Chapter 4

Knowledge-Based Systems as Database Design Tools:
A Comparative Study

W. Amber Lo
Millersville University & Knowledge-Based Systems, Inc., USA

Joobin Choobineh
Texas A&M University, USA

Database design process is a knowledge intensive task that requires expertise, practical experience, and judgment. It is not surprising, therefore, that over the last few years many research prototype database design expert systems have been reported in the literature. This paper is a survey of such tools. These tools are compared with respect to four major aspects: database design support, tool flexibility, expert system features, and implementation characteristics. This study reveals that, in general, there is lack of 1) support for all the phases of the design, 2) support for group database design, 3) graphic support, 4) empirical verification of effectiveness of the tools, 5) long-term maintenance of the tool and database schemata, and 6) specialized knowledge representation schemes, inference, and learning techniques.

A database is a collection of related data that represents some relevant reality. The task of designing a database has traditionally been performed manually by database designers. The design process turns informal end-user requirements into the design of static database structures, specification of integrity rules, and (may include) specification of dynamic aspects of data (transactions and queries to be made). The four major steps of database design

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are Requirements Collection, Conceptual Design, Logical Design, and Physical Design. This process is complex and error-prone. With the maturity of AI techniques, there is a significant potential to automate parts or all of the design process by developing knowledge-based systems as design tools.

The following terms will be used throughout the paper. A “database design methodology” is a system of principles, procedures, techniques, rules, data models, tools, documentation, planning, management, control, and evaluation applied to the entire design process. A methodology should describe each of the above components in detail (Maddison et al. 1983, p. 4). A “database design technique” is a systematic procedure by which a complex task within a step of the database design process is performed. A “data model” is a set of logical concepts that can be used to describe the structure of a database. It should consist of two parts, a notation for describing data and a set of operations used to manipulate that data (Ullman, 1988, p. 32). A data model usually is not as comprehensive as a methodology. It has a set of notations and a method of using it. However, it usually lacks a unified step-by-step guideline on how to use the concepts to represent a database structure. A “database design tool” is computer software used to perform or assist in one or more of the step(s) of the database design process. A tool is based on a data model or design technique. This can enhance the validity and uniformity of the design.

The objectives of this paper are threefold. First, to define desirable features of a knowledge-based database design tool. Second, to compare 23 existing knowledge-based systems so as to provide an overview and evaluation of the current state of research. Third, to identify future research directions in the development of computer-aided software engineering (CASE) tools for database design. Desirable database design tool features will be reviewed in the next section. The major body of the paper is contained in the third section where 23 existing intelligent tools will be compared. Based on this survey, we will conclude the paper by presenting a discussion on research progress and future research directions in section four.

DESIRABLE FEATURES OF KNOWLEDGE-BASED DATABASE DESIGN TOOLS

Based on published literature, we have chosen four distinct sets of desirable features of knowledge-based database design tools. These are database design support, tool flexibility, knowledge-based system features, and implementation features. A summary of these are presented in Figure 1.

The extent of usefulness of database design support includes the number of design steps covered, support for view integration, completeness of the
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