CHAPTER 1

Introductory Database Concepts

Chapter Objectives

In this chapter you will learn:

- How databases are used in everyday life
- The major functions of a database management system
- Advantages of using an integrated database system
- Disadvantages of databases
- Roles in the integrated database environment
- The history of information systems

1.1 Databases in Everyday Life

Today, databases are so widely used that they can be found in organizations of all sizes, ranging from large corporations and government agencies to small businesses and even homes. Everyday activities often bring you into contact with databases, either directly or indirectly.

- When you visit a **consumer Web site** that allows online browsing and ordering of goods such as books or clothing, you are accessing a database. The information about available products and the data about your order are stored in a database. You may also be able to view stored data about previous orders you have placed. Some Web sites may use information about your orders, or even your browsing activities, to suggest products or services that are likely to interest you.
- When you visit an interactive **customer service** Web site, such as the home page of a utility company or a health insurer, you are able to access information about your own records of services or products provided. You may be able to update database entries with personal information such as your address or telephone number. Some customer service Web sites allow you to make changes to the services you subscribe to. For example, your telephone services provider or electric company may allow you to change plans online.
- If you use **online banking,** you can retrieve database records about deposits, withdrawals, bill payments, and other transactions for your accounts. You can transfer funds, order checks, and perform many other functions, all of which involve using a database.
- When you use a **credit card,** the salesperson usually waits for computer approval of your purchase before presenting you with a receipt for your signature. The approval process consults a database to verify that your card has not been lost or stolen and to find your credit limit, current balance, and amount of purchases already approved. The database is automatically updated to reflect the new approved amount. For a debit card, your bank's database is consulted to verify your account number, your PIN, your current balance, and your adjusted balance prior to approval of the purchase. The purchase amount is automatically deducted from your account as the transaction is completed.

- When you buy goods in a **supermarket** or **retail store,** scanners are used to read universal product codes or other identifiers of merchandise. Using the scanned code, the database system can identify the exact item and produce a receipt with the name of the item and its price, taking into account any special sale price. The system may also provide input for an **inventory control** system, so that the inventory record for each item can be updated to reflect the sale. If the inventory falls below a level called the reorder point, the computer can automatically place an order to replenish the stock.
- When you make travel plans, you can access an **airline reservations system** in which a database is used to keep track of scheduled flights and passenger reservations. Since several travelers may request reservations simultaneously, the system must be able to handle requests quickly, resolving conflicts and accepting requests until the maximum number of seats is reached. Many hotel chains and rental car companies also have centralized reservation systems to accept reservations for any of their locations, using an integrated database system.
- If you visit a doctor, you may find that your **medical records** and **billing data** are kept in a database. When you have a prescription filled, your pharmacist will probably use a database to record information about the prescription, check for interactions with drugs you are currently using, and print the label and receipt. Both the doctor and the pharmacist may use their databases to do third-party billing, automatically verifying your coverage and submitting insurance claims for covered expenditures, while you pay only your co-payment. All health providers in the United States are required to protect your privacy during these transactions, in accordance with the Health Insurance Portability Accountability Act (HIPAA) privacy legislation.
- Your **employment records** might be kept in a database that stores basic information such as your name, address, employee ID, job assignments, and performance evaluations. Your payroll is probably produced using a database that stores information about each pay period and data about the year's gross pay, tax deductions, and taxes withheld, among other things. Your pay stub reflects this data each payday.

- Your **school records** are probably kept in a database that is updated each term to record your registration in, completion of, and grade for each class.
- To do research, you can use a **bibliographic database** in which you enter keywords that describe the subject of interest. You may get back results that contain hypertext, allowing you to retrieve abstracts or entire articles of interest in your subject area.

As this short overview of activities demonstrates, databases are used to satisfy the information needs of many organizations and individuals in a variety of areas. However, a poorly designed database fails to provide the required information, or provide outdated, flawed, or contradictory information. In order to maximize their potential benefits, it is important to understand the theoretical foundations, internal structure, design, and management of databases.

1.2 A Sample Database

Consider a simple database that records information about university students, the classes they take during one semester, and the professors who teach the classes. The information kept for each student includes the student's ID, name, major, and total number of credits earned. Using **Microsoft Access** for this example, we have a **table** for this data as shown in Figure 1.1(a). The Student table has five columns, named stuId, lastName, firstName, major, and credits. Each row of the table shows the student ID, last name, first name, major, and number of credits for one student. The values of these items for each student are placed in the columns with the corresponding names. The Faculty table has columns named facId, name, department, and rank, as shown in Figure 1.1(b). Each row of that table gives the faculty ID, last name, department, and rank of one faculty member. Class information kept for each class course offered includes the class number, the faculty ID of the professor, the schedule, and the room, in appropriate columns as shown in the Class table in Figure 1.1(c). These three tables alone do not allow us to determine which classes a student is taking. To represent the fact that a student is enrolled in a particular class, we need another table, which we call Enroll, pictured in Figure 1.1(d). The columns of Enroll are stuId, classNumber, and grade. Notice that the Enroll table represents the **relationship** between Student and Class, telling us which rows of these tables are related (i.e., which students take which classes). For example, the first row, with values S1001, ART103A, tells us that the student whose ID is S1001 is enrolled in the class whose class number is ART103A. The last column of the row tells us the

grade each student earned in each class. Since these represent current enrollments, we will assume that the grade is the mid-term grade. At the end of the semester, it can be changed to the final grade. Note that we did not put student names as well as the ID in this table, because they are already in the Stu-

