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**Chapter IV**

**The Conceptual  
Modeling Process  
and the Notion  
of a Concept**

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**ABSTRACT**

*We would like to believe that early in the new millennium the practice of conceptual modeling will rest on a sounder theory base than it does at present. Although a great deal of valuable research in information systems and conceptual modeling has been done during the last twenty years or so, the results in many cases have not yet sufficiently influenced other research work or found their way into current practice. Reasons for this might include the inaccessibility of much of the work and the time pressures on practising analysts. We think that inadequate consolidation of reported results is also a factor. Without consolidation, it is difficult to obtain an overall picture in a short time, and it can be hard to see the value of individual contributions.*

*While it is easy to see the need for consolidation, achieving it is harder. Reviews and surveys can help, but do not by themselves provide the necessary linking of individual research efforts into some larger framework. This chapter draws on theories from philosophy, linguistics, cognitive science, conceptual modeling and information systems in order to develop such a framework. Its goals include improving our under-*

*standing of conceptual modeling as a process and relating the different representations of concepts that can occur during conceptual modeling. To illustrate some of its benefits, the framework is applied to the case of object-role modeling in its intended use as a conceptual modeling method and notation at the ontological level of a universe of discourse. The framework is applicable to other modeling methods and notations that may view the universe of discourse at a different level (e.g., epistemological). It assists analysts assessing and working with the techniques that have emerged in the late twentieth century. It provides the sound theory base we need for the new millennium.*

## INTRODUCTION - CONTEXT AND MOTIVATION

*Conceptual modeling* is the activity in which a *conceptual model* of some *universe of discourse* (UoD) is created, usually as a step towards the software specification for an *information system* (IS).

A UoD is a selected area of interest from the perceived real world or the “enterprise” (Biller and Neuhold, 1977) about which information is to be stored and manipulated by an information system and communicated amongst users.

Conceptual models should reflect the conceptualization of a UoD and its environment that is most natural for users. They should be understandable, concise, efficient, simple and consistent. The *100 percent principle* (ISO, 1982) requires them to represent *all* conceptually relevant aspects of a UoD.

The *conceptualisation principle* (ISO, 1982) states that a conceptual model should not be concerned with matters of implementation. Nevertheless, decisions about what is conceptually relevant are influenced to some extent by the intended purpose of the IS application and by the technology that will be used to implement it.

Technological advances such as object-orientation, multimedia and the Internet, and users’ requirements for distributed and integrated applications are extending the scope of what must be considered conceptually relevant. They are creating a need for a more comprehensive approach to conceptual modeling.

Principles of conceptual modeling, requirements of a conceptual model and definitions for related terms have been described in an ISO report (ISO, 1982) and also in a recently-formulated draft on conceptual modeling standards (ISO, 1996). The term conceptual schema modeling facility (CSMF) is adopted from (ISO, 1996) as a combined description covering conceptual modeling notations, techniques and processes. Together these ISO reports can be considered to form a *theoretical basis* for conceptual modeling.

Some of the research in conceptual modeling is reported in (Loucopoulos and Zicari, 1992; Hull and King, 1987; Halpin and Meersman, 1994; Peckham and Maryanski, 1988; Brodie et al., 1984). The conference held annually since 1981 on the entity-relationship approach now has a broader scope and is now known as the “International Conference on Conceptual Modeling”. The topic of conceptual modeling appears in the themes of numerous other conferences in the areas of information systems, requirements engineering, object-orientation and databases.

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