3e Conférence Francophone de Modélisation et SIMulation "Conception, Analyse et Gestion des Systèmes Industriels"
MOSIM'01 - du 25 au 27 avril 2001 - Troyes(France)

A MODELLING LANGUAGE FOR USER ORIENTED ENTERPRISE MODELLING

Martin ZELM
CIMOSA Association e.V.
Gehenbühlstr. 18 A, D-70499 Stuttgart
Mél . Martin.Zelm@cimosa.de

Kurt KOSANKE
CIMOSA Association e.V.
Stockholmer Str. 7, D-71034 Böblingen
Mél . Kosanke@cimosa.de

Abstract: *Enterprise modelling provides the means to structure and decompose the enterprise system into less complex parts and to describe functionality and behaviour of the operation or any part thereof. The relevant enterprise knowledge can be captured, shared and managed through process models. Process models describe both the functionality and the flow of control in the enterprise and identify all the needed and produced information.*

However, the user should employ a modelling language consisting of modelling constructs relevant for the representation of his business. Constructs, which provide means for easy information capturing and are represented by easy to understand graphical symbols or icons. Both, common modelling construct types and their representation by icons will make the modelling process more effective and efficient and also improve the human understanding of enterprise models. The latter is especially important for the upcoming e-business to business and virtual enterprise type operations. Only with increased efforts in harmonisation and standardisation, will the envisaged improvements be realised.

Starting from the CIMOSA reference architecture the paper proposes structuring of user oriented modelling construct types and type hierarchies and presents an overview of construct icon types for graphical representation used in different modelling tools.

Key words: Enterprise modelling, generic construct types, standardisation, graphical construct presentation, CIMOSA

1. INTRODUCTION

Today's industrial environment is governed by fast changing, global markets for goods and services as well as by the worldwide availability of knowledge, technologies and capital. Mastering complexity and managing change requires flexible organisations and the ability to establish partnerships to co-operate in inter-organisational, virtual enterprises.

Enterprise engineering and integration and more specific business process oriented modelling is capable of providing the necessary technology to support the new forms of enterprise organisation. Enterprise modelling provides the means to describe, structure and decompose the enterprise system into less complex parts. The relevant enterprise knowledge can be captured, shared and managed through process models, which can be employed for simulation or model driven monitoring and control. Process models describe both the functionality and the flow of control in the enterprise and identify all the needed and produced information. (Kosanke, 1997)

A comprehensive overview on the state-of the-art of languages and methodologies for process oriented enterprise modelling and integration is provided by Vernadat (Vernadat, 1996) and Bernus (Bernus, 1999).

The focus of this paper is on enterprise modelling from the viewpoint of the business user. Starting from the reference architecture CIMOSA the paper presents aspects of and requirements on user oriented types of generic modelling constructs, on their content and on their graphical presentation with icons.

2. CIMOSA DEVELOPMENT

The ESPRIT Consortium AMICE has developed the definition and specification of a CIM architecture for enterprise integration (AMICE 1993, Wortmann 1994). The goal of this effort was to establish standards in the area of CIM with emphasis on:

- a framework for enterprise modelling (reference architecture),
- an enterprise modelling language,
- an integrating infrastructure for model enactment all to be supported by:
- a common terminology.

Final project results have been demonstrated in 1994 with model driven monitoring and control of a complete gearbox manufacturing process from order entry to final assembly.

CIMOSA has been a major input to European and International standardisation, namely in CEN ENV40003 (CEN, 1990) and ISO 15704 (ISO, 1999) concerned with Enterprise Modelling Frameworks as well as in CEN ENV12204 (CEN, 1995) concerned with Constructs for Enterprise Modelling.

In the meantime CIMOSA has been applied in numerous applications across a whole range of industries much beyond the original discrete parts manufacturing domain. It has been implemented in modelling tools and has been the base for a first set of standards in enterprise engineering and integration. (Kosanke, Vernadat and Zelm 1999)

3. CIMOSA MODELLING FRAMEWORK

The modelling framework is shown in Figure 1. CIMOSA defines a cube with three levels of genericity (generic, partial, particular), three modelling levels (requirement definition, design specification, implementation description) and four model views (function, information, resource, organisation). The concept of views allows working with a subset of the model rather than with the complete model, providing especially the business user with a reduced complexity for his particular area of interest.

