

# Chapter 1.14

## Semantically Modeled Databases in Integrated Enterprise Information Systems

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### INTRODUCTION

Semantically modeled databases require their component objects to correspond closely to real world phenomena and preclude the use of artifacts as system primitives (Dunn and McCarthy, 1997). Enterprise information systems (also known as enterprise resource planning systems) based on semantically modeled databases allow for full integration of all system components and facilitate the flexible use of information by decision-makers. Researchers have advocated semantically designed information systems because they provide benefits to individual decision-makers (Dunn and Grabski, 1998, 2000), they facilitate organizational productivity and inter-organizational communication (Cherrington et al., 1996; David, 1995;

Geerts and McCarthy, 2002), and they allow the database to evolve as the enterprise does through time (Abrial, 1974).

Organizations have implemented enterprise resource planning (ERP) systems in an attempt to improve information integration. Much of the value of these ERP systems is in the integrated database and associated data warehouse that is implemented. Unfortunately, a significant portion of the value is lost if the database is not a semantic representation of the organization. This value is lost because the semantic expressiveness is insufficient -- relevant information needed to reflect the underlying reality of the organization's activities is either not stored in the system at all, or it is stored in such a way that the underlying reality is hidden or disguised and therefore cannot be interpreted.

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Partly as a result of systems lacking expressive semantics, researchers have been developing ontologies. Gruber (2008) provides a useful definition of ontology:

*“In the context of database systems, ontology can be viewed as a level of abstraction of data models, analogous to hierarchical and relational models, but intended for modeling knowledge about individuals, their attributes, and their relationships to other individuals. Ontologies are typically specified in languages that allow abstraction away from data structures and implementation strategies; in practice, the languages of ontologies are closer in expressive power to first-order logic than languages used to model databases. For this reason, ontologies are said to be at the “semantic” level, whereas database schema are models of data at the “logical” or “physical” level. Due to their independence from lower level data models, ontologies are used for integrating heterogeneous databases, enabling interoperability among disparate systems, and specifying interfaces to independent, knowledge-based services.”*

We base our discussion in this paper on the Resources-Events-Agents (REA) ontology (McCarthy, 1982; Geerts and McCarthy 1999; 2000; 2004; 2001; 2002; Haugen and McCarthy, 2000) which is considered an enterprise ontology or a business domain ontology. Ontologically-based information systems with common semantics are regarded as a necessity to facilitate inter-organizational information systems (Geerts and McCarthy, 2002). Presently, most inter-organizational data is sent via EDI (which requires very strict specifications as to how the data are sequenced and requires some investment by adopting organizations). The same requirement holds true for web-based systems. There is no or very limited knowledge inherent in those systems. Alternatively, if trading partners implement systems based on the same

underlying semantic model, many of the current problems can be eliminated.

This chapter first presents a normative semantic model for enterprise information systems that has its roots in transaction processing information systems. We use this model because the majority of information processed and tracked by information systems is transactional in nature. We review empirical research on semantically modeled information systems and then provide an example company’s semantic model as a proof of concept. We next discuss how this model can be applied to ERP systems and to inter-organizational systems and present future trends and research directions, and provide concluding comments.

## **Semantic Model Development**

In this chapter, we adopt a definition of an enterprise information system that is based on David et al.’s (1999) definition of an accounting information system: an enterprise information system that captures, stores, manipulates, and presents data about an organization’s value-adding activities to aid decision-makers in planning, monitoring, and controlling the organization. This definition is also consistent with much of the research on ERP systems. We recommend that the REA ontology (REA semantic model) (McCarthy, 1982) be used as the core foundation of enterprise information systems due to the model’s robust and general nature. The semantics of the REA model are designed to capture the essential features of value added activities – activities that correspond to exchanges of resources (e.g., giving inventory and receiving cash) and transformations of resources (converting raw materials into finished goods). The basic REA model is presented in Figure 1 using entity-relationship notation (Batini et al., 1992), however, it has also been implemented in NIAM (Geerts and McCarthy, 1991) and in object notation (Nakamura and Johnson, 1998). The general REA model for any particular transaction cycle consists

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