# DATABASE PROCESSING

## *Fundamentals, Design & Implementation*

*Seventh Edition*

DAVID M. KROENKE

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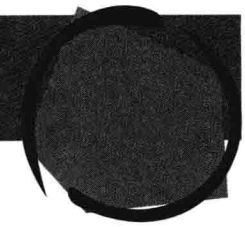
# PREFACE



In 1983, the popularity of the IBM personal computer prompted one industry pundit to write, "After years of explosive growth, the computer industry has finally reached its infancy." Today, the same statement can be made about the Internet: After years of explosive growth, the Internet has finally reached its infancy.

True enough, but why does the Internet matter to database processing? Part of the answer is that the Internet tremendously amplifies the importance of database technology, knowledge, and skills. Chapter 13 shows how to call Active Data Objects from script code in Microsoft IIS Active Server Pages for the purpose of listing a table. Basically, the example wraps a straightforward SQL SELECT statement with Internet technology to perform a task that was simple many years ago. This isn't particularly special except that, as of December, 1998, 153 million people worldwide can view that table with software that is already in place on their computer!

The Internet (and organizational intranets) need database technology to move from brochure publishing to application publishing. We know the stories of Amazon.com, Dell Computer, and other well-known "e-tailers." Database applications are, of course, critically important to those companies. Lesser known are smaller companies like the yacht broker in Seattle who used a database application to sell a boat located in Hawaii to a customer living in North Carolina. The broker never met the buyer nor saw the boat. The contract was negotiated over the Web, the buyer flew to Hawaii to inspect the boat, and the deal was done. The net was $4700 to the broker for basically an Internet information service.

The Internet is important to database processing not only as amplifier, however, but also because of the new technologies being developed. I believe that XML (see Chapter 11) is the most important development for database processing since the relational model. What justifies such a dramatic statement? By separating structure, content, and materialization, XML is the perfect protocol for exchanging database views. Because it is extensible in a standardized way, and because it readily represents arbitrary hierarchical structures, XML provides a superior means for organizations to exchange database views. In time, XML will revolutionize electronic data interchange.

Now, before we all run off to our offices shrieking in panic about the amount of new technology to be learned, consider this perspective: Internet technology provides a wrapper around the fundamentals we have always taught. Thus, I believe we need first to teach data modeling, normalization, database design, database application design, and then follow that by teaching the application of these fundamentals for the Internet and organizational intranets. Hence, in this text, the first 10 chapters address fundamentals; it is only the next three that concern Internet technologies.

One last note on important new developments—with Office 2000, Microsoft will place its Pivot Table Service on the desktops of the world. This service is a desktop version of its OLAP server and, indeed, it can process not only local OLAP cubes, but also those stored on remote computers providing OLAP services for large databases. Hence, this edition augments the data warehousing material in Chapter 14 with a substantial discussion of OLAP.

## Microsoft Access and SQL Server and Wall Data's DBApp

I have used Access 2000 to illustrate discussion points throughout the text. This is done primarily to give form and substance to otherwise ethereal ideas. Also, since Access is the world's most popular database management system (DBMS), it is the product students are most likely to have now and to encounter later in their careers.

In addition to Access, the Microsoft Corporation agreed to license the Evaluation Edition of SQL Server 7.0 to users of this text, free of charge. A copy of this software is shrink-wrapped with this text. This version of SQL Server 7.0 can be run on Windows 95, Windows 98, Windows NT, and Windows 2000. It requires a 166 MHz or higher Pentium processor, 32 megabytes of RAM, and from 65–180 MB of disk storage. The license for this software lasts for 120 days from the date of installation, which should be more than adequate for student use in your course. Installation and use of SQL Server is described in Appendix B.

Appendix C presents Wall Data's DBApp. This software, which is available for free to students from the Prentice Hall Web site (**www.prenhall.com/kroenke**), can be used to create semantic object data models, to generate both Access and SQL Server database schemas, and to create .asp pages for publishing database views on the Web. DBApp will also reverse engineer existing databases and create semantic object models from them. See Appendix C for more information.

