1. Introduction

Graphs representing a description of a database can be used as the basis for various types of interfaces, with each interface suitable to a different type of database user. A forms administrator can manipulate the graph to create form templates that are used to display data from the database. Database Management System (DBMS) users can manipulate the graph directly to formulate DBMS requests. Graphs play an important role in an interface for novice DBMS users learning a traditional query language. Manipulating graphs is a powerful tool for database administrators in database design. This paper describes four interfaces that use entity relationship (E–R) graphs:

- Interface for forms administrators to create forms templates used to display data from the database;
- Interface of DBMS users to formulate requests by directly manipulating the E–R graph;
- Interface for novice users learning a traditional DBMS command language;
- Interface for database administrators to design databases.

The entity–relationship data model and its variants have become very popular in database design. This is in part due to their graphic notation. Algorithms have been designed to lay out and display an E–R graph on a video screen. By using these algorithms, the display of a graphical structure representing the schema of a database can be used in a variety of situations.

Figure 1 shows an example of an E–R schema for a university database. Entity sets are represented by rectangles; attributes are represented...
by ovals; and relationships between entity sets are represented by diamonds. The entity sets are Department, Student, Instructor, Course, and Section. Each student has the attributes Name, Ssn (Social Security Number), and Class (such as Freshman, Senior, Graduate), and is related to major department.

Each student is also related to the sections of courses completed, and the Grade in that course is an attribute of the relationship. Each section has the attributes Number (the section number of a course), Year, and Qtr (the year and quarter in which the section was given). A section is related to the course of which it is a section, to the students that enrolled in that section, and to the instructor who taught the section. An instructor has the attributes Name, Ssn, Rank (such as assistant professor), and Salary, and is related to a department and to the sections of a course that he or she taught. A department has the attribute Name and is related to the instructors in that department, the courses offered by the department, and the students who major in that department. Finally, each course has a Name (such as Introduction to Computing) and number (such as CS105) and is related to the sections of that course given and the department under