20 Years of Quality of Models

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Abstract We are very pleased that our CAiSE'95 paper has been selected to be included in the Springer book that celebrates the 25th anniversary of the CAiSE conferences series. This paper entitled '*Towards a Deeper Understanding of Quality in Requirements Engineering'* presented a development of work started some years earlier in the research group of Arne Sølvberg on the topic of quality of models. This topic has been of interest during the next 20 years by us and a number of other researchers both in the context of IS development and in other areas, and will in our view be a relevant topic for the foreseeable future.

1 Background for the Original Model

Work in our group on quality of models can be traced back to at least 1992. The first manifestation of this work was in the PhD-thesis of Odd Ivar Lindland in 1993 [8]. In one particular group meeting, Odd Ivar described his early ideas on quality of models, and how to differentiate goals and means and relating modelling languages, domain, and actors. Jon Atle Gulla and Guttorm Sindre, also having degrees in linguistics, suggested that he should look at the differentiation between syntax, semantics, and pragmatics found in linguistics and semiotics, which have been a cornerstone in our thinking about quality of models from the start. Guttorm Sindre and Odd Ivar Lindland in particular collaborated on the next step, which ended up in a widely cited article [9] as one of the best papers of the ICRE conference in 1994 being selected to a special issue in IEEE Software.

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J. Bubenko et al. (eds.), *Seminal Contributions to Information Systems Engineering*,
DOI 10.1007/978-3-642-36926-1_8, © Springer-Verlag Berlin Heidelberg 2013

Although a very elegant framework which was easily applicable for understanding important aspects of quality of models, several other works pointed to the need for extending the framework. Important inspirations in this regard was the three dimensions of RE [14] (also represented and commented in this volume), and the work related to the semiotic ladder presented in early versions of the IFIP 8.1 FRISCO framework [7] and work on social construction of 'reality' (and models thereof) constituting the domain, which is typically not as ideal and objectively given in practice that as the original framework worked with. Specifically the framework of Pohl also pointed to the need for agreement between the stakeholders of the model.

These extension, in addition to a specific focus on requirements specification models resulted in the framework presented in the CAiSE 1995-article, the main addition being the description of perceived semantic quality and social quality.

2 Later Developments

There was not only us working with quality of models and modelling languages in the mid-90s. For instance Moody and Shanks and Moody [10] worked in particular on quality of data models. Becker, Rosemann and Schütte [1] focused on the quality of process models. For us (and the framework later named SEQUAL) on the other hand, the story could have ended here. John Krogstie delivered his PhD-thesis in 1995 and started working in Andersen Consulting; Guttorm Sindre took some years off pursuing a career as a fictional writer, whereas Odd Ivar Lindland had already joined IBM. Both John and Guttorm though kept in contact with academia, and drifted back to more academic positions towards the end of the 90s, taking up work on quality of models.

In hindsight the work done on SEQUAL can be framed as design science research, with the quality framework as the main artefact. Whereas the early validation was primarily analytical, later work e.g. together with Moody [11] has also extended the evaluation with empirical techniques. The framework has been developed through a number of iterations, and has also in some cases been established as part of the knowledge base e.g. in the development of a framework for quality of maps [13]. The current version of the framework is described in [2] where also newer work on language quality is included. The framework has been used for evaluation of modelling and modelling languages of a large number of perspectives, including data [6], process [3, 15], enterprise [5], and goal-oriented [4] approaches. It has been used both for models on the type level and instance level (i.e. data quality [12]). The current framework is illustrated in Fig. 1. Quality has been defined referring to the correspondence between statements belonging to the following sets:

- ***G,*** the set of goals of the modelling task.
- ***L,*** the language extension, i.e., the set of all statements that are possible to make according to the rules of the modelling languages used.

