

# Innovations in Information Systems Modeling: Methods and Best Practices

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## **Section I Conceptual Information Modeling**

### **Chapter I**

Enriched Conceptualization of Subtyping

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When modeling information systems, one often encounters subtyping aspects of the business domain that can prove challenging to implement in either relational databases or object-oriented code. In practice, some of these aspects are often handled incorrectly. This chapter examines a number of subtyping issues that require special attention (e.g. derivation options, subtype rigidity, subtype migration), and discusses how to model them conceptually. Because of its richer semantics, the main graphic notation used is that of second generation Object-Role Modeling (ORM 2). However, the main ideas could be adapted for UML and ER, so these are also included in the discussion. A basic implementation of the proposed approach has been prototyped in Neumont ORM Architect (NORMA), an open-source tool supporting ORM 2.

### **Chapter II**

Essential, Mandatory, and Shared Parts in Conceptual Data Models

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This chapter focuses on formally representing lifecycle semantics of part-whole relations in conceptual data models by utilizing the temporal modality. This chapter approaches this by resorting to the temporal conceptual data modeling language ERVT and extend it with the novel notion of status relations. This enables a precise axiomatization of the constraints for essential parts and wholes compared to mandatory parts and wholes, as well as introduction of temporally suspended part-whole relations. To facilitate usage in the conceptual stage, a set of closed questions and decision diagram are proposed. The long-term objectives are to ascertain which type of shareability and which lifetime aspects are possible for part-whole relations, investigate the formal semantics for shareability, and how to model these kind of differences in conceptual data models.

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This chapter will extend the ORM conceptual modeling language with constructs for capturing the relevant parts of an application ontology in a list of concept definitions. It will give the adapted ORM meta model and provide an extension of the accompanying Conceptual Schema Design Procedure (CSDP) to cater for the explicit modeling of the relevant parts of an application- or domain ontology in a list of concept definitions. The application of these modeling constructs will significantly increase the perceived quality and ease-of-use of (web-based) applications.

## **Section II Modeling Approaches**

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EKD: An Enterprise Modeling Approach to Support Creativity and Quality in Information  
Systems and Business Development

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*Anne Persson, University of Skovde, Sweden*

This chapter presents experiences and reflections from using the EKD Enterprise Modeling method in a number of European organizations. The EKD modeling method is presented. The chapter then focuses on the EKD application in practice taking six cases as an example. Our observations and lessons learned are reported concerning general aspects of Enterprise Modeling projects, the EKD modeling language, the participative modeling process, tool support, and issues of Enterprise Model quality. It also discussed a number of current and emerging trends for development of Enterprise Modeling approaches in general and for EKD in particular.

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This chapter discussed how an Enterprise Modeling approach, namely C3S3P, has been applied in an automotive supplier company. The chapter concentrates on the phases of the C3S3P development process such as Concept Study, Scaffolding, Scoping, and Requirements Modeling. It also presents the concept of task pattern which has been used for capturing, documenting and sharing best practices concerning business processes in an organization. Within this application context the authors have analyzed their experiences concerning stakeholder participation and task pattern development. They have also described how they have derived four different categories of requirements from scenario descriptions for the task patterns and from modeling of the task patterns.

## **Chapter VI**

Methodologies for Active Knowledge Modeling

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Innovative design is the most important competitive factor for global engineering and manufacturing. Critical challenges include cutting lead times for new products, increasing stakeholder involvement, facilitating life-cycle knowledge sharing, service provisioning, and support. Current IT solutions for product lifecycle management fail to meet these challenges because they are built to perform routine information processing, rather than support agile, innovative work. Active Knowledge Modeling (AKM) provides an approach, methodologies, and a platform to remedy this situation. This chapter describes the AKM-approach applied by manufacturing industries and consultants to implement pragmatic and powerful design platforms. A collaborative product design methodology describes how teams should work together in innovative design spaces. How to configure the AKM platform to support such teams with model-configured workplaces for the different roles is described in the visual solutions development methodology. The use of this approach is illustrated through a case study and is compared with related work in the enterprise modeling arena to illustrate the novelty of the approach

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Class Diagrams and Use Cases

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In the analysis phase of the information system development, the user requirements are studied, and analysis models are created. In most UML-based methodologies, the analysis activities include mainly modeling the problem domain using a class diagram, and modeling the user/functional requirements using use cases. Different development methodologies prescribe different orders of carrying out these activities, but there is no commonly agreed order for performing them.

In order to find out whether the order of analysis activities makes any difference, and which order leads to better results, a comparative controlled experiment was carried out in a laboratory environment. The subjects were asked to create two analysis models of a given system while working in two opposite orders. The main results of the experiment are that the class diagrams are of better quality when created as the first modeling task, and that analysts prefer starting the analysis by creating class diagrams first.

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OntoFrame: An Ontological Framework for Method Engineering.

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A large number of strategies, approaches, meta models, techniques and procedures have been suggested to support method engineering (ME). Most of these artifacts, here called the ME artifacts, have been constructed, in an inductive manner, synthesizing ME practice and existing ISD methods without any theory-driven conceptual foundation. Also those ME artifacts which have some conceptual groundwork have been anchored on foundations that only partly cover ME. This chapter presents an ontological framework, called OntoFrame, which can be used as a coherent conceptual foundation for the construction, analysis and comparison of ME artifacts. Due to its largeness, the article here describes its modular structure composed of multiple ontologies. For each ontology, this article highlights its purpose, sub-domains and theoretical foundations. It also outlines the approaches and process by which OntoFrame has been constructed and deploy OntoFrame to make a comparative analysis of existing conceptual artifacts.

