Preface

Although enterprise modeling as a discipline is relatively young, enterprises have been using models to describe their business for quite some time. A business plan, for example, can be seen as a first-draft model of a business yet to be founded. And already at this early stage, we need something tangible to go upon: Potential investors and banks want to know about the chances and the risks of this new endeavor. Government agencies require some information in this model for deciding on approval. Likewise, business associates and top-level managers are interested in such a model. During a company's life, many more models come into play, very often in the context of planning situations: Production plans, marketing plans, project plans, personnel schedules, organizational charts, and so on. Enterprise modeling adds to those only two new aspects: comprehensiveness and integration. Comprehensiveness means that the set of all enterprise models covers the whole enterprise, that is, allows us to see the business from all relevant perspectives. Integration forces us to make sure that the models form a network of tightly coupled units that support each other. For example, if two models represent different views on an enterprise but overlap partially, that is, they contain descriptions of the same part of reality, then the overlapping parts should be consistent with each other, that is, the two descriptions must coincide.

Achieving comprehensiveness and integration in modeling is an ambitious task, and for many companies enterprise modeling is therefore rather a vision than reality. But the development towards that vision is driven by real forces. These forces have their origin in a changing economic environment that requires companies to respond at such a pace that change has become a constant process rather than an occasional endeavor. Among these changes is the increasing complexity of products and services that leads to value networks that mirror this complexity. Increased product complexity is in turn the result of any of the following factors (or a combination thereof):

- Technological advancement
- Additional product features
- New combinations of services
- Additional product-related services
- New or improved services
- Aggregated products

In other words, in order to provide an "attractive" package of complementing products and services to the market, enterprises often have to join forces because they cannot manage the inherent complexity of that task themselves. They do so by forming value networks, that is, by collaborating closely in a way that goes beyond the traditional value chain. These networks are relatively instable. They are formed, restructured, and abandoned to adapt to the changing needs of the market. For each organization in such a network, this has, naturally, a substantial impact on almost all aspects of their business. Changing supplier relations affect procurement processes; changing customer relations affect sales and marketing. In the same way, changing characteristics of products and services affect production and service provision.

Managing organizational changes of that magnitude requires a new form of knowledge. This knowledge is organized in a discipline called enterprise engineering (Davenport & Short, 1990; Fox, Gruninger, & Zhan, 1994; Gustas & Gustiene, 2004; Jochem, 2002). It provides the methods and tools to align the business processes with the strategic goals of the organization and the requirements posed by network partners. Like in other engineering disciplines, blueprints of the system to be engineered are at the heart of enterprise engineering. These blueprints, called models, are a prerequisite of any engineering activity such as the design of a new organization or the redesign of an existing one. They are provided by a discipline called enterprise modeling (Barrios & Nurcan, 2004; Fox, 1994; Fox, Barbuceanu, & Gruninger, 1996; Fox, Barbuceanu, Gruninger, & Lin, 1998; Fox & Gruninger, 1998; Gruninger & Fox, 1996; Jureta & Faulkner, 2005; Liles & Presley, 1996; Shinkawa & Matsumoto, 2001). Enterprise modeling provides a number of potential benefits such as better understanding of the enterprise, support for information systems development, more flexibility in organizational design, and a solid foundation for reorganizing the business.

According to ATHENA (2004), enterprise modeling can be structured in three parts:

•   Enterprise frameworks and architectures
•   Enterprise modeling languages
•   Other approaches by industrial initiatives, standardization bodies, and organizations working on enterprise modeling concepts

An enterprise framework is "a fundamental structure which allows defining the main sets of concepts to model and to build an enterprise" (ATHENA, 2004). Some frameworks are used for integrating enterprise modeling, others for integrating enterprise applications. Among the frameworks that address integrated enterprise modeling are

•   The **Zachman** Framework (Sowa & Zachman, 1992; Zachman, 1987)
•   The **GERAM** (generalised enterprise reference architecture and methodology) Framework (Bernus & Nemes, 1996)
•   The **GRAI** (graphs with results and activities interrelated) Framework (Chen & Doumeingts, 1996; Doumeingts, Vallespir, & Chen, 1998)
•   The **ARIS** (achitecture of integrated information systems) Framework (Scheer, 1999a, 1999b)
•   The **CIMOSA** (computer integrated manufacturing open systems architecture) Framework (ESPRIT Consortium AMICE, 1993; Zelm, 1995)
•   The **DoDAF** (Department of Defense architecture framework) Architecture Methodology (DoD, 2003a, 2003b)

- TOGAF (The Open Group architecture framework) Architecture Methodology (Open Group, 2005)
- AKM (active knowledge modeling) (Lillehagen & Krogstie, 2002)

