Advanced modelling for e-learning platforms

EDUARD A. STOICA,
Communication Centre,
Lucian Blaga University of Sibiu,
Str. Victoriei 10, 550024,
Sibiu, ROMANIA

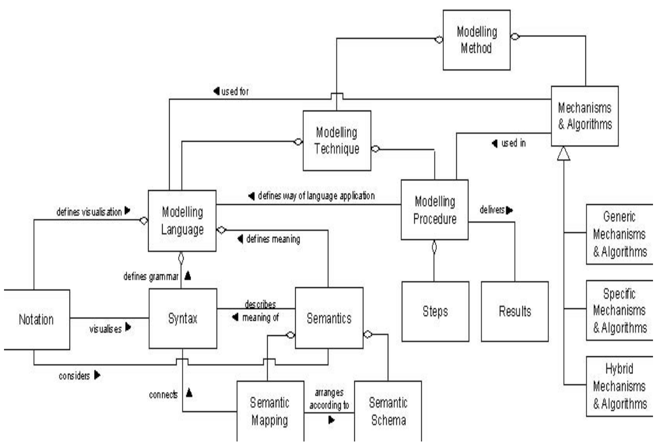
BOGDAN A. BRUMAR,
Department of Computer Science,
Lucian Blaga University of Sibiu,
Faculty of Sciences
Str. Dr. Ion Ratiu 5-7, 550012,
Sibiu, ROMANIA

Abstract: - The state-of-the-art in the area of modelling of organisations is based on fixed metamodels. This paper gives an introduction into metamodelling concepts and presents a generic architecture for metamodelling platforms. Three best practice examples from industry projects applying metamodelling concepts in the area of business process modelling for e-business, e-learning, and knowledge management are presented. Due to rapid changing business requirements the complexity in developing applications which deliver business solutions is continually growing. To manage this complexity, environments providing flexible metamodelling capabilities instead of fixed metamodels has shown to be helpful. The main characteristic of such environments is that the formalism of modelling -the metamodel -can be freely defined and therefore be adapted to the problem under consideration. Finally, an outlook to future developments and research directions in the area of metamodelling is given.

Key-Words: - knowledge-management, metamodelling approaches, metamodelling architecture, mechanism, e-learning.

1 Introduction

Modelling methods consists of two components: a modelling technique, which is divided in a modelling language and a modelling procedure, and mechanisms & algorithms (shorten: mechanisms) working on the models described by the modelling language (see figure 1). The *modelling language* contains the elements, with which a model can be described. A modelling language itself is described by its syntax, semantics, and notation. The *modelling procedure* describes the steps applying the modelling language to create results, i.e. models. In this paper we define a metamodel as a model of a modelling language. Applying language theory for levelling languages, the result is a hierarchy of languages, meta-languages etc. The hierarchy of the corresponding models, metamodels etc. is described in next section. This gives a short overview of the definition of metamodelling approaches and last section describes different roles in metamodelling. This is fig.1-Components of modelling methods :



2 Modelling Hierarchy. Roles in metamodelling.

The creation of a metamodel is also done by using a modelling language. This modelling language is called the *metamodelling language*. The model defining the metamodelling language is the meta-metamodel or *meta*^{2}*-model*.

Building language levels is not limited to a certain level. To "finish" the modelling hierarchy, it is important to find a useful level of abstraction. To use concepts such as "thing", "property" and "relation" may be helpful, but lack of semantics especially if the language of the "finishing" level should provide the foundation for implementing the lower levels. In practice a four layer metamodel architecture is widely used such as shown in figure 3 [e.g. 2, 4, 5, 9, 11]. The lowest level is the original, from which a model is build on the second level. Often the lowest level is seen as runtime data, but we prefer to use the expression "original" because its not always runtime data from which a model is build. The highest level in the four layer architecture is the meta^2-level, which describes the concepts for building metamodels.

Considering the elements of a modelling method described in figure 1, different roles in administering and using such platforms can be distinguished.

