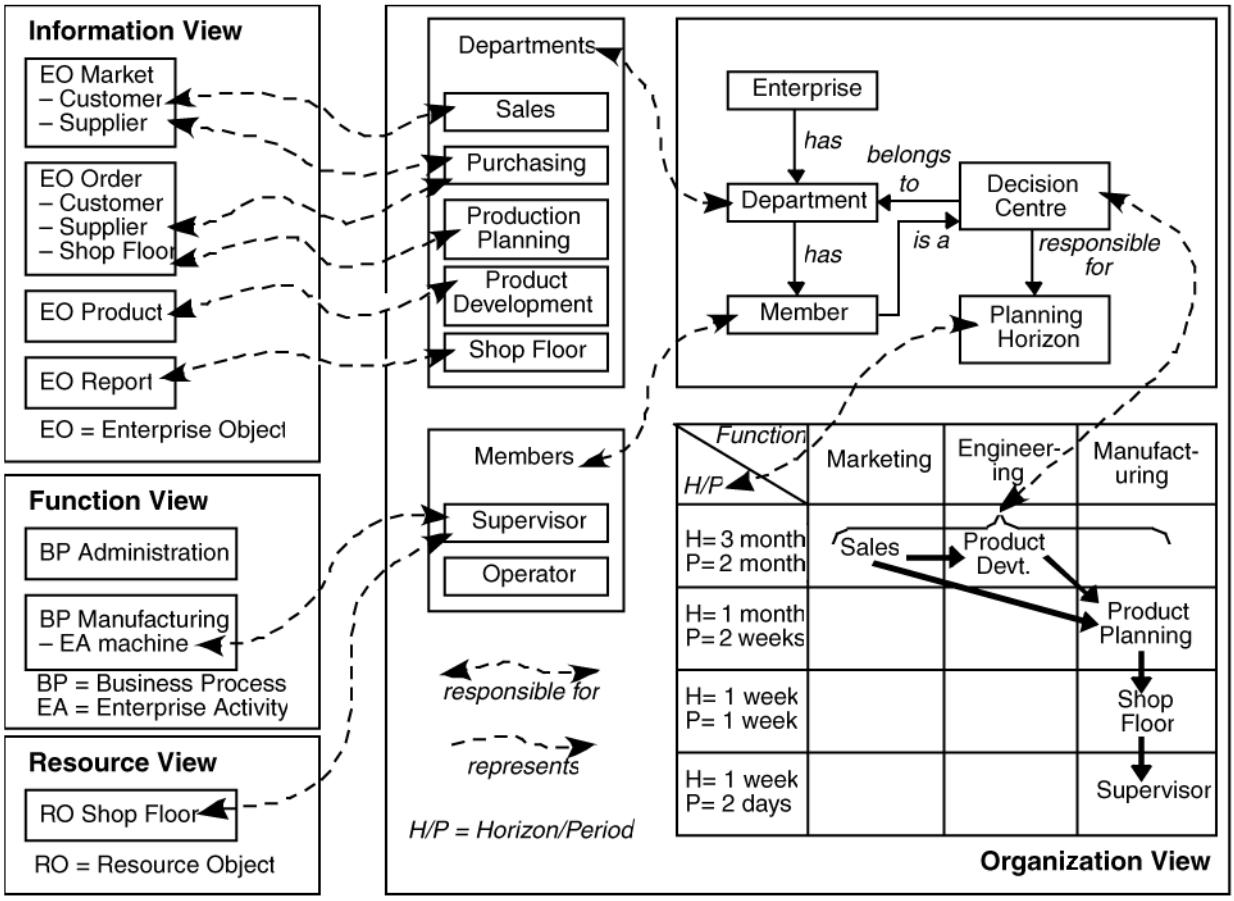


Figure B.6 — Organization view for order processing

In the lower right of Figure B.6 the GRAI grid [12] is used to represent the relations between different decision centres (indicated by the arrow). Decision centres are ordered in the grid according to the duration of their planning horizons and the associated period for revision of the decision.

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