SLOVENSKI STANDARD
SIST ENV 40003:2003

01-oktober-2003

Raļ unalniġko integrirana proizvodnja ï Sistemska arhitektura ï Okvirne doloļ be o podjetniġkem modeliranju

Computer integrated manufacturing - Systems architecture - Framework for enterprise modelling

Rechnerintegrierte Fertigung - System-Architektur - Rahmenwerk zur Erstellung von Unternehmensmodellen

Productique - Architecture des systèmes - cadre pour la modélisation d'entreprise

Ta slovenski standard je istoveten z: **ENV 40003:1990**

ICS:

35.240.50	Uporabniške rešitve IT v industriji	IT applications in industry

SIST ENV 40003:2003 **en**

EUROPEAN PRESTANDARD
PRENORME EUROPEENNE
EUROPAISCHE VORNORM

ENV 40 003

July 1990

UDC: 658.52.011:681.3:65.012.2

Key words: Computer integrated, manufacturing, companies, architecture, models

English Version

Computer Integrated Manufacturing - Systems Architecture - Framework for Enterprise Modelling.

Productique - Architecture des Systèmes - Cadre pour la modelisation de l'Enterprise.

Rechner Integrierte Fertigung - System Architektur - Rahmewerk für Unternehmensmodellierung

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CEN/CENELEC

The joint European Standards Institution
Organisation Commune Européenne de Normalisation
Die Gemeinsame Europaische Normeninstitution

Central Secretariat: rue Bréderode 2, B-1000 Brussels

Ref. No. ENV 40 003:1990 E

BRIEF HISTORY

This European Prestandard (ENV) was elaborated by the Working Group CEN/CENELEC/IT/WG ARC and submitted by the CEN/CENELEC Central Secretariat to the members for Formal Vote on 10 January 1990. The technical and editorial comments were reviewed at an editing meeting on 5 April 1990.

The resulting amended version was adopted at the CEN/CENELEC voting meeting on 18 and 19 April 1990, where the following member countries voted for its acceptance : Belgium, Denmark, France, Germany, Italy and United Kingdom.

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FOREWORD

This European Prestandard (ENV) sets out a framework for future standardisation in the area of Computer Integrated Manufacturing [1] enterprise modelling. Like the ISO Reference Model for Open System Interconnection, the ENV guides the structuring and the development of related, detailed standards.

This ENV was prepared by CEN/CENELEC/AMT/WG-ARC to help in the identification of necessary standards in the area of Computer Integrated Manufacturing (CIM), focusing on the needs of Discrete Parts Manufacturing.

Many of the concepts of this ENV may be usable in other industries (process industry, transportation industry, etc.) which are outside the mandate of this present work as defined in CEN/CENELEC/ETSI Memorandum M-IT-04, Directory of European Standardisation Requirements for Advanced Manufacturing Technology and Programme for the Development of Standards. Representatives of other industries are encouraged to consider the applicability of this ENV elsewhere.

This ENV is the result of an evaluation of a number of activities in the development of architectures for Computer Integrated Manufacturing.

The method of selecting contributions from these activities has been to make an evaluation of their work, and based on this to select some of the projects for further assessment.

The selected projects were assessed relative to each other, leading to the conclusion that the CIM-OSA Framework for Enterprise Modelling is adequate to express the common concepts of those projects.

So while the work draws upon ideas in a number of European projects, the work is based mainly on the CIM-OSA architecture resulting from the ESPRIT 1 project 688, AMICE, whose results have proved to be of particular value.

0 INTRODUCTION

0.1 The needs for Computer Integrated Manufacturing

An enterprise can be defined as an entire corporation, consisting of one or more organisational components, with the prime objective of producing products or offering service. For enterprises in the manufacturing industry, the manufacturing process itself (that is the transformation of raw material into marketable products) is changing from a semi-stable process to a highly dynamic one. The reasons for this change are many, and only some of the major reasons are listed below:

- Fast changes in market demands leads to fast obsolescence of established products;
- World-wide availability of technology, capital and information (know-how) leads to shorter development cycles for new products;
- World-wide marketing of products leads to strong cost competition in established markets.

Footnote (not constituting part of this ENV)

1) For the purposes of this ENV on Systems Architecture, Computer Integrated Manufacturing (CIM) is defined as the joint application of Information Technology and Manufacturing Technology to increase the productivity and responsiveness of manufacturing enterprises, whereby all functional, informational and organisational aspects of an enterprise are parts of an integrated whole.

The result for the manufacturing industry is a forthcoming era of continual change in its economic and technological environment. Coping with this continual change is the major future challenge for the manufacturing industry. For each enterprise the challenge is to stay synchronised with the external changes.

Today, manufacturing industry still strives for stability of its production as a major enterprise goal and management of change is not yet considered a permanent objective.

Information processing is still very fragmented even in computerised applications. This is due to previous bottom-up development of computer applications without the use of a general framework, to the use of multi-vendor hardware and software and to the organisational boundaries in manufacturing companies. Therefore, the decision making process in the companies is still based on traditional information processing; that is information gathering with paper and pencil, on request and from inconsistent sources. This process is at the least very time consuming. In many cases it yields only insufficient or even incorrect information.

