Model-Based Development and Evolution of Information Systems

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A Quality Approach

Springer

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Preface

The work presented in this book is rooted many years back, both directly through own work over the last 20 years, and obviously indirectly, since this work has been done in a tradition of conceptual modelling going back additionally 20 years or more.

When I did my Master Thesis at NTH (now NTNU) in 1990, the 'five year plan' was to work 2 years in a consulting company to get more practical experience, before going back to do a Ph.D. in an area related to conceptual modelling. I still remember the interview with my later employer (Andersen Consulting) when being given the 'what do you do in 5 years' question. I obviously did not mention the Ph.D. plans.

Anyway, after 18 months in the trenches with Andersen Consulting, I was back at NTH as a Ph.D. student, with Arne Sølvberg as supervisor. At this time Arne had around ten Ph.D. students, all highly qualified. I had met several of them as a master student (as lecturers, supervisors and co-students), and quickly started to discuss. I remember in particular discussions with Odd Ivar Lindland on aspects of quality of models, discussion later followed up by many in the group, including my current colleagues at NTNU Jon Atle Gulla and Guttorm Sindre. In one particular group meeting, Odd Ivar described his early ideas on quality of models. Jon Atle, also having a masters in linguistics, suggested that he should look at the differentiation between syntax, semantics, and pragmatics found in linguistics and semiotics. The seed of the most important structuring principles you find in this book, the SEQUAL framework, was planted in these discussions almost 20 years ago.

So why this focus on (conceptual) modelling?

One can argue that the main reason why humans have excelled as species is our ability to represent, reuse and transfer knowledge across time and space. Whereas in most areas of human conduct, one-dimensional natural language is used to express and share knowledge, we see the need for and use of two and many-dimensional representational forms to be on the rise. One such representational form is called *conceptual modelling.* A *conceptual model* is traditionally defined as a description of the phenomena in a domain at some level of abstraction, which is expressed in a semi-formal or formal diagrammatical language.

Modelling is an important part of both information systems development and evolution, and organisational development in general (e.g. used in enterprise modelling/ enterprise architecture). The field includes numerous evolving modelling methods,

notations and approaches. Even with some attempts to standardise (e.g. UML for object-oriented design), new modelling methods are being introduced regularly.

Whereas modelling techniques traditionally were used to create intermediate artefacts in systems analysis and design, more and more modelling methodologies take a more active approach to the exploitation of this particular form of knowledge representation. In approaches such as business process management (BPM), model driven architecture (MDA) and domain specific modelling/domain specific modelling languages (DSM/DSL). In enterprise architecture (EA) and active knowledge modelling (AKM), the models are used directly to form the information system of the organisation. At the same time, similar techniques are used also for sense-making and communication, model simulation, quality assurance and requirements specification in connection to more traditional forms of information systems development.

Given that modelling techniques are used in such a large variety of tasks with very different goals, it is important for appropriate use of the techniques to have a proper overview of different uses of modelling, and guidelines for what make a model sufficiently *good* to achieve the decided goals. An important aspect of this book is to discuss the quality of models and modelling languages in this setting. To help us in this process, a framework for understanding quality of models and modelling languages (SEQUAL) has been developed, and its use is described in detail in the book. Although we have been working relative to this framework over a long period, the book will provide many new developments and applications of the framework.

A number of books exist on particular approaches to modelling. There exist a number of standard system analysis and design books (dealing with ER-modelling, DFD, UML etc.), generally using these as tools to be learnt as part of software development. In our book we will look more broadly at the topic of modelling, making it easier when needing to use a new modelling approach to identify the type of approach and its strength and weaknesses.

What characterises existing books is that they look in particular on a given technique (and is often overly positive relative to this approach), without giving sufficient basis for judging the appropriateness of this technique relative to other available techniques for a given situation. There is no approach to modelling and model-based systems development that is best for all types of situations, thus a high-level overview to make it possible to evaluate the appropriateness of different approaches is called for.