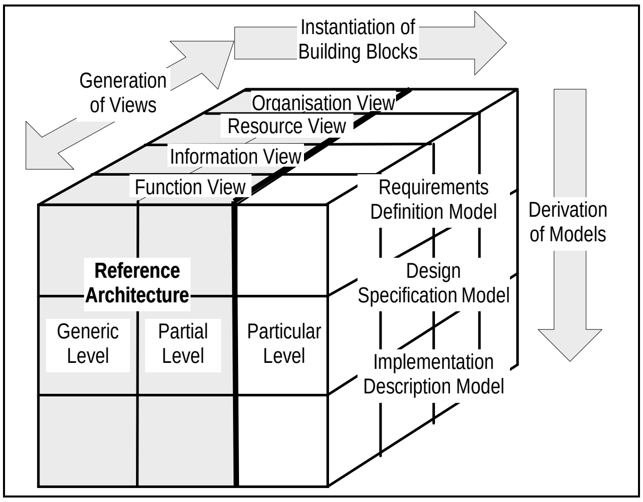

Figure 1. The CIMOSA Modelling Framework

4. CIMOSA MODELLING LANGUAGE

With a set of common building blocks, the CIMOSA Reference Architecture provides the base for evolutionary enterprise modelling. This allows different people to model different areas of the enterprise but provides the integrity of the overall model. Each building block is also expressed in a description template listing the specific attributes.

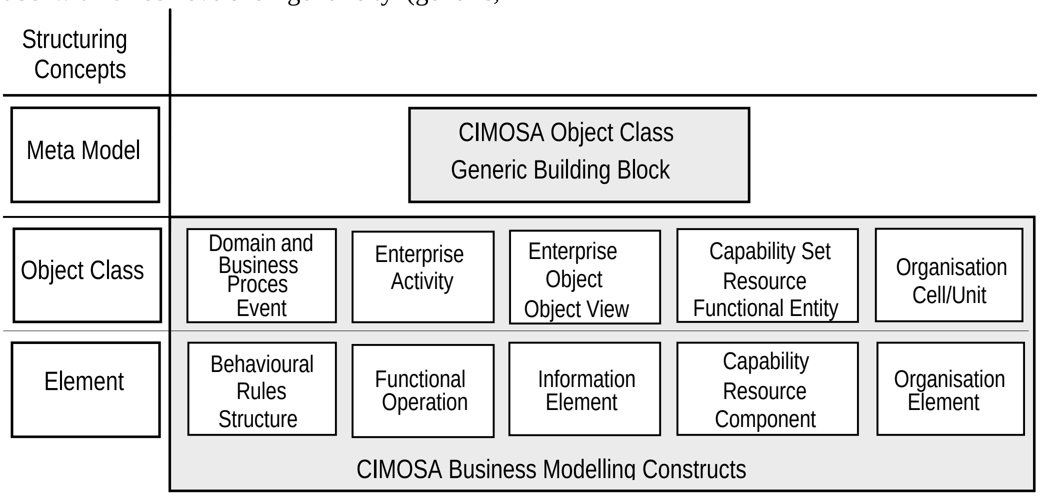

Figure 2. CIMOSA modelling constructs

Figure 2 shows the basic set of CIMOSA constructs for business modelling. The constructs are defined in a class structure, deriving the different business modelling constructs from a meta level Generic Building Block. The constructs Domain/Business Process and Event describe the behaviour of the enterprise, whereas Enterprise

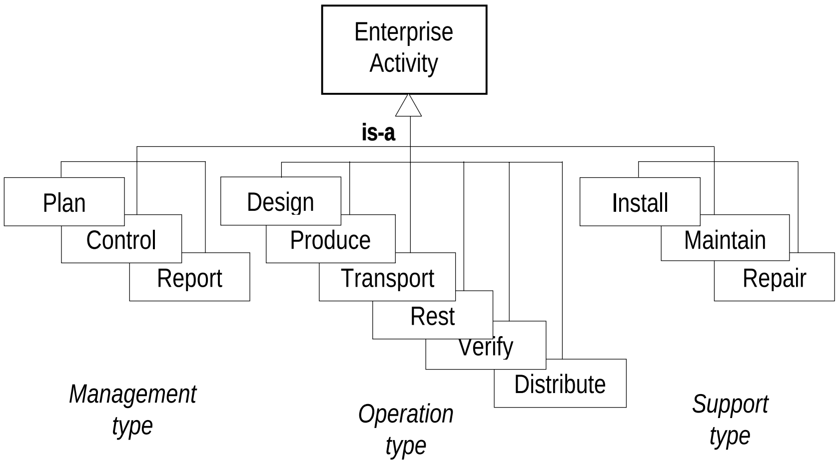

Figure 4. User oriented types of Enterprise Activity

Activity describes the enterprise functionality. Information and resources are described by the Enterprise Objects and Resource constructs. The latter provides the set of capabilities required by the Enterprise Activity. Organisational aspects are described in terms of responsibilities and authorisation for functionalities, information, resources and organisation. They are represented as attributes of Organisational Units e.g. persons or Organisation Cells, for instance departments.

