Steps in Enterprise Modelling

a Roadmap

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Abstract: see Quad Chart on page 2

1 INTRODUCTION

Advances in Information Technology have made Enterprise Modelling possible for many enterprises of today. A variety of software tools has appeared in the market, processing power has dramatically increased, modelling architectures have evolved and even matured. Despite such advances however, widespread use of models, as a strategic decision support tool encompassing large industrial sectors, remains unattainable. The working group analysed the current situation, identified major problems and issues as causes and suggested a roadmap for the next steps in Enterprise Modelling.

The following Quad-Chart (Table 1) summarises the work of the group that addressed those requirements. It identifies the approach taken to resolve the issues and proposes a project and ideas for future work for testing and enhancing the proposed solutions.

The original version of this chapter was revised: The copyright line was incorrect. This has been corrected. The Erratum to this chapter is available at DOI: [10.1007/978-0-387-35621-1_43](https://doi.org/10.1007/978-0-387-35621-1_43)

Table 1: Working Group Quad-Chart

<i>EI3-IC Workshop 4 Common Representation of Enterprise Models</i>	<i>Workgroup 1: Steps in Enterprise Modelling: a Roadmap</i>	<i>2002-02-20/22 IPK, Germany</i>
<p>Abstract:</p> <p>Critical issues, which will affect the near future of Enterprise Modelling, include the identification of the modelled enterprise, the role of the user and his requirements in the modelling process and the use of formal methods for semantic mappings between different tools and models. Particular emphasis is placed on the relationship of the user to the model life cycle: the user should be enabled to use current process information in order to evaluate proposed solutions.</p> <p>The working group explored methodologies needed to support user-enabled business process modelling for model based decision support.</p>	<p>Major problems and issues:</p> <ul style="list-style-type: none">– How to convince users of the value of EM?– How to reduce the gap between user expectations towards EM and modelling expert results?– How to enhance the faithfulness of models to the reality and the maintainability of models?– How to enhance EM to enable model based decision support?<ul style="list-style-type: none">– How to guide the user in modelling and evaluating process alternatives?– How to link business-process models to the actual operational data bases of the enterprise?	
<p>Approach:</p> <ul style="list-style-type: none">– Re-define the role of business-process models in the enterprise– Identify the needs of the user for business-process model based decision support– Identify mechanism for mapping different user representations to the underlying common business-process model– Identify mechanism to link the business-process model to the operational data of the enterprise– Discuss the needs for formal underpinning of the common business-process model	<p>Results:</p> <ul style="list-style-type: none">– Established the need for a public view of the business-process model to be the blueprint of the enterprise– Identified a project on user enabled business process modelling directed towards model based decision support aimed to develop the necessary methodologies, user guidance and ICT with focus on system consistency assurance and adaptation of model representation to the users way of thinking <p>Future work:</p> <ul style="list-style-type: none">– Identify the common set of modelling language constructs (e.g. UEMML) from which the representations needed by the different users can be derived– Develop the methodologies to support the users in modelling and evaluating alternatives to the current way of doing business	

2 CURRENT SITUATION

Models provide structure to information generated and manipulated by the enterprise. This structure (model) is, in turn, provided by another more generic structure (language, meta-model) and this again by another, even

more generic, based on definition formalisms. Each of these levels of increasing genericity is executed by humans (actors) to whom specific roles are assigned as parts of the model creation process. To understand the issues affecting modelling today one must address not only the model itself but the actors and the roles (e.g. the process) they play in its creation.

- The lowest level is that of occurrences, themselves divided in two types: those of fully tangible artefacts and happenings (products, performed processes, resources, etc.) and those of less tangible informational artefacts (e.g. data objects in databases).
- The next upper level is that of models. It is usually populated by classes of objects in order to describe the commonalities of a set of occurrences at the level below. Different models can be created and may describe partially overlapping sets of occurrences.
- The next upper level is that of languages: their constructs are instantiated into models lying on the next lower level. Different languages may provide similar but still slightly distinct constructs.
- The uppermost level is generic: it contains definitions of formalisms used to describe the elements of the next lower level, e.g. languages.

Referring to Fig. 1, the actors of the process are shown on the left side of each level. They create, use and modify information according to their roles:

Figure 1: The enterprise model creation process

- Work performers (users): they perform the processes of the enterprise by generating, modifying and destroying instances of products, events, occurrences of business processes, objects such as documents, data through databases etc.
- Enterprise modellers: they analyse, create and modify models and links between them
- Enterprise Modelling Languages (EML) designers: they define syntax, semantics and correspondences between languages.