The book has two intended audiences:

- It is primarily for computer science, software engineering and information system students on the post-graduate level (master's/Ph.D.), after they have had an introduction to information system analysis and design (for example, UML for systems design or process modelling-based using e.g. BPMN), and databases, that want to know more about conceptual modelling in their preparation for professional practice.
- Professionals with detailed experience and responsibilities related to development and evolution of information systems and information systems methodology including enterprise modelling and enterprise architecture that need to formalise

and structure their practical experiences or to update their knowledge, as a way to improve their professional activity.

At this level, many students have learnt modelling as a predefined tool, and have limited training in evaluating the appropriateness of models and modelling languages for a certain task. They also have limited practical experience with more than a few notations, and seldom real-life experiences with large-scale modelling and systems development. Many of the concepts and principles underlying the concrete modelling notation easily get abstract, and there is a need to exemplify the points and bridge the theoretical parts of the course to how it can address problems in practice.

Courses of this type often are a mix of general material and presentation of the favourite approaches of the lecturer. Thus I foresee the book to be a possible basis for many such courses, but where the syllabi in addition to material from the textbook can contain a number of recent articles and more detailed descriptions of selected techniques.

Acknowledgements

A large number of people deserve to be mentioned relative to the content of this book as collaborators and co-writers of projects and research work bringing us to the point we are today. Whereas many of our debts in this regard is visible through the references in the text, also many people have contributed in a more subtle way, bringing inspiration or roadblocks to be overcome.

When I started working in this field in the early 1990s, the research group around Arne Sølvberg was very important. I have already mentioned Arne, Odd Ivar, Jon Atle and Guttorm. Other collaborators at the time were Anne Helga Seltveit, Gunnar Brattås, Rudolf Andersen, Geir Willumsen, Mingwei Yang and Harald Rønneberg. In the Tempora project, I worked also with Benkt Wangler, Peter McBrien, and Richard Owens. The international collaboration led me into the IFIP WG 8.1 community and the CAiSE conference, which I have followed over the years collaborating with among others Wil van der Aalst, Jan Recker, Michael Rosemann, Andreas Opdahl, Sjaak Brinkkemper, Kalle Lyytinen, Barbara Pernici, Keng Siau, Terry Halpin, Antoni Olive, Oscar Pastor, Erik Proper, Janis Bubenko, Colette Rolland, Peri Loucopoulos, Janis Stirna, Anne Persson, Peter Fettke, Peter Loos and Constantin Houy.

After doing my Ph.D. I was again over in Andersen Consulting, and want to thank in particular Bjørn Ivar Danielsen, Nils Øveraas and Lars Henriksen for making it possible to keep in contact with the academic community also when working as a consultant. After this I worked in SINTEF, in particular on a number of Norwegian and EU projects where modelling of information systems was central. In particular I would like to thank Steinar Carlsen, Håvard Jørgensen, Dag Karlsen, Frank Lillehagen, Oddrun Ohren, Svein Johnsen, Heidi Brovold, Vibeke Dalberg, Siri Moe Jensen, Rolf Kenneth Rolfsen, Arne Jørgen Berre, Asbjørn Følstad, Reidar Gjersvik and Bjørn Skjellaug on the national front and Joerg Haake, Weigang Wang, Jessica Rubart, Michael Petit, Kurt Kosanke, Martin Zelm, Nacer Boudlidja, Herve Panetto, Guy Doumeingts and Thomas Knothe on the international front.

Also in the years connected to NTH and NTNU, I have had the pleasure to collaborate with a number of master's and Ph.D. students and postdocs, including Babak Amin Farschchian, Sofie de Flon Arnesen, Maria Rygge, Anna Gunnhild Nysetvold, Alexander Nossum, Yun Lin, Csaba Veres, Jennifer Sampson, Eirik Berg, Shang Gao, Sundar Gopalakrishnan, Gustav Aagesen and Lillian Hella.