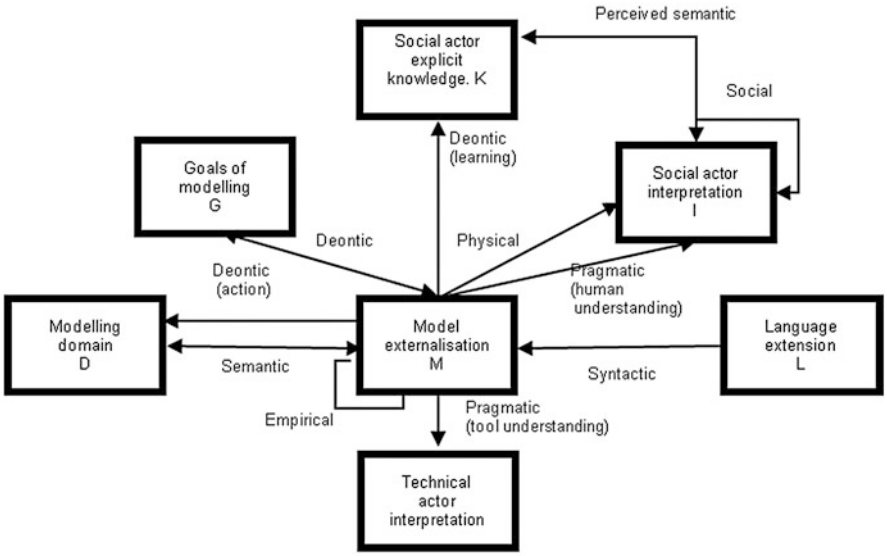

Fig. 1 SEQUAL framework for discussing quality of models

- ***D***, the domain, i.e., the set of all statements that can be stated about the situation.
- ***M***, the externalized model itself.
- ***K***, the explicit knowledge relevant to the domain of the audience.
- ***I***, the social actor interpretation, i.e., the set of all statements that the audience interprets that an externalized model consists of.
- ***T***, the technical actor interpretation, i.e., the statements in the model as 'interpreted' by modelling tools.

The main quality types are:

1. Physical quality: The basic quality goal is that the externalized model ***M*** is available to the relevant actors.
2. Empirical quality deals with comprehension when a visual model ***M*** is read by different social actors. Before evaluating empirical quality, physical quality should be addressed.
3. Syntactic quality is the correspondence between the model ***M*** and the language extension ***L***. Before evaluating syntactic quality, physical quality should be addressed.
4. Semantic quality is the correspondence between the model ***M*** and the domain ***D***. This includes both validity and completeness. Before evaluating semantic quality, syntactic quality should be addressed. Domains can be divided into two parts, exemplified with a software requirements model:
   - Everything the computerized information system (CIS) is supposed to do (for the moment ignoring the different views the stakeholders have on the CIS to be produced).

- Constraints on the model because of earlier baselined models such as system level requirements specifications, enterprise architecture models, statements of work, and earlier versions of the requirement specification to which the new requirement specification model must be compatible.
- Perceived semantic quality is the similar correspondence between the social actor interpretation ***I*** of a model ***M*** and his or hers current knowledge ***K*** of domain ***D***. Before evaluating perceived semantic quality, pragmatic quality should be addressed.

5. Pragmatic quality is the correspondence between the model ***M*** and the actor interpretation (***I*** and ***T***) of it. One differentiates between social pragmatic quality (to what extent people understand the model) and technical pragmatic quality (to what extent tools can be made that can interpret the model). Before evaluating pragmatic quality, empirical quality should be addressed.
6. The goal defined for social quality is agreement among social actor's interpretations (***I***). Before evaluating social quality, perceived semantic quality should be addressed.
7. The deontic quality of the model relates to that all statements in the model ***M*** contribute to fulfilling the goals of modelling ***G***, and that all the goals of modelling ***G*** are addressed through the model ***M***. In particular, one often includes under deontic quality the extent that the participants after interpreting the model learn based on the model (increase ***K***) and that the audience are able to change the domain ***D*** if this is beneficially to achieve the goals of modelling (if the model is prescriptive).

3 Future Directions

More and more modelling methodologies take an active approach to the exploitation of models. In approaches such as Business Process Management (BPM), Model Driven Architecture (MDA), and Domain specific modelling/domain specific modelling languages (DSM/DSL), 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, simulation, quality assurance and requirements specification in connection to more traditional forms of information systems development. Thus we expect the need to judge the quality of models will retain. Although much work has been done on thinking relative to quality of models and modelling languages over the last years, there is still room for developments. Whereas main parts of the framework are supported by empirical evidence some of the later developments should be worked on further. Even if more guidelines for modelling is produced [2, 12], having these put into use in methodologies and tools in an appropriate way are also open for further research and practical exploitation in future model-based development and evolution of information systems such as reported in [16].

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