Modern practice in the creation of enterprise models distinguishes three roles within the above process, performed by different people-actors, namely work performers, modellers and language designers.

Modellers are not work performers, however, meaning that the knowledge of the enterprise they have is rarely as deep as that of work performers. Moreover, it is this knowledge that has to be extracted and validated in order to produce a model. On the other hand, work performers usually have no explicit mental model of their work and therefore no understanding of the consequences of their actions on other parts of the enterprise. A similar, rigid separation of roles exists between language (EML) designers and modellers.

3 MAJOR PROBLEMS AND ISSUES

The result of the allocation of roles being as described in the previous section amounts to modelling errors, imprecise abstractions and model maintenance difficulties. The situation worsens in proportion to the size of the model.

Corresponding problems arise at the language level. Because EML designers are not enterprise modellers, languages often are:

- Too generic for the purpose, causing unnecessary modelling effort
- Insufficient or not adapted to the situation at hand
- Semantically imprecise resulting in differences in understanding between EML designers and enterprise modellers.

From an outside observer's point of view, the model creation processes of today are characterised by a marked deviation between user expectations and actual results produced by the modelling experts.

It is therefore not surprising that users still have to be convinced about the value of enterprise models. The working group considers this to be the central issue facing enterprise modelling today and, to this end, identifies the following steps as being critical to its solution.

- Enhancement of models so that they are faithful to reality and easy to maintain. For this to happen roles in the model creation process must

be brought together: work performers, model experts and EML designers.

- Enhancement of the entire model creation process so as to enable model-based decision support, which relies on actual enterprise data. This calls for competencies on the user side (inclusion and evaluation of process alternatives), as well as the model side, which should be linked to the operational enterprise data bases.

4 APPROACH

The working group believes that the role of business-process models within the enterprise life cycle should be seen under a new light. To draw a parallel, any form of management by humans is based on a mental model of the situation at hand. Our brain can take decisions only when a model of reality (built according to perception, logic, data etc.) is available.

We envisage a similar role for our models of the enterprise: they should not be seen only as a description of some activities but as a true blueprint of the architecture of the entire enterprise in operation; a means of making this architecture explicit and transparent to the users.

4.1 User-enabled modelling

One significant problem area identified so far is the distinct allocation of roles to different actors participating in the model creation process (Fig. 1). Instead, they should be interlinked and partly overlapping.

Starting with the lowest level, there are significant advantages in putting the users in charge of their own model, which can then be a reflection of their superior process knowledge. What needs to be overcome is the alienation caused when they are faced by large complex models.

Although help by experts will always be required, especially at the first stages of drawing a model, users should eventually be able to have full ownership of their modelling domain and full access to its decision support capabilities.

To achieve this, a new model creation process paradigm is required with features, largely not available today, such as:

- A user-defined modelling universe customised to his own domain of interest, such that:
 - It does not limit the expression of his needs
 - It does not lead to inconsistencies and semantic conflict with other users (possibly implemented through sub-typing out of some underlying semantic domain as described in section 4.3 below)

- It supplies a limited set of clearly defined constructs implemented with a similarly equipped modelling language
- It supports user-created new object-types, through a registration and administration process with the underlying semantic domain, thus safeguarding semantic uniformity throughout the entire model
- It adheres to a commonly agreed enterprise ontology to which all semantics and objects used by the various models are anchored (for example, the same person can be used as a resource on one model and an organisation unit on another)
- A set of derivable views on a larger model, adapted to the needs of specific users
- A consistency preservation mechanism between model and enterprise data bases
- A flexible, customisable software support tool

A model creation process with those characteristics does indeed bring together all roles: work performers, modellers and language designers. Users do modelling and language customisation tuned to their needs, thus transversing all three levels of Fig. 1. We use the term *user-enabled modelling* to refer to the new model creation process paradigm.

Finally, although there are significant advantages in bringing power to the users, it must be acknowledged that unification and integration for different models and languages is likely to encounter partly redundant and/or conflicting items.