## Organization of This Book

This text is organized into seven parts. Part I provides an introduction. A number of different types of databases and applications are presented in Chapter 1, along with important definitions and a brief history of database processing. Chapter 2 illustrates the components of a DBMS and provides an overview of the process of building a database and related applications.

The focus of Part II is on data modeling. Chapter 3 explains the concepts and constructs of the entity-relationship model and illustrates its use. Chapter 4 presents the semantic object model in a similar way. Either of these models can be used to express the users' data requirements.

Part III discusses the transformation of data models into relational database designs. Chapter 5 sets the stage by discussing the relational model and normalization. Normalization techniques are then used in Chapter 6 to explain the transformation of entity-relationship data models into relational designs and in Chapter 7 to explain the transformation of semantic object models into relational designs.

The implementation of relational databases is presented in Part IV. Chapter 8 discusses the foundations of relational implementation and relational algebra. Chapter 9 then presents SQL in a DBMS-independent manner. Chapter 10 concludes Part IV by discussing the design of database applications. This chapter sets the stage for the next three chapters by making a clear distinction between database views and materializations on database views. It also discusses application roles in the enforcement of constraints and business rules.

Part V concerns database processing using Internet technologies. Chapter 11 introduces basic Web concepts and describes the three-tier processing architecture. Web-oriented programming languages like JavaScript, VBScript, and Java are described and the features and functions of DHTML and XML are discussed. The chapter concludes with an explanation of the role and purpose of Active Server Pages. Chapter 12 then focuses on the database server tier. Concurrency control, transaction management, backup and recovery, and security are all addressed.

Finally, Chapter 13 describes standards for accessing Web databases including ODBC, OLE DB, and ADO.

Enterprise database processing is addressed in Part VI. Chapter 14 discusses enterprise database system architectures, describes the processing of downloaded data, and surveys OLAP. It concludes with a discussion of data warehousing and data administration. Chapter 15 then presents a case example of DB2 and Chapter 16 discusses the hierarchical and network data models. Both of these models are old but have come back into prominence because of the need to fix Y2K problems as well as the need to find some way to put their data on the Web. OLE DB will give new importance to IMS to our students.

Chapter 17, the sole chapter in Part VII, addresses object-oriented DBMS technology. While such databases are of conceptual interest, they play, at most, a minor role in commercial database processing. This chapter therefore presents basic concepts so that students will be familiar with the important ODBMS terminology and standards.

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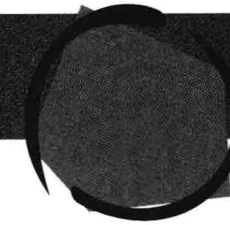
Thanks to the Microsoft Corporation for the complementary license to readers of this text for SQL Server 7.0. I am especially grateful to John Wall and the executive team at Wall Data for the complementary license to use DBApp and also for their continuous support of the educational community since 1992. Many of the ideas in this text arose from delightful and interesting conversations with Wall Data employees and especially with Ted Carroll, Lee Eggebrotten, Ed Fogard, Mike Gardner, Pat Hammack, Kenji Kawai, Michael Miller, Nick Nichols, Chris Olds, Charles Porter, Danny Rosenthal, and Cathy Stanford. I am most grateful to all of them for their time, their thoughts, and their consideration. Finally, a special thanks to Lynda, whose delightful presence has been not only an inspiration but also a steadfast support through thick and thin.

The computer industry is as exciting and interesting today as at any time since I entered it in 1967. I sincerely hope that readers of this text will have as much fun with this technology as I have had. If they have even half as much, they will truly be blessed.