Frameworks for enterprise application integration include ISO 15745 (ISO, 2003b) and MISSION (Popplewell, Harding, & Rabe, 2001). Enterprise modeling languages are languages that allow us to express knowledge about an enterprise in an explicit, semiformal way. It is done with the help of models that capture this knowledge in a diagrammatic and/or textual form. The knowledge concerns organization and operations of the enterprise, that is, processes, behavior, activities, information, objects, material flows, resources and organizational units, system infrastructure, and architecture. The models describe the enterprise from different points of view such as functional, process, data, and economic. Examples of enterprise modeling languages are:

- **IEM:** Integrated enterprise modelling (Mertins & Jochem, 1999; Spur, Mertins, & Jochem, 1996),
- **Metis ITM, BPM, and UML** (Lillehagen, Dehli, Fjeld, Krogstie, & Jørgensen, 2002)
- **PN:** Petri nets (Aalst, Desel, & Oberweis, 2000)
- **CIMOSA:** Computer integrated manufacturing open systems architecture (ESPRIT Consortium AMICE, 1993)
- **GRAI:** Graphs with results and activities interrelated (Chen & Doumeingts, 1996; Doumeingts et al., 1998)
- **IDEF:** Integrated DEFinition (Menzel & Mayer, 1998)
- **PSL:** Process specification language (ISO, 2003a)
- **XPDL:** XML process definition language (Shapiro, 2005)
- **UML-EDOC:** UML profile for enterprise distributed object computing specification (OMG, 2004a)
- **UML-EAI:** UML profile for enterprise application integration (OMG, 2004b)
- **ebXML:** Electronic business eXtensible markup language (http://www.ebxml.org)
- **PIF:** Process interchange format (Lee, Yost, & PIF Working Group, 1994)
- **UEML:** Unified enterprise modeling language (Vernadat, 2002)
- **BPDM:** Business process definition metamodel (OMG, 2004d)
- **BPMN:** Business process modeling notation (OMG, 2004c)

As enterprise modeling is of significant interest to many industries, they have formed their own consortia and initiatives to establish industry standards. Many of the conventional standardization bodies are also involved in that work. The following is a noncomprehensive list of relevant organizations:

- **BPMI:** Business Process Management Initiative (now part of OMG)
- **WfMC:** Workflow Management Coalition
- **OAG:** Open Applications Group
- **OASIS:** Organization for the Advancement of Structured Information Standards
- **UN/CEFACT:** United Nations Centre for Trade Facilitation and Electronic Business
- **RosettaNet** (http://www.rosettanet.org)
- **W3C:** World Wide Web Consortium
- **OMG:** Object Management Group

Standards that concern enterprise modeling include:

- **EN/ISO 19439:** Enterprise integration — Framework for enterprise modeling
- **EN/ISO 19400:** Enterprise integration — Constructs for enterprise modeling
- **CEN TS 14818:** Enterprise integration — Decisional reference model
- **ISO CD 18629:** Process specification language (PSL)
- **ISO 15704:** Requirements for enterprise architecture and methodologies
- **ISO 14258:** Concepts and rules for enterprise models
- **ISO/IEC 15414:** Open distributed processing — Reference model — Enterprise language

The large number of methods and languages listed in the previous paragraphs represent only a fraction of available enterprise modeling options. In the face of this overwhelming multitude, it is not surprising that some proponents suggest the use of a single, standardized modeling language such as the unified modeling language (UML). But the diversity of approaches to enterprise modeling is not so much a sign of the immaturity of the field as an expression of its extraordinary complexity. An enterprise can be viewed from many angles and at the same time, we can focus on different facets of the enterprise. Any combination of angles and facets will yield a different methodology, each of them equally justifiable. Nevertheless, we cannot afford to maintain an almost infinite repertoire of methodologies from which the enterprise engineer selects the most appropriate one for the task at hand. This would imply that different tasks within the same enterprise might be performed with different methodologies, so that the whole enterprise would have to be modeled again from scratch for each new task. In such a situation, it is more feasible to develop an extensible set of integrated language components for each modeling purpose. The UML can play an important integrative role in this context.

The common factor of all enterprise modeling approaches is that they view the enterprise as a system where the information system is a subsystem of that system. The information system is that part of the overall system of the enterprise that collects, stores, administrates, processes, and retrieves information required for operating the business. Both systems are so tightly coupled that none of them can be seriously studied in isolation. This means that a modeling language for information systems must take into account enterprise modeling issues. And by the same argument, enterprise modeling cannot neglect the information system. As mentioned before, one of the major reasons for modeling an enterprise is precisely that the models can support us in developing or improving the information system.