All business-modelling constructs are presented to the user as description templates and in a graphical form. The templates consist of a header part with name, id etc, a body part with the descriptive attributes and a structure part that describes the relations to the other constructs.

The modelling constructs have components or elements which are part of a construct. Behavioural Rule Set defines the flow of control of a Business Process or Domain Process. Functional Operation represents the basic unit of work that is performed by a Functional Entity. The latter may consists of resource components. Information Element provides the atomic, indivisible part of information in an Enterprise Object. The organisation element is the smallest part of an Organisation Unit or its aggregation into an Organisation Cell. Further details are described in the specification. (CIMOSA, 1996)

5. CONSTRUCT TYPES AND TYPE HIERARCHIES

The efficiency of modelling will be significantly improved by using more specialised modelling constructs in addition to the basic constructs described above. The specialisation of constructs also helps the model designer as well as the model user to better understand the content of the model and thereby enhance the use of models in the enterprise operation.

Modelling construct types can be organised into classes according to their nature. CIMOSA defines in its specification (CIMOSA, 1996) a set of such specialised constructs derived from the Enterprise Activity construct (see Figure 4). These activity types define typical generic tasks in the enterprise. Three groups of activity types have been identified, namely management-, operation- and support-oriented activities. Each activity type is characterised by a set of specific attributes with a quantified range of values.

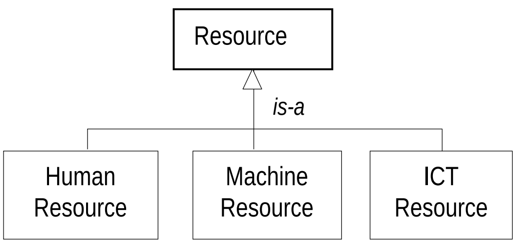

Figure 5. Resource types

Resources Types can also be divided into classes according to their nature. Vernadat (Vernadat, 1996) describes an example of resource taxonomy – the split of resources in humans, devices and applications or manufacturing resources . Manufacturing resources are further separated into operators, machines and tools.

CIMOSA distinguishes three generic types of resources, human, machine and information/ communication technology resources as shown in Figure 5 (CIMOSA, 1996). They are all described by capacity and cost and are characterised by more specific attributes. Human resources have typical attributes defining skills, education or qualification. Machine resources are devised into active resources, being able to perform tasks or passive resources limited to hold and store material or information. ICT Resources are characterised by a set of technology capabilities such as for instance adaptability, connectivity or interoperability.

6. APPLICATION EXAMPLE: MODELLING WITH ACTIVITY TYPES

In an industrial application FIAT has reported (Kosanke, 1994) to employ generic re-usable building block types in the modelling of their gearbox production. They derived 340 Particular functionalities of the Gearbox Assembly System Model from 6 generic basic function types - *move, split, prepare, manage, assemble, produce.* From these building blocks or activity types, 17 partial models or modelling macros of standard function types - like *split order, produce gearbox* etc have been created and reused in the modelling process.

As a result, an increase of modelling productivity by a factor of up to 8 through the use of building block types was achieved. Other tangible business values included the enhancement of the quality of the process analysis, the reduction of the analysis cost and validation lead times and further opportunities for new modelling applications.

7. TOOL EXAMPLE: ACTIVITY TYPES AND ATTRIBUTES

User oriented construct types have been implemented in the modelling tool 'FirstSTEP Designer', a modelling tool that adopts rather closely the CIMOSA modelling concepts and its modelling language. Its modelling constructs are represented by graphical symbols and with description templates (Interfacing, 2000). FirstSTEP defines six activity types *trigger, transform, transport, verify, terminate and distribute.* The activity types are used under different conditions: *Trigger* and *terminate* start and end a process. *Transform* converts material from one state into another state enacted by a resource. *Transport* moves material from one resource to another resource. Verify and distribute split the material flow creating from an input more than one output. Material can occur as physical material or as information.

