Chapter 1.23
Databases Modeling of Engineering Information

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ABSTRACT

Information systems have become the nerve center of current computer-based engineering applications, which hereby put the requirements on engineering information modeling. Databases are designed to support data storage, processing, and retrieval activities related to data management, and database systems are the key to implementing engineering information modeling. It should be noted that, however, the current mainstream databases are mainly used for business applications. Some new engineering requirements challenge today's database technologies and promote their evolvement. Database modeling can be classified into two levels: conceptual data modeling and logical database modeling. In this chapter, we try to identify the requirements for engineering information modeling and then investigate the satisfactions of current database models to these requirements at two levels: conceptual data models and logical database models. In addition, the relationships among the conceptual data models and the logical database models for engineering information modeling are presented in the chapter viewed from database conceptual design.

INTRODUCTION

To increase product competitiveness, current manufacturing enterprises have to deliver their products at reduced cost and high quality in a short time. The change from sellers' market to buyers' market results in a steady decrease in the product life cycle time and the demands for tailor-made and small-batch products. All these changes require that manufacturing enterprises quickly respond to market changes. Traditional production patterns and manufacturing technologies may find it difficult to satisfy the requirements of current product development. Many types of advanced manufacturing techniques, such as Computer Integrated Manufacturing (CIM), Agile Manufacturing (AM), Concurrent Engineering (CE), and Virtual Enterprise (VE) based on global manufacturing have been proposed to meet these requirements. One of the foundational support-

ing strategies is the computer-based information technology. Information systems have become the nerve center of current manufacturing systems. So some new requirements on information modeling are introduced.

Database systems are the key to implementing information modeling. Engineering information modeling requires database support. Engineering applications, however, are data- and knowledge-intensive applications. Some unique characteristics and usage of new technologies have put many potential requirements on engineering information modeling, which challenge today's database systems and promote their evolvement. Database systems have gone through the development from hierarchical and network databases to relational databases. But in non-transaction processing such as CAD/CAPP/CAM (computer-aided design/computer-aided process planning/computer-aided manufacturing), knowledge-based system, multimedia and Internet systems, most of these data-intensive application systems suffer from the same limitations of relational databases. Therefore, some non-traditional data models have been proposed. These data models are fundamental tools for modeling databases or the potential database models. Incorporation between additional semantics and data models has been a major goal for database research and development.

Focusing on engineering applications of databases, in this chapter, we identify the requirements for engineering information modeling and investigate the satisfactions of current database models to these requirements. Here we differentiate two levels of database models: conceptual data models and logical database models. Constructions of database models for engineering information modeling are hereby proposed.

The remainder of the chapter is organized as follows: The next section identifies the generic requirements of engineering information modeling. The issues that current databases satisfy these requirements are then investigated in the third section. The fourth section proposes the constructions of database models. The final section concludes this chapter.

NEEDS FOR ENGINEERING INFORMATION MODELING

Complex Objects and Relationships

Engineering data have complex structures and are usually large in volume. But engineering design objects and their components are not independent. In particular, they are generally organized into taxonomical hierarchies. The specialization association is the well-known association. Also the part-whole association, which relates components to the compound of which they are part, is another key association in engineering settings.

In addition, the position relationships between the components of design objects and the configuration information are typically multi-dimensional. Also, the information of version evolution is obviously time-related. All these kinds of information should be stored. It is clear that spatio-temporal data modeling is essential in engineering design (Manwaring, Jones, & Glagowski, 1996).

Typically, product modeling for product family and product variants has resulted in product data models, which define the form and content of product data generated through the product lifecycle from specification through design to manufacturing. Products are generally complex (see Figure 1, which shows a simple example of product structure) and product data models should hereby have advanced modeling abilities for unstructured objects, relationships, abstractions, and so on (Shaw, Bloor, & de Pennington, 1989).

Data Exchange and Share

Engineering activities are generally performed across departmental and organization boundaries.