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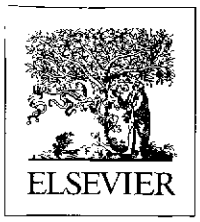

DATA & KNOWLEDGE ENGINEERING

Special issue: Quality in Conceptual Modeling
Guest editors: H.J. Nelson, G. Poels, M. Genero and M. Piattini
Last issue of this volume

DATA & KNOWLEDGE ENGINEERING

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Special issue: Quality in Conceptual Modeling
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Guest editorial

Quality in conceptual modeling: five examples of the state of the art

1. Introduction

Conceptual modeling serves as the cornerstone of many information systems related activities (development, evaluation, reengineering). These models help us to understand the structure and operations of organizations, the flow and the nature of data through business processes, and how the various software elements (objects, entities, functions, tasks, etc.) interact with elements inside and outside of the final system. They are the primary means of communication between system stakeholders such as owners, service providers, business analysts, developers, and users. Accurate, complete, reusable, maintainable, and evolvable conceptual models are critical to the success of the installed system, for if the initial model is incorrect, then all activities that are based on it will be increasingly incorrect. The cost of correcting errors that are missed in the early stages of development increases by an order of magnitude in each subsequent development stage [6] until the final installed system does not meet the user's requirements and the development process must be restarted. Yet despite the importance of having high quality conceptual models, research into the nature of conceptual model quality is still in its infancy. Evaluating the quality of conceptual models is still very much more 'art' than 'science'. The dimensions of quality have only recently been defined and explored [1,3–6]. Quantitative methods for evaluating the quality of a model are virtually nonexistent. Attempts at describing even overall quality goals generally only list desirable properties [5]. Definitions of quality, when given, are vague and complicated, and there is no underlying structure that helps the user to understand how the properties relate to one another.

However, this situation is changing as researchers who realize the importance of good conceptual models work to define the field and advance the discipline. Where once the field was highly dispersed and independent, researchers are now coming together in an international forum to discuss important issues in conceptual modeling research. The International Workshop on Conceptual Modeling Quality (IWCMQ), held in conjunction with the International Conference on Conceptual Modeling (ER) has explored such issues as the theoretical foundations of conceptual

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model quality, QA, evaluating quality, and controlling and improving model quality. This special issue of *Data & Knowledge Engineering* grew out of the great deal of interest that was generated in the 2002 and 2003 IWCMQ workshops, organized by us.

Top researchers in conceptual model quality were invited to submit papers to this special issue, and after rigorous review five papers were selected. These papers explore the state of the art in evaluating and understanding the quality of conceptual models, propose methods for improving conceptual modeling quality in general, and make more specific recommendations for quality assuring representations developed using widespread conceptual modeling technology such as the ER model and UML. We believe that these papers exemplify the state of the art of conceptual model quality research and continue driving the interest in this field, currently very high on the research agenda of IS researchers [7].

The rest of the paper is organized as follows: Section 2 presents the framework of conceptual model quality that we used to organize the five papers in this special issue. Next, in Section 3, each paper is briefly introduced by positioning it into the framework of Section 2.

2. Quality in conceptual modeling

One of the first attempts to systematically define quality in relationship to conceptual modeling was made by Lindland, Sindre, and Sølvberg in their article, 'Understanding Quality in Conceptual Modeling' [5]. Prior to this point, research outputs were merely simply defined lists of desirable properties for obtaining high quality models. Fig. 1 shows a quality framework for conceptual models that is based upon Lindland et al.'s framework and subsequent research by Krogstie. Each of the elements is explained below.

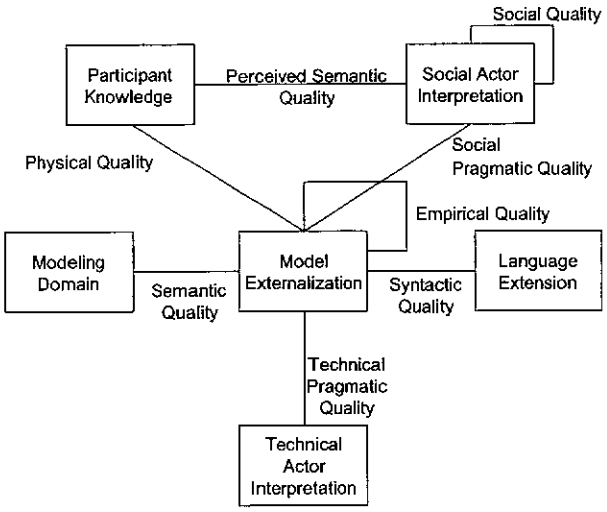

Fig. 1. Dimensions of conceptual model quality (based on [2]).