The *method engineer* is responsible for a consistent and properly defined modelling method. Additional to his technical skills, the method engineer often has professional skills in an application domain. Application domains can be divided into verticals such as financial services, telecommunications, public administration, and manufacturing and horizontals such as business process modelling, application development, workflow management, and knowledge management.

The *language engineer* defines the modelling language. He is responsible for an adequate definition of the syntax, semantics, and notation.

The *process engineer* is responsible for the definition of the modelling procedure. Often the process engineer is an expert in applying modelling languages and has considerable experiences in project management and project execution.

The *tool engineer* configures the mechanisms of a metamodelling platform for particular metamodels. If additional mechanisms are needed, he is the responsible for implementing these mechanisms.

The *infrastructure engineer* provides the necessary IT infrastructure to run a metamodelling platform and to integrate the platform into existing infrastructures.

The *method user* applies the modelling method by using the platform. He creates models by using the modelling language, following the modelling procedure and applying the available mechanisms.

3 E-Learning

The *ADVISOR* project, which was finished in the year 2000, dealt with *new ways of learning and training methods* in the field of business process re-engineering in the insurance sector and was the successor of REFINE [11]. Frequent changes in business processes, resulting from new products and the adaptation of existing products to new market situations, require tool-based methods in order to provide individuals and teams quickly with the appropriate information for their tasks. In addition, measures for (re-)training staff should be derivable as quickly as possible. In order to capitalise on employees' knowledge, creativity and experience, they should be enabled to provide input to their company's knowledge in a systematic and motivating manner. Starting from these business needs, three main issues were addressed in the ADVISOR project:

a. Improved access for employees to company and performance related information

b. rapid, semi-automatic production of training materials

c. knowledge acquisition for organisational learning.

The first objective of ADVISOR was to provide methods and tools which allow for a holistic approach to information access, training and learning by closely coupling business re-engineering measures with training/learning measures. The second objective was to improve upon the psychological and organisational measures which are necessary to change the attitude towards continuous learning and to lead to better acceptance of new technology and processes. Both objectives were realised on three levels of learning: individual, team, and organisation.

In order to realise these objectives, the project built upon existing business process management methods and tools, which were extended by metamodelling in order to specify information and training needs for employees and to capture employees' experiences with business procedures and training measures. Extensive trial studies with and formative evaluation of the extended technology in the insurance companies accomplished the second main objective.

4 Knowledge Management

There is a significant gap between the importance of knowledge management and the realisation on all levels in an organisation: There are many surveys that show that knowledge management is recognized as a management task with high priority. When looking at concrete projects and initiatives, however, knowledge management receives much less attraction. Lack of time is a main reason that knowledge workers mention when asked why they do not support knowledge management.

To overcome these barriers the *PROMOTE* project [12], which will has finished in autumn 2002 with two industrial trial cases, provides solutions to two

critical challenges of knowledge management:
a. *integration with the operational business:* knowledge management tasks are associated with knowledge-intensive activities in business processes
b. *providing access to available knowledge:* explicit graphical knowledge structures help to get an immediate overview of available knowledge.

PROMOTE is a process-oriented and metamodelling-based approach to knowledge management using the concept of a flexible organisational memory information system to store relevant information and provide pointers to people with relevant know how. Within the project a modelling language was designed to deal with the above-mentioned content and context characteristics. Amongst others, the modelling language contains:

- *Topic maps* which are semantic networks consisting of knowledge objects (topics) and relations between them. A graphical representation of topic maps helps a knowledge seeker to navigate in the organisational memory. If, for instance, he is looking for knowledge about cancer, a medical topic map shows all the related topics like smoking etc. Thus the knowledge seeker gets hints about relevant knowledge he/she did not think of.
- *Skill models* relate topic maps to people and represent the skill status of a particular person with respect to topics in a topic map.
- *Process models* represent the work context. Knowledge objects and people can be associated to knowledge-intensive activities via so-called knowledge processes.

Using a metamodelling approach, time and implementation costs were saved. Additionally, the resulting modelling languages are highly applicable and accepted because of repeated adaptations after several quality reviews.

