Chapter 7.12
Evaluating Conceptual Modelling Practices:
Composites, Things, Properties

Graeme Shanks
Monash University, Australia

Jasmina Nuredini
Monash University, Australia

Ron Weber
Monash University, Australia

ABSTRACT

This chapter examines how ontological theory can be used to predict how alternative conceptual modelling representations affect end-user understanding of these representations. Specifically, it examines how ontological theory can be used to show how part-whole relations (composites) and things and properties can be best represented to enhance understanding of these real-world phenomena. We report the outcomes of two experiments that provide evidence to support the ontologically sound representation of part-whole relations and things and properties. We also discuss the outcomes of a cognitive process tracing study that explains why the ontologically sound representation of things and properties is more easily understood. In essence, our empirical research provides evidence to support the use of ontology as a theoretical basis to guide conceptual modelling practices.

INTRODUCTION

The representation of real-world phenomena as conceptual models has been a concern of information systems practitioners and researchers for some time. For example, Wand, Storey, and Weber (1999) have sought to build a rigorous ontological theory to provide a model of the structure and dynamics of some facets of the real world in general. Their goal has been to provide a theoretical basis for evaluating conceptual modelling practices. Their theory is an adaptation and extension of an ontological theory proposed

by Bunge (1977). Bunge's theory was selected because of its rigour and comprehensiveness. It provides thorough articulation of constructs such as things (entities), properties of things, states of things, and compositions of things — phenomena that are of major interest to conceptual modelling practitioners.

In this chapter, we focus on two features of the real world that conceptual modellers encounter — namely, the existence of things that are part of another thing and the distinction between things and properties. The notions that one thing may be part of another thing (e.g., a wheel is part of a bicycle) and the distinction between things and properties (e.g., a person is a thing with properties such as height and weight) are fundamental to the way people perceive and understand the world. In the context of conceptual modelling, these notions are problematic because alternative representations have been proposed and substantive theoretical issues remain unresolved. To illustrate, Rumbaugh, Jacobson, and Booch (1999, p. 146) state: "The aggregation (part-whole) relationship is transitive and antisymmetric across all aggregation links, even across those from different aggregation associations", yet Winston, Chaffin, and Herrman (1987, pp. 431-432) argue that not all part-whole relations are transitive. Furthermore, composite things are sometimes represented explicitly as entities (e.g., Kilov & Ross, 1994, pp. 96-97) and sometimes implicitly as relationships between the components of the composite (e.g., Chen, 1976, p. 31). In terms of distinguishing between things and properties, proponents of the object-role approach to conceptual modelling claim the distinction is unimportant (Halpin, 1995). They model things and properties of things using the object symbol in a conceptual schema. In the entity-relationship model (Chen, 1976), however, things are represented as entity types, and properties are represented as attribute types.

In our view, conceptual models should be used to discover and document stakeholder perceptions of a domain to provide a basis for informed discernment about how phenomena should be represented in an information system (Hischheim, Klein & Lyytinen, 1995) rather than being driven by database design considerations (Simsion & Witt, 2001, p. 101). For this reason, we argue that the representation of part-whole relations and things and properties in conceptual models should be based on a sound underlying theory of how the world is structured. To the best of our knowledge, however, no rigorous empirical evaluation of alternative representations of part-whole relations and things and properties has been undertaken. In the absence of such research, we undertook to empirically evaluate alternative representations.

Our research had several motivations. First, the cost of fixing errors increases the later they are discovered in the system development process (e.g., Boehm, 1981). Because, conceptual modelling work is undertaken early in the system development process, improvements in conceptual modelling practice potentially will lead to high payoffs (Moody & Shanks, 1998). Second, we sought to test prior theoretical work undertaken to predict how well different types of representations facilitate or inhibit human understanding of real-world phenomena. If accurate predictions about the types of conceptual modelling practices that are likely to be effective can be made, the high cost of learning the strengths and weaknesses of different practices through experience can be avoided. Third, we seek to improve user understanding of conceptual models. When conceptual models are prepared initially (e.g., by systems analysts), the users of an information system are asked to validate them to determine how accurately and completely the models represent their perceptual worlds. Finally, we sought to contribute to improved conceptual modelling practice. Numerous varying and sometimes ambiguous guidelines for representation of part-whole relations and things and properties exist in the literature. These guidelines tend to confuse rather than assist practitioners (Simsion & Witt, 2001). We aim to help