Understanding and Assessing Quality of Models and Modeling Languages

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INTRODUCTION

An important challenge for organizational activity is to effectively represent and transfer *knowledge*. One reason why humans have excelled as species is our ability to create common stories and represent, reuse and transfer this as knowledge across time and space. Whereas in most areas of human conduct, one-dimensional natural language texts are the main way of expressing and sharing knowledge, we see the need for and use of two and many-dimensional forms of knowledge representational to be on the rise. A form of representation which plays an increasingly important role in information systems and enterprise development is *conceptual models* (Krogstie, Opdahl, & Brinkkemper, 2007), which are diagrams expressed in some (semi-) formal visual language (e.g. nodes interconnected with edges), describing some area of interest. In (Krogstie, 2007), the following vision was stated: "Over time the use of modelling will become an established way of expressing knowledge in all fields of human conduct. Everyone (not only expert 'modelers') is involved in the process of developing and activating models made in adapted modelling language." Examples of models could be organization charts, strategy and goal breakdown structures, business process models, or models of the information to be contained in a database. The *quality* of a conceptual model will strongly affect decisions based on the model, and can therefore be of vital importance to the stakeholders.

According to general model theory (Stachowiak, 1973) there are three common characteristics of models: *Representation, Simplification* and *Pragmatic orientation.*

- **Representation:** Models represents something else than the model itself.
- **Simplification:** Models possess a reductive trait in that they represent only a subset of attributes of the phenomenon being modelled.
- **Pragmatic Orientation:** Models have a substitutive function in that they substitute a certain phenomenon as being conceptualized by a certain subject in a given temporal space with a certain *intention* or operation in mind.

Thus a model is not just a representation of something else; it is a conscious construction to achieve a certain goal beyond the making of the model itself. Whereas modeling techniques traditionally have been used to create intermediate artifacts in systems analysis and design, modern modeling methodologies support a more active role for the models. For instance in Business Process Management (BPM) (Havey, 2005), Model Driven Architecture (MDA) and Model-driven Software Engineering (MDSE) (Brambilla, Cabot & Wimmer, 2012), Domain specific modeling (DSM) (Kelly & Tolvanen, 2008), Enterprise Architecture (EA) (Lankhorst, 2005), Enterprise modeling (EM) (Sandkuhl, Stirna, Persson & Wißotzki, 2014), Interactive Models (Krogstie & Jørgensen, 2004) and Active Knowledge Modelling (AKM) (Lillehagen & Krogstie, 2002; Lillehagen & Krogstie, 2008), the models are used directly as part of the information system of the organization. At the same time, similar modeling techniques are also used for sense-making and communication, model simulation, quality assur-

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ance, and requirements specification in connection to more traditional forms of information systems and enterprise development (Krogstie, Dalberg & Jensen, 2008).

Since modeling techniques are used in such a large variety of tasks with different goals, it is hard to assess whether a model is sufficiently *good* to achieve the goals. To provide guidance in this process, the latest version of *SEQUAL,* a framework for understanding quality of models and modeling languages, will be presented in this chapter.

BACKGROUND

Since the early 90ties, many researchers have worked on quality of models. Work on SEQUAL can be traced back to at least 1993 (Lindland, 1993). Sindre and Lindland in particular collaborated on the next step (Lindland, Sindre & Sølvberg, 1994). Although an 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 work on 3 dimensions of requirements engineering (Pohl, 1993), work related to the semiotic ladder presented in early versions of the IFIP 8.1 FRISCO framework (Lindgren, 1990) and work on social construction of 'reality' and models thereof of the domain, which is typically not as ideal and objectively given in practice that as the original framework took as an outset (Berger & Luckmann, 1966). Specifically the framework of Pohl also pointed to the need for achieving *agreement* among the stakeholders of the model.

These extensions, in addition to a specific focus on requirements specification models resulted in the framework presented in (Krogstie, Lindland & Sindre, 1995). At the same time Shanks and Moody (Moody & Shanks, 1994) started their work on quality of data models. Becker, Rosemann and Schütte (1995) focused on the quality of process models. Later a number of other researchers, e.g. (Nelson, Poels, Genero & Piattini, 2011) have worked within this area.

In hindsight the work done on SEQUAL can be framed as design science research (Hevner et al, 2004), with the quality framework as the core artifact. Whereas the early validation was primarily analytical, later work e.g. together with Moody (Moody, Sindre, Brasethvik & Sølvberg, 2002) also included empirical evaluations, and practical applications of the framework have been reported in (Heggset, Krogstie & Wesenberg, 2014; Heggset, Krogstie & Wesenberg, 2015b). The framework has been developed through a number of iterations, and have also in some cases been established as part of the knowledge base e.g. in the development of a framework for quality of maps (Nossum & Krogstie, 2009). The current version of the framework is described in (Krogstie, 2012a) where also newer work on quality of modeling languages (including the work presented by Moody (2009)) is incorporated.

To summarize, SEQUAL has three unique properties compared to the early work on quality of models:

- It distinguishes between quality characteristics (goals) and means to potentially achieve these goals by separating what you are trying to achieve from how to achieve it.
- It is based on a constructivistic worldview, recognizing that significant models are usually created as part of a dialogue between the many stakeholders involved in modelling, whose knowledge of the modelling domain changes as modelling takes place.
- It is closely linked to linguistic and semiotic concepts. In particular, the core of the framework including the discussion on syntax, semantics, and pragmatics is parallel to the use of these terms in the se-