Chapter I
Semantics of the MibML Conceptual Modeling Grammar:
An Ontological Analysis Using the Bunge–Wand–Weber Framework

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ABSTRACT

A conceptual modeling grammar should be based on the theory of ontology and possess clear ontological semantics to represent problem domain knowledge in a precise and consistent manner. In this paper, we follow the notion of ontological expressiveness and conduct an ontological analysis of a newly-developed conceptual modeling grammar termed MibML (Multiagent-based Integrative Business Modeling Language). The grammar is developed to respond to the emerging needs for a special-purpose conceptual modeling grammar for the MIBIS (Multiagent-based Integrative Business Information Systems) universe. We assign ontological semantics to the MibML constructs and their relationship using the BWW (Bunge-Wand-Weber) model. This paper provides a starting point to further develop ontological principles and step-by-step guidelines to ensure the straightforward mapping from domain knowledge into MibML modeling constructs.

INTRODUCTION

Conceptual modeling is the activity of formally describing some aspects of the physical and social world around us for purposes of understanding and communication (Mylopoulos, 1992). It is the first step for system developers to understand and describe the conceived or the real world system in information system (IS) analysis and design. A conceptual-modeling grammar is the language used to generate conceptual models. It provides a set of constructs and rules that show how to combine the constructs to model real-world domains (Wand & Weber, 2002). A conceptual modeling grammar should be based on a theory of ontology—a theory that articulates those constructs needed to describe the structure and behavior of the world in general (Wand & Weber, 1993; Weber, 2003). Upper-level Ontologies help clarify the semantics of a conceptual modeling grammar and enhance its expressive power to capture problem domain knowledge precisely and unambiguously.

The precision, unambiguity, coherence, and expressive power of conceptual grammars broadly address two fundamental requirements in conceptual grammar development: soundness and completeness. While precision, unambiguity, and coherence address the soundness issue, the expressive power of a conceptual grammar is a measure of completeness of the grammar. Soundness of a grammar can be ensured by its careful design, but universal completeness is generally not attainable. Conceptual modeling grammars may only be boundedly complete in the sense that their expressive strength is adequate to satisfy most requirements within a bounded universe of discourse (Kishore, Sharman, & Ramesh, 2004). The notion of ontological expressiveness and a formal approach to assess ontological expressiveness of conceptual modeling grammars have been proposed by Wand and Weber (1993, 2004), and have been used by several researchers in the past (e.g., Milton, 2004; Green & Rosemann, 2000, 2004; Wand, Storey, & Weber, 2000).

The goal of this article is to elaborate the semantics of a recently developed conceptual modeling grammar from an ontological expressiveness perspective. The grammar, termed MibML (*M*ultiagent-based *I*ntegrative *B*usiness *M*odeling *L*anguage), provides fundamental constructs, relationships, and axioms specially developed for systems analysis and design in the MIBIS (multi-agent-based integrative business information system) universe (Zhang, Kishore, Sharman, & Ramesh, 2004, 2005). Nevertheless, there is a need to understand the clear ontological semantics of the MibML grammar in order to apply it for conceptual modeling in a problem domain. As stated above, conceptual precision, unambiguous definitions, coherence of conceptual structures, and expressive power of the semantics are central to capturing problem domain knowledge correctly into MibML conceptual models. Otherwise, conceptual modeling could become arbitrary and the mapping of domain knowledge into modeling constructs could become highly dependent upon the beliefs, knowledge, and prior experience of system analysts. For example, the MibML grammar includes both *goal* and *task* as foundation constructs. Without a precise, unambiguous, and coherent denotation of these constructs, it may be difficult to model an instance such as "order inventory" as a goal or as a task. This problem of semantic ambiguity (clarity) is common in many conceptual grammars including the ER modeling formalism, which has recently been addressed by Wand et al. (2000). We believe such difficulties can be overcome by providing ontological semantics of the MibML constructs and their relationships via ontological analysis of the grammar.

In this article, we follow recent work in this area and apply the upper-level ontology of the Bunge-Wand-Weber (BWW) model (Wand, 1996) to interpreting the ontological expressiveness (Wand,