Modeling Domain is the set of all statements that are relevant and correct for describing a problem domain, *Language Extension* is the set of all statements that are possible given the grammar and vocabulary of the modeling languages used. *Model Externalization* is the conceptual representation of the problem domain. It is defined as the set of statements about the problem domain that are actually made. *Social Actor Interpretation* and *Technical Actor Interpretation* are the sets of statements that actors (human model users and tools that interact with the model, respectively) 'think' the conceptual representation of the problem domain contains. Finally, *Participant Knowledge* is the set of statements that human actors, who are involved in the modeling process, believe should be made to represent the problem domain.

Each quality dimension is defined as the correspondence between two elements. For example, *Semantic Quality* is determined by checking the correspondence between Modeling Domain and Model Externalization. If there are statements describing the problem domain that are not in the conceptual representation, then the representation is incomplete. If there are statements in the conceptual representation that do not describe the problem domain, then those extra statements are invalid. Analogously, the other quality dimensions are defined as the correspondence between the elements they relate in Fig. 1.

This set-theoretic approach to defining the dimensions of conceptual model quality was the first in a wave of renewed interest in the field of conceptual model quality, leading to over 100 articles in top journals and conferences in the last ten years.

3. Contents of the special issue

The five articles in this special issue cover all of the elements in Lindland et al.'s framework and provide examples of state-of-the-art research in each of its areas of interest. They illustrate the considerable breadth of the field and the wide range of research methods used to investigate, and to improve conceptual model quality. The top researchers in the field were invited to submit papers to this special issue, and all of the papers were subjected to extensive peer review. We believe that these papers can serve not only to illustrate how far the field has come, but also to spark additional interest in this very important research area.

The first article, by Daniel Moody, keynote speaker at IWCMQ 2002 in Tampere, Finland, is entitled 'Theoretical and Practical Issues in Evaluating the Quality of Conceptual Models: Current State and Future Directions'. This article sets the stage for the special issue by examining past research to identify where significant 'gaps' exist. This article covers the whole of the Lindland et al. framework and proposes how to move conceptual model quality practice from an art to an engineering discipline.

The second article is entitled 'Improving the Quality of Conceptual Modeling Using Cognitive Mapping Techniques.' Written by Keng Siau and Xin Tan, this article covers the human side of conceptual model quality: participant knowledge and social actor interpretation. This paper contributes to our understanding of how human cognition is tightly coupled to the quality of models and to the quality of the process of developing models.

The third article, by Andreas Opdahl and Brian Henderson-Sellers, is entitled 'A Unified Modelling Language Without Referential Redundancy.' This article deals with the quality of the modelling language itself. In this case, the Unified Modeling Language is examined to show that the

quality of the model externalization (i.e., the conceptual representation of the problem domain) can be improved by reducing the number of referentially redundant modeling constructs. The authors propose a reformulation of UML using faceted metamodeling that eliminates this redundancy, increasing the quality of the final representation.

The fourth article, by Andrew Gemino and Yair Wand, is entitled 'Complexity and Clarity in Conceptual Modeling: Comparison of Mandatory and Optional Properties.' This article also examines a modeling language: the Entity–Relationship model. The authors show that mandatory properties and subtypes lead to higher quality representations than optional properties in ER diagrams.

The fifth and final article, by Jeffrey Parsons (keynote speaker at IWCMQ 2003 in Chicago) and Linda Cole, is entitled 'What Do the Pictures Mean? Guidelines for Experimental Evaluation of Representation Fidelity in Diagrammatical Conceptual Modeling Techniques'. This article examines again the whole of the framework, describing a set of guidelines for experimentally testing the suitability of a modeling technique for expressing the semantics of a particular domain.

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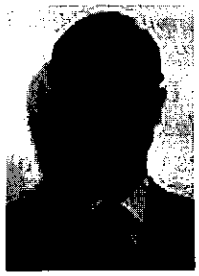

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