5 Metamodelling Approaches

There exist various metamodelling approaches, different in richness of concepts and ranging from conceptual proposals to already implemented products. In the following, some of them will be illustrated briefly.

Atkinson proposes a modelling hierarchy aligned with the MOF hierarchy [5]. The focus is modelling in the area of distributed object systems. Atkinson stresses the dichotomy of “class” and “instance” which occurs changing the language level and proposes requirements for metamodelling approaches.

Frank proposes within his *MEMO* approach (“multi perspective enterprise modeling”) a three level modelling hierarchy. Based on this hierarchy a modelling framework with the same named is suggested [6].

The *Resource Description Framework (RDF)* provides a modelling hierarchy for semantic networks. The foundation of RDF is build by three object types (“resource”, “property” and “statement”) for representing named properties and property values.

The *CASE Data Interchange Format (CDIF)* is based on a four level model architecture [7]. CDIF is a standard designed for the exchange of CASE models between tools of different tool providers. CDIF is not be further developed but major parts of the concepts influence the design of other metamodelling approaches such as the Meta Object Facility (MOF).

The *MOF* is a infrastructure for managing meta information [8]. Conceptually, MOF can be divided into two major parts: (a) the definition and maintenance of meta information based on a four level modelling hierarchy and (b) specifications of interfaces to access the metainformation within a distributed environment.

The *General Modeling Environment (GME)* is based on a four level modeling architecture. In [9] general metamodelling requirements and a approach of model integrated computing (MIC) is proposed.

The *MétaGen* system distinguish a “user metamodel” and a “implementation metamodel”. Based on transformation rules between these metamodels, the system development should be more aligned with the requirements definition [10].

Kühn et al. propose a four level modelling hierarchy [4].

Another commercial product is the metaCASE tool *MetaEdit+* from MetaCase Consulting. MetaEdit+ is a configurable CASE tool, based on a metamodelling approach.

6 Conclusion

Metamodelling concepts and metamodelling platforms are getting more and more an *integral part of business engineering* strategies and approaches. Prominent examples are the international standards UML and MOF, which are both based on a four level metamodelling approach [8]. In addition, this trend is underpinned by metamodelling products already available such as ADONIS or MetaEdit+

[3]. The *major advantages* from out experiences using flexible metamodel approaches instead of approaches using fixed metamodels are considerable savings in time and costs in application development, increased quality of delivered solutions, and enhanced acceptance because of directly mapping the domain under consideration.

Nevertheless, metamodelling is still a very challenging field for innovative future developments and essential research activities. Some of the developments and research directions we are expecting are:

- *Integration and interoperability:* The integration of heterogeneous systems to interoperable systems is part of enterprise application integration (EAI) efforts. In addition to technical integrations, the systems have to be integrated on a semantically level. Coordinated metamodels, integration of ontologies, and enterprise model integration (EMI) give rise to further research.
- *Semantic Web:* The vision stated by Berners-Lee [11] aims at developing languages for expressing information in the WWW in a machine understandable form. Currently, most information in the Web is for human consumption. Promising efforts such as RDF are based on metamodelling concepts.
- *Model-driven Business Engineering:* Managing organisations and developing large enterprise applications causes complex interdependencies between different parts of organisations and applications. Often these parts are managed and realized by using different technologies and, if any used, different modeling environments. Chaining models for business, development and evaluation ("straight through business engineering") to measure and control business decisions based on operational data generated by business applications is of vital research interest.
- *Combination of modelling paradigms:* Modelling paradigms used in the IS development field are mostly descriptive. Other paradigms such as decision support models and predictive models are often used focusing on the business domain. We expect strong interest in combining these approaches by metamodelling to form new possibilities in enterprise management and development.
- *Language Engineering:* The definition of "good" modelling languages and their implementation in helpful software support still need a lot of experience and knowledge. To capture these experiences, patterns could be an appropriate formalism. E.g. the current definition of semantics of modelling languages is either informal, and therefore often error prone and not directly understandable by machines, or formal, i.e. very time-consuming and expensive. In this area we are expecting improvements by interdisciplinary research.

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