David Kroenke
Seattle, Washington

# DATABASE PROCESSING

# BRIEF CONTENTS



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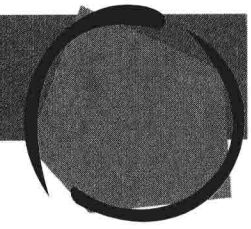

PART I

# INTRODUCTION

The two chapters in Part I introduce the topic of database processing. Chapter 1 describes four typical database applications and discusses the advantages of databases over earlier file-processing systems. It also defines the term *database* and surveys the history of database processing. Chapter 2 then summarizes the tasks necessary to develop a database and related applications. It also describes the elements of a database and surveys the functions of the DBMS as well.

This part provides an overview of the need for databases and the nature of the components of databases and their related applications. Its purpose is to set the stage for your study of the details of database technology in subsequent chapters.


# Introduction to Database Processing

Database processing has always been an important topic in the study of information systems. In recent years, however, the explosion of the World Wide Web (WWW) and the dramatic development of new technology for the Internet has made knowledge of database technology one of the hottest career paths. Database technology enables Internet applications to step beyond the simple brochure publishing that characterized early applications. At the same time, Internet technology provides a standardized and readily accessible means of publishing database content to users. None of these new developments takes away from the need for classical database applications that were vital to business interests prior to the rise of the Internet. They simply amplify the importance of database knowledge.

Many students find this subject enjoyable and interesting, even though it can be challenging. Database design and development involve both art and engineering. Understanding user requirements and translating them into effective database designs is an artistic process. Transforming those designs into physical databases with functionally complete, high performance applications is an engineering process. Both aspects are full of challenging and enjoyable intellectual puzzles.

Because of the immense need for database technology, the skills you develop and the knowledge you gain in this course will be in great demand. The goal of this text is to provide a solid foundation in the fundamentals of database technology so that you can begin a successful career in this field if you choose to do so.

## ➤ FOUR DATABASE EXAMPLES

The purpose of a database is to help people keep track of things. The classical database applications concern the tracking of items like orders, customers, jobs, employees, phone calls, or other items of interest to a business person. Recently, as databases have become more readily available, database technology has been applied to new areas such as databases for the Internet or for organizational intranets. Also, databases are increasingly used to create and maintain multimedia applications. Consider several typical examples.

## Mary Richards Housepainting

Mary Richards is a professional housepainter who owns and operates a small company consisting of herself, another professional painter, and, when needed, part-time painters. Mary has been in business for ten years and has earned a reputation as a high-quality painter who works for a reasonable rate. Mary gets most of her work through repeat business from customers who hire her to paint their houses and also from their word-of-mouth referrals. In addition, Mary gets some work from building contractors and professional interior designers.

Customers remember Mary far better than she remembers them. Indeed, sometimes she is embarrassed when a customer calls and says something like, "Hi Mary, this is John Maples. You painted my house three years ago." Mary knows she is supposed to remember the caller and the work she did for him, but since she paints more than fifty houses a year, it usually is difficult for her to do so. This situation becomes worse when the customer says something like, "My neighbor liked the job you did on our house and would like something similar done to her house."

In order to help her memory and to keep better track of her business records, Mary had a consultant develop a database and database application that she uses on her personal computer. The database stores records regarding customers, jobs, and sources in the form of tables, as shown in the example in Figure 1-1.

It is the job of a program called a database management system (DBMS) to store and retrieve the data in these tables. Unfortunately, when such data are in the form of tables, they are not very useful to Mary. Rather, she would like to know how customers and jobs and referrals relate to one another, for example, what jobs she has done for a particular customer or what customers have been referred by a particular person.

To provide this capability, Mary's consultant created a database application that processes data entry forms and produces reports. Consider the example form in Figure 1-2. Here, Mary keys in data about customers such as name, phone, and address. She also links the customer to a particular referral source and keys in data about jobs performed for the customer. This data can then be displayed in

➤ FIGURE 1-1

*Tables of Data for Mary Richards Housepainting*