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A process-oriented framework (QoMo) is pre-sented that aims to further the study of analysis and support of processes for modelling. The framework is strongly goal-oriented, and expressed largely by means of formal rules. The concepts in the framework are partly derived from the SEQUAL framework for quality of modelling. A number of modelling goal categories is discussed in view of SE-QUAL/QoMo, as well as a formal approach to the description of strategies to help achieve those goals. Finally, a pro-totype implementation of the framework is presented as an illustration and proof of concept.

## **Chapter X**

Service Oriented Architecture: A Research Review from the Software and Applications  
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*John Erickson, University of Nebraska-Omaha, USA*

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This chapter presents the basic ideas underlying Service Oriented Architecture as well as a brief overview of current research into the phenomena also known as SOA. SOA is defined, and principal components of one proposed SOA framework are discussed. The more relevant historical background behind the move toward SOA is presented, including SOA antecedents such as Web Services, SOAP, and CORBA, and enabling technologies such as XML and EJB. A basis for understanding SOA is presented, based on Krafzig, Banke, and Slama's (2005) three-level hierarchical perspective. The common SOA components including UDDI, Application Programming Interface, Service Bus, Service Contract, Interface, Implementation, Data, and Business Logic are also presented. Finally, relevant research in four categories is presented, including implementation strategies, patterns and blueprints, tool development, standards proposals or modifications (including middleware), and ontological or meta-model development or modification.



## Chapter XI

Designing Web Information Systems for a Framework-Based Construction

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In the Web Engineering area, many methods and frameworks to support Web Information Systems (WISs) development have already been proposed. Particularly, the use of frameworks and container-based architectures is state-of-the-practice. This chapter presents a method for designing framework-based WISs called FrameWeb, which defines a standard architecture for framework-based WISs and a modeling language that extends UML to build diagrams that specifically depict framework-related components. Considering that the Semantic Web has been gaining momentum in the last few years, this chapter also proposes an extension to FrameWeb, called S-FrameWeb, that aims to support the development of Semantic WISs.

### Section IV Selected Readings

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Business Process Simulation: An Alternative Modelling Technique for the Information System Development Process

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*Tony Elliman, Brunei University, UK*

*Tally Hatzakis, Brunei University, UK*

*Alan Serrano, Brunei University, UK*

This chapter discusses the idea that even though information systems development (ISD) approaches have long advocated the use of integrated organisational views, the modelling techniques used have not been adapted accordingly and remain focused on the automated information system (IS) solution. Existing research provides evidence that business process simulation (BPS) can be used at different points in the ISD process to provide better integrated organisational views that aid the design of appropriate IS solutions. Despite this fact, research in this area is not extensive; suggesting that the potential of using BPS for the ISD process is not yet well understood. The chapter uses the findings from three different case studies to illustrate the ways BPS has been used at different points in the ISD process. It compares the results against IS modelling techniques, highlighting the advantages and disadvantages that BPS has over the latter. The research necessary to develop appropriate BPS tools and give guidance on their use in the ISD process is discussed.

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An Agent Based Formal Approach for Modeling and Verifying Integrated Intelligent Information Systems

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In this chapter a formal agent based approach for the modeling and verification of intelligent information systems using Coloured Petri Nets is presented. The use of a formal method allows analysis techniques such as automatic simulation and verification, increasing the confidence on the system behavior. The agent based modelling allows separating distribution, integration and intelligent features of the system, improving model reuse, flexibility and maintenance. As a case study an intelligent information control system for parking meters price is presented.

## **Chapter XIV**

Design Principles for Reference Modelling: Reusing Information Models by Means of Aggregation, Specialisation, Instantiation and Analogy

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With the design of reference models, an increase in the efficiency of information systems engineering is intended. This is expected to be achieved by reusing information models. Current research focuses mainly on configuration as one principle for reusing artifacts. According to this principle, all variants of a model are incorporated in the reference model facilitating adaptations by choices. In practice, however, situations arise whereby various requirements to a model are unforeseen: Either results are inappropriate or costs of design are exploding. This chapter introduces additional design principles that aim toward giving more flexibility to both the design and application of reference models.

## **Chapter XV**

Examining the Quality of Evaluation Frameworks and Metamodeling Paradigms of Information Systems Development Methodologies

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Information systems development methodologies and associated CASE tools have been considered as cornerstones for building quality in an information system. The construction and evaluation of methodologies are usually carried out by evaluation frameworks and metamodels - both considered as meta-methodologies. This chapter investigates and reviews representative metamodels and evaluation frameworks for assessing the capability of methodologies to contribute to high-quality outcomes. It presents a summary of their quality features, strengths and weaknesses. The chapter ultimately leads to a comparison and discussion of the functional and formal quality properties that traditional meta-methodologies and method evaluation paradigms offer. The discussion emphasizes the limitations of both

methods and meta-methods to model and evaluate software quality properties such as computability and implementability, testing, dynamic semantics capture, and people's involvement. This analysis along with the comparison of the philosophy, assumptions, and quality perceptions of different process methods used in information systems development, provides the basis for recommendations about the need for future research in this area.

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