In addition, most companies are not organised for fast decision making processes. Departments are still managed according to their own sub-goals rather than to real enterprise goals. The responsibilities are usually structured in one-dimensional hierarchies which mix responsibilities for enterprise assets with those for enterprise operations. In fact matrix organisation is to a great extent a theoretical concept.

It is expected that CIM will improve enterprise competitiveness through adaptability and flexibility of enterprise operation and organisation. CIM should ensure efficient use of enterprise assets and resources like people, capital investments and information.

To cope with the continuing change of the environment, the enterprise has to be able to anticipate the required internal changes. That means ensuring that the internal adaptation process is shorter than the external change cycle. This requires the closed loop control of the whole manufacturing process from material source to product availability in the market. It also requires the ability to make timely decisions.

To establish the required fast decision-making processes, all responsibilities in a company need to be clear and visible, requiring not the equivalent of today's organisation chart but rather the explicit representation of knowledge about all decision-making individuals and processes in the company, and about their specific responsibilities for processes and resources.

This clear and explicit representation can best be given by an individual model describing all processes, information requirements, resources used and responsibilities of an enterprise. Generation of such models requires assistance by a description method and tools which make the generation of such models feasible and manageable.

0.2 The role of Information Technology

Information Technology in conjunction with Manufacturing Technology provide significant and powerful tools for these objectives. They are very important parts for CIM and are regarded as the means by which enterprise tasks are performed in the most effective and economic way. However, Information Technology is a tool which still needs further improvement before it can fulfill these high expectations. This European Prestandard (ENV) defines a framework which allows the identification of many of the improvements required to reach the high goals of CIM.

Information Technology makes it possible even today to install very large networks of computer systems with almost unrestricted processing capabilities. What are missing are the necessary concepts and

implemented software which allow meaningful processing of the vast amount of information in the enterprise. This meaningful processing, that is the processing of the right information, for the right purpose, at the right time, in the right place is still the major problem in the application of Information Technology.

Many of today's computer programs have been developed as stand-alone units. Functional aspects, information and data aspects, and even organisational aspects are part of the application. Thus portability is limited even if heterogeneous Information Technology systems would allow it.

Application software and its development are not the only weak points in the application of Information Technology. Another is the need to access and to keep consistent information generated and used by different applications, running on different computer systems.

To support the decision-making process, the right information has to be timely and the results of the decision-making process have to be available in the right place. Decision-making also has to take into account alternative solutions and their possible impact on the total enterprise operation. Therefore, processable description and simulation of alternative approaches are requirements for future decision support systems.

0.3 The need for integration

Integration is expected to solve many of the problems in the manufacturing industry today. However, integration is understood in different ways by the people in the industry. The users expect CIM to provide integration of information in terms of availability, accessibility and consistency. The vendors see system integration in terms of hardware system connectivity and portability of computer application as the main goal of CIM. Therefore integration has to be carried out in more than one phase.

Three different phases of integration have been identified for the development of CIM: physical system integration, application integration and business integration. Each of these phases builds on the phase(s) below it.

The first necessary phase of integration, the physical system integration, is mainly concerned with inter-system communication. It is expected that this phase of integration will be provided by current Information Technology concepts and standards (as, for example, OSI) and so it is not addressed in this ENV.

According to progress made in the physical system integration phase, and partially in parallel with it, the second phase of application integration can be realised. That phase deals with information integration, with the portability of application programs and with the standardisation of the interfaces between Information Technology systems, human resources and machines.

The third phase of integration, business integration, deals with the integration of the different business functions such as design, production, marketing, finance etc., within the enterprise. It also deals with the ability to accommodate, in a dynamic and flexible way, all changes occurring in those business functions.

1 SCOPE [2)]

This European PreStandard (ENV) provides a standard for a framework, which will serve as a common basis for identifying and coordinating standards development for computer-based modelling of enterprises, focusing on Discrete Parts Manufacturing. Models generated using this framework will be ultimately computer executable and enable the daily operations of an enterprise possibly to be run, monitored and controlled by such models. [3)]

2 NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this European Prestandard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this European Prestandard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ISO 7498 -
Information Processing Systems - Open Systems Interconnection - Basic Reference Model, October 1984.

ISO TR10314 -
ISO Reference Model for Shop Floor Production Standards, Part 1.

3 ABBREVIATIONS

The following abbreviations and acronyms occur in the main text of this ENV:

AMICE	The ESPRIT consortium 'AMICE', established to undertake the ESPRIT 1 project 688
CAD/CAM	Computer Aided Design / Computer Aided Manufacturing
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
AMT/WG-ARC	The CEN/CENELEC Working Group on CIM Architecture
CIM	Computer Integrated Manufacturing
CIM-OSA	CIM Open System Architecture, as developed by AMICE in ESPRIT 1 project 688
ENV	European Prestandard
ESPRIT	European Strategic Programme in Information Technology
ETSI	European Telecommunications Standards Institute
ISO	International Organisation for Standardisation
NC	Numerical Control
OSI	Open Systems Interconnection

Footnotes (not constituting part of this ENV)

2) The Scope of this ENV is identical with the accepted Scope of the ISO/TC184 New Work Item as defined in TC184 N144 and thus reflects the European goal to have international standards available for global implementation.

