Chapter IX

Imprecise and Uncertain Engineering Information Modeling in Databases: Models and Formal Transformations

Z. M. Ma, Université de Sherbrooke, Canada

Abstract

Computer-based information systems have become the nerve center of current manufacturing systems. Engineering information modeling in databases is thus essential. However, information imprecision and uncertainty extensively arise in engineering design and manufacturing. So contemporary engineering applications have put a requirement on imprecise and uncertain information modeling. Viewed from database systems, engineering information modeling can be identified at two levels: conceptual data modeling and logical database modeling and correspondingly we have conceptual data models and logical database models, respectively. In this chapter, we firstly investigate information imprecision and uncertainty
in engineering applications. Then EXPRESS-G, which is a graphical modeling tool of EXPRESS for conceptual data modeling of engineering information, and nested relational databases are extended based on possibility distribution theory, respectively, in order to model imprecise and uncertain engineering information. The formal methods to mapping fuzzy EXPRESS-G schema to fuzzy nested relational schema are developed.

Introduction

Nowadays computer-based information systems have become the nerve center of current manufacturing systems. Engineering information modeling in databases is thus essential. From the point of view of database systems, engineering information modeling can be identified at two levels: conceptual data modeling and logical database modeling. Correspondingly, we have conceptual data models and logical database models for engineering information modeling, respectively. Product data models, for example, can be viewed as a class of conceptual data models that take into account the needs of engineering data (Shaw, Bloor & Pennington, 1989). Much attention has been directed at conceptual data modeling of engineering information because conceptual data models can capture and represent rich and complex semantics in engineering applications at a high abstract level. Limited by the power of traditional ER/EER (Chen, 1976) in engineering modeling, the International Organization for Standardization (ISO) has developed the Standard for the Exchange of Product Data (STEP, ISO 10303) in order to define a common data model and procedures for the exchange of information. STEP provides a means to describe a product model throughout its life cycle and to exchange data between different units. STEP consists of four major categories: description methods, implementation methods, conformance testing methodology and framework, and standardized application data models/schemata. EXPRESS (Schenck & Wilson, 1994), being the description methods of STEP and a conceptual schema language, can model product design, manufacturing, and production data and EXPRESS model hereby becomes a major one of the conceptual data models for engineering information modeling (Eastman & Fereshetian, 1994). Note that, however, not being the same as ER/EER and IDEF1X, EXPRESS is not a graphical schema language. In order to construct an EXPRESS data model at a higher abstract level, EXPRESS-G is introduced as the graphical representation of EXPRESS. Here EXPRESS-G can only express a subset of the full language of EXPRESS. In addition to EXPRESS-G, it is also suggested in STEP that IDEF1X or ER/EER can be used as one of the optional languages for EXPRESS data model design. Then EXPRESS-G, IDEF1X, ER/EER, or even UML data