While enterprise modeling is characterized by a multitude of approaches, information systems modeling is largely dominated by only one language: UML. This, and the fact that enterprise modeling and information systems modeling are so closely related, leads many to believe that the UML should also play a major role in enterprise modeling. The purpose of this book is to investigate this issue. To do so, we have divided the book into sections that deal with different approaches to it:

- Section I: UML Extensions for Enterprise Modeling
- Section II: UML as Meta-Language for Enterprise Modeling
- Section III: Enterprise Modeling Frontends for UML
- Section IV: Applying UML in Enterprise Modeling
- Section V: Quality and Consistency in Enterprise Modeling

The chapters in the first section start from the assumption that the UML itself can be used to model the whole enterprise when we extend the language in a suitable way. Specifically for this purpose, the UML provides a number of extension mechanisms such as stereotypes and profiles. There are three chapters in that section. Lars Bækgaard's chapter, "Extending UML to Support Business Activity Modeling," extends UML's activity diagrams by an important concept for business process modeling, that is, events. The second chapter, "Modeling and Specification of Collaborative Business Processes with an MDA Approach and a UML Profile," is written by Pablo David Villarreal, Enrique Salomone, and Omar Chiotti. It proposes a UML profile that can be used to model collaborative processes. The third and final chapter of this section investigates the user requirements notation (URN): "Enterprise Modeling with the Joint Use of User Requirements Notation and UML" by Anna Medve. The URN is a UML extension that supports requirements analysis.

The second section subsumes approaches that employ the UML as a metalanguage, which is, as a language for defining other, more specific languages for enterprise modeling. The first chapter in Section II, "Enterprise Architecture Modeling with the Unified Modeling Language" by Pedro Sousa, Artur Caetano, André Vasconcelos, Carla Pereira, and José Tribolet, specifies a language to describe the architecture of an enterprise based on the UML. Stefan Dietze does the same to arrive at a language for modeling software development processes. The title of his chapter is "Adaption of the UML to Formalized Software Development Process Assessment and Modeling: Dedicated Metamodel and Case Study." The final chapter in this second section, "Enterprise Modeling with ODP and UML," is written by the team of Sandy Tyndale-Biscoe, Antonio Vallecillo, and Bryan Wood. They make use of UML as a metalanguage for expressing enterprise viewpoint specifications of the reference model of open distributed processing (RM-ODP).

The third section, "Enterprise Modeling Frontends for UML" represents a fundamentally different approach. The two chapters in this section deny that the UML, as such, is sufficient for enterprise modeling, even if we allow for certain extensions and alterations. They claim that we need completely different types of languages because of differences in the natures of enterprises and information systems, respectively. The enterprise modeling language in this scenario functions as a kind of front-end for the system design in UML. A suitable procedure has to be established that helps with "translating" enterprise models into information system models. The first chapter in this section, "A Language-Action Approach to the Design of UML Models" by Peter Rittgen, describes such a (semiformal) procedure for a particular enterprise modeling language, dynamic essential modeling of organization (DEMO). The second chapter studies the differences between enterprises and information systems that we have mentioned, by comparing the characteristics of the metamodels of business action theory and the UML. The authors identify the conceptual deficiencies of the UML with respect to enterprise modeling, and thereby support the necessity of a separate enterprise modeling language. The title of the chapter is "Using UML Notation for Modeling Business Interaction," and it is written by Sandra Haraldson, Mikael Lind, and Jan Olausson.

The fourth section, "Applying UML in Enterprise Modeling," subsumes papers that apply the UML as it is in an enterprise modeling context. The first chapter of this section, "Using UML for Reference Modeling" by Peter Fettke, Peter Loos, and Jörg Zwicker investigates the suitability of the UML for reference modeling. Reference modeling implies the (re)use of existing (standard) models with the aim of improving the quality of new models and reducing the costs of developing them. The second chapter, "Modeling the Resource Perspective of Business Processes by UML Activity Diagram and Object Petri Net" by

Kamyar Sarshar and Peter Loos, employs activity diagrams to model the resources of a business processes and compares them to object petri nets.

The fifth and final section addresses issues of "Quality and Consistency in Enterprise Modeling" with UML. Herman Balsters opens this section with a chapter on "Merging and Outsourcing Information Systems with UML." This chapter suggests how models of businesses can be merged when the corresponding businesses have likewise been merged, or how the models can be split if a part of a business is to be outsourced to another business. This is achieved by so-called view transformations that are aimed at ensuring model consistency. András Pataricza, András Balogh, and Lázló Gönczy contribute the final chapter, "Verification and Validation of Nonfunctional Aspects in Enterprise Modeling." They take up the issue of model quality in general, and dependability in particular.

Together, the five sections and 12 chapters offer a fairly broad set of perspectives on the topic of enterprise modeling. The book is a joint effort of 27 scholars and practitioners from around the globe. We hope that our readers, whether they may be academics or practitioners, can benefit from this comprehensive view, and that the book provides them with helpful insights into the dynamic field of enterprise modeling. We firmly believe in the importance of enterprise modeling and engineering as major tools for creating and maintaining competitive advantage in today's and tomorrow's cutting-edge enterprises, in line with the "old" saying: If you can't model it, you can't manage it!

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