Table 1 provides an overview of the FirstSTEP activity types and their mandatory attributes. Material defines the material input and output for instance the material status before and after a transform activity. A resource allocated to each activity is needed for the execution of the activity. Time describes the duration of an activity either as a fix time, with a time distribution, with start stop conditions or according to calendars identifying working hours and working days. Rules constrain the application of an activity in a process. Further internal activity rules, like resource and material delays are available. They are not described here in detail and can be found in the technical literature of FirstSTEP

Table 1. Activity types and predefined attributes (Example FirstSTEP Designer)

Activity type / *Predefined Attribute*	Trigger	Transform	Transport	Verify	Distribute	Terminate
Material	Output only	Multiple inputs/outputs	Input only	One input, two outputs	One input, multiple outputs	Output only
Resource	Allocated	Allocated	Allocated	Allocated	Allocated	Allocated
Time	Start/Stop condition	Duration	Duration	Duration	Duration	NA
Rule	Must start a process		Between two resources			Must end a process

NA = not applicable

The list of mandatory attributes completely defines and characterises an activity type distinguishing it from other types. The attributes insure the consistency of activities and the correct placing in the process flow by predefined attributes.

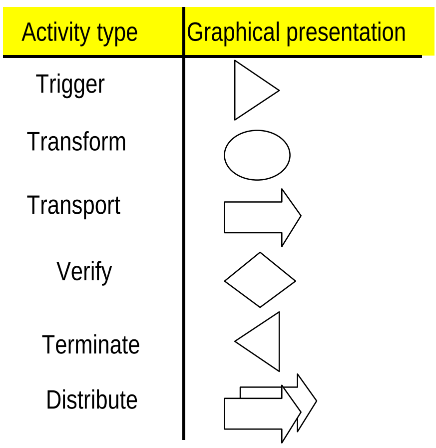

Figure 6. Graphical presentation of activity types - example FirstSTEP

Further, a specific graphical presentation has been assigned to each activity type. Graphical symbols help to better capture the activities in a model and improve the productivity of the modeller during the model design. In addition, a model can be easier understood by selecting appropriate colours for the different activity types. The main processes, functions and resources become immediately clear. Figure 6 shows the FirstSTEP activity types and their graphical presentation.

8. GRAPHICAL PRESENTATION OF CONSTRTUCTS

Today a large number of modelling tools are offered on the market. Each modelling tool is using a particular language with its own set of constructs and an own graphical presentation. Those icons are different though they have the same or similar meaning.

A common modelling language and graphical presentation of the modelling constructs will provide a common understanding of business process models and will thereby improve acceptance and re-use of such models. This is especially important in the area of virtual enterprises. In inter-organisational activities, a common presentation of the model content achieved with standardised icons will lead to a very significant improvement in the model based establishment and operation of virtual enterprises. The productivity of the modeller will be increased during the model design, model maintenance and especially in the case of interoperation with more than one modelling tool.

Table 2 shows a comparison of the graphical representations of constructs of three methodologies: ARIS (Scheer, 1998), CIMOSA (CIMOSA, 1996) and IEM (Jochem, Mertins and Spur, 1996). The constructs are implemented in the respective tools *ARIS*, *FirstSTEP Designer* and *MO^2GO*.

Table 2. Graphical construct presentation

Construct	*ARIS / ARIS* (IDS-Scheer)	*CIMOSA / FirstSTEP* (Interfacing Technologies)	*IEM / MO^2GO* (IPK Fraunhofer)
Activity			
Process			No Symbol
Event			No Symbol
Sequencing Rule	xor		
Domain	Not applicable		Not applicable
Enterprise Object			
Resource	No Symbol		
Organisation Unit			No Symbol
Product, Order	No Symbol	No Symbol	

Straight rectangles or rounded rectangles are used to discriminate between enterprise objects and business processes / activities. Events tend to have special symbols: triangle or hexagon. For the tool *MO^2GO*, the sequencing rules have special symbols according to their functions e.g. *forced*, *distribute*, *unify* etc. *ARIS* deploys symbols for sequencing rules *split*, *join*, *XOR*. Further, construct types can be identified either by inscribed text or by specific colours – as for example *Product*, *Order* and *Resource* in the tool *MO^2GO*.

9. CONCLUSION

Enterprise modelling as a significant step towards enterprise integration has grown from the research area to industrial application and has demonstrated qualitative and quantitative benefits. User oriented languages, methodologies and tools are becoming more and more available and the general use of enterprise modelling becomes feasible.

The presented examples demonstrate significant benefits of easier use and improved modelling performance through the typification of constructs. Still, more work is required to reach agreements in the area of user languages, particularly on construct types, type hierarchies, and attributes as well as on common structure, content and common graphical representation to reduce the complexity for the user. Existing and upcoming standards related to enterprise modelling and targeting model interoperability must be deployed and extended. The challenge in front is to unify the developments supported by standardisation and to transfer the technology into industry.

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