

## Chapter 2

# Ontology Theory, Management and Design: An Overview and Future Directions

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### ABSTRACT

*Ontologies now play an important role in providing a commonly agreed understanding of a domain and in developing knowledge-based systems. They intend to capture the intrinsic conceptual and semantic structure of a specific domain. Many methodologies, tools and languages are already available to help anthologies' designers and users. However, a number of questions remain open: what ontology development methodology provides the best guidance to model a given problem, what steps to be performed in order to develop an ontology? which techniques are appropriate for each step? how ontology' lifecycle steps are upheld by the software tools? how to maintain an ontology and to evolve it in a consistent way? how to adapt an ontology to a given context? To provide answers to these questions, the authors review in this chapter the main methodologies, tools and languages for building, updating and representing ontologies that have been reported in literature.*

### INTRODUCTION

Nowadays, we can easily notice a mass information sources, accompanied by a proliferation of users' requirements, which became more complex and demanding. In fact, new information systems have to handle a variety of information sources, from proprietary ones to those available in web services worldwide.

Since the information systems are imperative for the survival of any organization, they must guarantee a good circulation, coherence and an assistance to make appropriate decisions. However, currently, the new information systems are increasingly complex, requiring an enormous work of modeling. Designers are often confronted with a set of difficulties related mainly to the complexity of the domain of study and to the multitude of terms used to express the domain concepts. These problems are due to the lack of a consensus on the vocabulary used for a

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given domain. So, designers can, in some cases, make syntactic, structural and/or semantic errors. These errors will affect the coherence of the conceptual schema and consequently the quality of their implementation.

In this context, ontologies could play an important role, as they do in other disciplines, since they provide a source of precisely defined terms that can be communicated across people, organisations and applications. They offer a consensual shared understanding concerning a domain of knowledge to support communication among humans, computers and softwares (Gruninger et al., 2002). Ontologies are also used to share a common understanding of information structure and allow analyzing knowledge based on the terms specification of the domain area. The formal analysis of terms is extremely valuable for reuse of existing ontologies and for its extension (Bachimont, 2000).

In this chapter, we are interested in work conducted in the domain of ontology engineering and particularly in the approaches, languages and tools for ontology building, contextualization and evolution. It is intended to give an intuitive view, not an exhaustive account. In fact, regardless of the complexity of the ontology engineering setting, what is currently lacking is a unified overview of the wide variety of models and mechanisms that can be used to support all steps of ontology lifecycle.

The rest of chapter is structured as follows. In Section 2, we discuss some problems confronted during the information system modeling and the importance of ontology as support for the modeling of information systems. Then, the theoretical foundations of the ontological engineering field will be presented while commenting on the ontology utility, use and definitions. This will be followed by a presentation of related work regarding the ontology building and design. An overview of the notions of context and multi-representation problems in the domain of ontology and information systems is also proposed in section 5.

Section 6 reviews approaches and works which focus on ontology evolution. Finally, we conclude in section 7.

## **FROM INFORMATION SYSTEMS DESIGN TO ONTOLOGY MODELING**

Conceptual modeling is one of the most important tasks in the development of information systems in terms of both organizational understanding and systems development. It requires a determination of the domain entities and their relationships as well as different static and dynamic views of the expected system. The domain entities are not always simple nor organized since we must consider, when modeling, all the field's concepts belonging to the universe of discourse as well as their pertinent relationships.

The result of a design step is usually expressed using a model (Sánchez et al., 2005). This model may contain some ambiguities and errors due to the incomprehension of the domain of study and the difficulty to determine its concepts and relationships.

### **Conflicts in Information Systems**

The information system modeling requires a perfect knowledge of the studied domain and a deep analysis of the user's requirements. This task becomes very difficult because the current applications become increasingly complex and use an enormous quantity of concepts coming from heterogeneous sources. For example, in the case of cooperative applications, the design step requires the extraction of an enormous quantity of data concerning the various intervening actors (e. g. customers, suppliers, produced). Modeling such data requires an analysis step allowing the determination, the distinction and the classification of the domain concepts. This step must be based on the designers' knowledge and expertise, helped by some domain's specialists. However,

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