4.2 Requirements on support technology

User enabled modelling cannot be effective without the support of software technology. We shall briefly refer to the needs of each role in the process in relation to existing products and tools:

- Work performers: tools for creation of occurrences and what-if scenarios. Examples of existing such tools include various DBMS, systems, process control and enactment tools, simulation tools, workflow management systems, etc. A new class of needed tools would be interfaces between models and enterprise data bases so that decision support is based on real operational data.
- Enterprise modellers: tools for model creation, modification and integration. Existing categories of tools, in diminishing order of effectiveness, take care of: enterprise modelling (various in the market), model verification (syntax and consistency checks), CASE, database integration and executable code-generation. New needed support includes tools for: modelling adapted for particular users (i.e. providing an interface tailored to the language chosen by the user), exchange of

models through some import/export facility, model linking and integration platforms and model translators

- EML designers: tools for creation and modification of languages and constructs. The capabilities of existing tools lie in:
 - EML definition and adaptation (generic syntax definition and checking tools such as Lex, Yacc, (Levine, et al, 1992) and (Araatzis, et al, 1995), where an early application of the tools to a model execution prototype is reported
 - Meta-CASE (see Engelbert, 2000 for a survey)
 - Modelling which enables language customisation or extension (see MO²GO, <http://>, Merge, <http://>, Popkin, <http://>)
 - Knowledge modelling environments (e.g. Metis, <http://>)
 - Multi-level modelling environments enabling the definition of meta-models, models and instances in a single setting (e.g. Conceptbase, <http://>)
 - Integration and linking of other modelling tools or CASE tools (e.g. Pohl, 1999)

New capabilities would comprise: generation of dedicated modelling tools and translators for customised EMLs, language integration and linking (consistency checking), meta-models integration, semantics definition and mapping between different EMLs.

4.3 Formal semantics

The semantics of Enterprise Modelling Languages (EMLs) are pinned to real world objects and features; therefore they exist by definition, even in an intuitive form (referred to as “designations” by Jackson (1995), for example). Despite this, the arrival of computing power and modelling tools has pushed for more machine-automated features such as error checking, code generation, simulation, animation etc. To support those, formalisation of semantics is imperative, something which, however, has not been fully achieved, despite the calls from theoreticians. More precisely, although research effort has been present, fragmentation and lack of co-ordination have so far resulted in no widely acceptable definition, unification and resolution mechanisms for the semantics of modelling languages.

Given this state of affairs, the new model creation process paradigm put forward in section 4.1 seems not feasible: interoperability between all types of user-defined modelling universe is a key feature. The problem now appears to be even more complex than before: the notion of semantics is divorced from the notion of language, as each modelling universe may use a subset of the same language but different semantics. Fig. 2 shows a semantics mapping mechanism (to be formally defined) such that:

- An underlying semantic domain exists as a universal enterprise-wide “receptor” pegged to the enterprise ontology
- A semantics composition/decomposition operation is available
- It appears that assigning unique formal semantics to a certain language is rather undesirable. One could assign multiple compatible formal semantics for an EML, thus accommodating different analysis needs. Exchange of models is then taken care of by the Underlying Semantic Domain (Fig. 2).

Figure 2: A semantics mapping mechanism

Finally, an Underlying Semantic Domain cannot be constructed without the existence of a corresponding Underlying Domain Theory. This could provide mapping mechanisms to a corresponding underlying language such as the proposed Universal Enterprise Modelling Language (UEML) (Petit, et al, 1997) and also be used as a representation of the enterprise ontology. Capabilities on abstraction, unification and universality should be present in the mathematical framework of such a theory (Kotsiopoulos, 2002).

5 CONCLUSIONS AND FUTURE WORK

The working group has reviewed the enterprise modelling scene of the last five years and has identified the need for a public view of the business-process model as a blueprint of the enterprise. The new model creation process paradigm needed is epitomised in the following call for research and development.

5.1 Project Proposal: User Enabled Process Modelling

Rational: The need for model based operational decision support requires process models to be modified for representation of potential solutions to the problem to be solved. The optimal source for such potential solution is the

person responsible for the business process under consideration. Therefore, he has to be enabled to do the required model modifications himself.

However, such decisions can only be made if the model represents reality not only by representing the current structure of the process, but also by using current process information in the evaluation of the proposed solutions. The model has to be linked to the data bases of the process.

Objectives: To develop the necessary methodologies, user guidance and ICT support for user enabled process modelling with focus on system consistency, assurance and adaptation of model representation to the users way of thinking.

Future directions along this line of work have been identified as:

- The establishment of a common set of modelling language constructs (e.g. such as those to be provided by UEML, (Jochem, 2002)) and semantics from which the representations needed by the different users can be derived
- The development of methodologies to support users in modelling and evaluating alternatives to the current way of doing business

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