3) The following comments also apply:
   a) computer-based modelling is not to be confused with automated modelling. It may still require human intervention;
   b) it is not intended to preclude the use of manual modelling methods should these be feasible;
   c) the term "be ultimately computer executable" refers to representations of the model, which is itself a representation of the enterprise.

4 FRAMEWORK FOR ENTERPRISE MODELLING

4.1 The reason for a framework

Computer Integrated Manufacturing (CIM) requires that all functions of an enterprise work together as an interrelated whole.

To ensure that all activities, data and resources of an enterprise are put in proper relationship to each other, it is necessary to model the enterprise in order to identify all these activities, data, resources and responsibilities in an unambiguous way. The above mentioned items should be easily identifiable, one in relation to the other, and implementable. This should include possibilities for easy modification of the enterprise itself (for example its structure, its modes of operation) as well as all the modelled items.

This ENV sets out a Framework for Enterprise Modelling which is connected to the real industrial world of personnel, software and equipment in at least two ways:

- the Framework for Enterprise Modelling provides a structure which clarifies the links between Information Technology and Manufacturing Technology Components (such as industrial messaging, time-critical communication protocols, numerical control languages, CAD/CAM data exchange formats etc.) as described in 4.6, and the methods and software tools required to describe and/or simulate an industrial system and
- both the Information Technology and Manufacturing Technology Components have a place inside this Framework for Enterprise Modelling through their representation.

When modelling such components, different points of view, different aspects and degrees of detail may well need to be considered. To ensure completeness, consistency and a proper separation of concerns, it is useful to structure the different viewpoints, aspects and details in a framework.

A framework can have one or more dimensions, according to the complexity of the object under consideration. A well known framework is the reference model of OSI with its seven layers (ISO 7498 Information Processing Systems - Open Systems Interconnection - Basic Reference Model, October 1984) which is a one dimensional framework.

On the subject of industrial automation, there are so many aspects and viewpoints to be considered that they cannot be structured in a one dimensional framework. Possible dimensions of a framework for industrial automation could be, among others, dimensions of genericity, of applicability, of industry type of product type, of enterprise function, together with dimensions for each of these representing ways in which they can change. Any of the above listed dimensions may stand alone, however in practice most of the dimensions are interrelated and are not complete without these relations.

It is usual to present different dimensions of a subject on orthogonal axes, so that the axes by themselves can be analysed independently and the dependencies can be indicated in the space embraced by the axes used. This presentation also allows for dividing the axes according to sub-dimensions, thus providing for sub-spaces.

It has proved difficult because of the complexity to find answers to all the aspects involved in CIM - to date only partial solutions have been found. Therefore it appears necessary to structure the most important aspects of CIM into one Framework for Enterprise Modelling, which can be used to direct future standardisation work on the integration of:

- functional structures;
- organisational structures;
- machine technology;
- information technology

for Computer Integrated Manufacturing enterprise modelling.

As an abstract framework, this ENV is an important starting point for future collaborative work on a common basis and a common understanding.

4.2 The general description of the Framework for Enterprise Modelling

4.2.1 The three dimensions

Among all possible dimensions, three have been selected for their ability to include all the concepts needed for the modelling of enterprises:

- One dimension is concerned with the life-cycle of the model starting from the statement of requirements to a processable model, this is the dimension of Model of an enterprise.
- One dimension is concerned with the structure and behaviour of a model which considers appropriate aspects of an enterprise, this is the dimension of Views.
- One dimension is concerned with the degree of particularisation which identifies the set of possible models, this is the dimension of Genericity.

The set of possible models, the structure and behaviour of a model and the different phases of the life-cycle of a model are the key concepts which characterise a model from a generic aspect which is non-application dependent.

As such, the application of these concepts to the industrial environment can be considered as valid for the description of the models envisaged in the scope of this ENV.

4.2.2 The concepts of the Framework for Enterprise Modelling

The enterprise modelling process, that is the transformation of different CIM aspects into one integrated, computer processable model, is enabled by generic, easy to use, standardised constructs. These constructs are used to compose Partial Models. The Partial Models and/or the generic constructs are used for modelling particular enterprises Models. Different Enterprise Views covering different aspects, and different Model Levels covering different levels of detail are used to structure the enterprise modelling process. These concepts and their interrelationships are set out in what follows.

At the three Levels of Genericity, the properties of Information Technology and Manufacturing Technology Components, as described later in 4.6, are used at an appropriate level of abstraction to construct Generic, Partial or Particular Models. For example, the concepts of a message-handling protocol for a particular industry would be used in modelling the corresponding Partial Implementation Model for that industry. So the properties of the supporting Information Technology and Manufacturing Technology Components are gradually to be introduced in increasing level of detail as development progresses towards the Implementation Model at the Particular Level for a specific enterprise.