A number of people at NTNU have also been influential through the normal scientific discourse, including Hallvard Trætteberg, Reidar Conradi, Monica Divitini, Dag Svanæs, Eric Monteiro, Agnar Aamodt, Pieter Toussaint, Letizia Jaccheri, Alf Inge Wang, Kjetil Nørvåg, Arild Faxvaag, Rolv Bræk, Sobah Abbas Petersen, Peter Herrmann, Frank Kraemer and Tor Stålhane.

Finally, I should mention my wife, Birgit Rognebakke Krogstie. Birgit also has a Ph.D. in Computer Science. Although it is in a somewhat different field, we often meet on various arenas including at home, making the dinner table discussions at times quite abstract and conceptual, to our children's irritation and at times (I hope) inspiration.

John Krogstie

Outline of the Book

In the first chapter we introduce the topic area and the most important concepts, including overall philosophy underlying the thinking on quality of models. This includes social constructivism, knowledge creation in organisations, semiotics and model monopoly. We also give a high-level overview of the most important goals of modelling and techniques for model-based development such as MDSD, DSM/DSL, BPM, MDA and AKM. The case studies used throughout the book both for illustrations in the book itself, and as cases for the exercises are briefly described (the actual case studies being provided in Appendix C).

Chapter 2. Methodology for Computerised Information Systems support in Organisation: Present the generic tasks and model types found in information systems development and evolution, and main methodologies for mixing different phases of information system development. In particular we describe in more detail the main approaches to model-based development presented on a high level in Chap. 1, but also provide a historical account of the development of methodologies in the area. Methodologies are classified relative to goal, process, product, capabilities needed, stakeholder participation, organisation and location of the tasks to be done.

Chapter 3. Modelling languages: Perspectives and abstraction mechanisms: Present main abstraction mechanisms used in modelling languages (generalisation, aggregation, classification, association), and survey well-known modelling approaches according to the perspective of modelling (behavioural, functional, structural, goal and rule, object-oriented, communicational, actor and role and topological). Process modelling is discussed relative to all perspectives. In addition, we present examples of multi-perspective modelling languages such as UML, EEML and GEMAL.

Chapter 4. Quality of models: Present the framework for quality of models (SEQUAL), including examples of means to achieve model quality of different levels (such as tool functionality and modelling techniques being appropriate for the development of models of high quality). Quality is discussed on seven levels: physical, empirical, syntactic, semantic, pragmatic, social and deontic.

Chapter 5. Quality of modelling languages: One important mean for making good models is the use of an appropriate modelling language. We describe here six facets of quality of a modelling language: domain appropriateness, comprehensibility appropriateness, participant appropriateness, modeller appropriateness, tool appropriateness and organisational appropriateness. The use of this part of the framework for the choice and guidance of development of new languages is further described in Chap. 7.

Chapter 6. Specialisation of SEQUAL: Whereas a strength of SEQUAL is that it is applicable on a large range of model types, this can also be a limitation since different types of models have their different characteristics and limitations. We have through practical needs devised a number of specialisations of the framework for different types of models, including for business process models, requirements models, data models, ontologies and interactive process models. We also see how we can apply SEQUAL for understanding data quality and the quality of maps, a different form of two-dimensional representation of knowledge.

Chapter 7. Applications of SEQUAL: Illustrates how to apply SEQUAL in connection to support modelling, but also in the assessment of existing and new models, modelling languages, modelling methodologies and modelling tools. Examples are provided from the application of SEQUAL in both industrial and governmental settings.

Chapter 8. Summary and outlook: Discusses the potential for model-based techniques in the future in the light of future developments in the business and IT world.

Each chapter ends with a summary of main aspects, and include a number of possible tasks. Whereas some of these are review question, where the answers can be found more or less directly in the text, the exercises are more demanding. The exercises are divided in three categories.

1. Smaller tasks that can be done alone
2. Pair exercises that for instance can be used during class in small breakout sessions
3. Group task, which are larger tasks, often including a more thorough investigation or modelling assignment to be done

Many tasks are to some extent open relative to for instance the modelling notations and tools that are used, to make it easier to adjust them to the interests and focus of concrete modelling courses using the book as a basis.

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