Student

stuId	lastName	firstName	major	credits
S1001	Smith	Tom	History	90
S1002	Chin	Ann	Math	36
S1005	Lee	Perry	History	3
S1010	Burns	Edward	Art	63
S1013	McCarthy	Owen	Math	0
S1015	Jones	Mary	Math	42
S1020	Rivera	Jane	CSC	15

FIGURE 1.1(a)
The Student Table

Faculty

facId	name	department	rank
F101	Adams	Art	Professor
F105	Tanaka	CSC	Instructor
F110	Byrne	Math	Assistant
F115	Smith	History	Associate
F221	Smith	CSC	Professor

FIGURE 1.1(b)
The Faculty Table

Class

classNumber	facId	schedule	room
ART103A	F101	MWF9	H221
CSC201A	F105	TuThF10	M110
CSC203A	F105	MThF12	M110
HST205A	F115	MWF11	H221
MTH101B	F110	MTuTh9	H225
MTH103C	F110	MWF11	H225

FIGURE 1.1(c)
The Class Table

FIGURE 1.1(d)
The Enroll Table

Enroll

stuId	classNumber	grade
S1001	ART103A	A
S1001	HST205A	C
S1002	ART103A	D
S1002	CSC201A	F
S1002	MTH103C	B
S1010	ART103A	
S1010	MTH103C	
S1020	CSC201A	B
S1020	MTH101B	A

dent table, and we want to avoid the redundancy and possible inconsistency that storing the names twice would cause. The tables shown were created using Access, and we can use Access to update them, to ask questions (queries) about the data in them, to create reports about the data, and to do many other functions. As an example of a query, suppose we want the names of all students enrolled in ART103A. First, how do we find the answer to the question visually? Looking at the database, we see that the Enroll table tells us which students are enrolled in ART103A. However, it gives us the stuId of each student, not the name. Student names appear on the Student table. One plan for answering the question is to look at the Enroll table and find all the rows where the value of classNumber is ART103 and make note of the stuId values in those rows, namely, S1001, S1002, and S1010. Then we look at the Student table and find the rows containing those values in the stuId column. We find the answer to the question by listing the lastName and firstName values in those rows, giving us Smith Tom, Chin Ann, and Burns Edward. Access provides a **query tool** that allows us to check off which columns are included in a query and to specify conditions for the records in the results. Figure 1.2 shows the results of executing the preceding query using this tool. We can also use the **reporting tool** in Access to generate a variety of reports. Figure 1.3 shows a typical report called Class Lists that shows each class number, the ID and name of the faculty member teaching the class, and the IDs and names of all the students in that class.

Query1

lastName	firstName
Smith	Tom
Chin	Ann
Lee	Perry

FIGURE 1.2
Results of the Query: "Find names of all students enrolled in ART103A"

Class Lists

classNumber	facId	name	stuId	lastName	firstName
ART103A	*F101*	*Adams*	S1001	Smith	Tom
			S1002	Chin	Ann
			S1010	Burns	Edward
CSC201A	*F105*	*Tanaka*	S1002	Chin	Ann
			S1020	Rivera	Jane
HST205A	*F115*	*Smith*	S1001	Smith	Tom
MTH101B	*F110*	*Byrne*	S1020	Rivera	Jane
MTH103C	*F110*	*Byrne*	S1002	Chin	Ann
			S1010	Burns	Edward

FIGURE 1.3
Class Lists Report

1.3 The Integrated Database Environment

An **integrated database environment** has a single large repository of data, called the database, which is used simultaneously by many departments and users in an organization. All data needed by the organization for a specific group of applications or even for all of its applications is stored together, with as little repetition as possible. (Note: Although the word *data* is plural in standard English, it is customary to use it as both singular and plural in database literature, as in "data is" and "data are.") Several different types of records may appear in the database. The logical connections between the data items and records are also stored in the database, so that the system "knows," for example, which faculty record is connected to a particular class record. The database is not owned by a single department, but is a shared resource. In a large organization, the database is managed by a **database administrator** (DBA), who is responsible for

creating and maintaining the database to satisfy the needs of users. All access to the database is controlled by a sophisticated software package called the **Database Management System** (DBMS). This package has programs that set up the original storage structures, load the data, accept data requests from programs and users, format retrieved data so that it appears in the form the program or user expects, hide data that a particular user should not have access to, accept and perform updates, allow concurrent use of the data without having users interfere with each other, and perform backup and recovery procedures automatically. These are just some of the many functions of the database management system.

Figure 1.4 illustrates an integrated database environment. Here, all the data about students, classes, faculty, and enrollments is stored in a single database. The data is integrated, so that the data items are stored in compatible formats and logical connections between them are also stored. The database contains a description of its own structure so the DBMS "knows" what data items exist and how they are structured or grouped. It is shared by many users, usually concurrently. All access to the data is through the DBMS. The applications programs, which might be written in different programming languages, go through the DBMS, which can present data in the form each program expects. Only the DBMS is aware of the storage structures used in the database. In addition to providing support for applications, the DBMS provides a user interface for interactive queries. Authorized users can question the database directly, using the query language of the particular DBMS.

1.4 Roles in the Integrated Database Environment

Many individuals or groups are involved in the operations of a database system. They play different roles, depending on the way they interact with the database, as depicted in Figure 1.5.

- End Users
  The database is designed, created, and maintained to serve the information needs of **end users,** people who use the data to perform their jobs. Regardless of the elegance of the database design or the sophistication of the hardware and software used, if the database does not provide adequate information to users, it is a failure. Ultimately, it is the users who judge the success of the system. Users can be categorized according to the way they access data. Sophisticated users (also called **casual users**) are trained in the use of the interactive query language, and access data by enter-

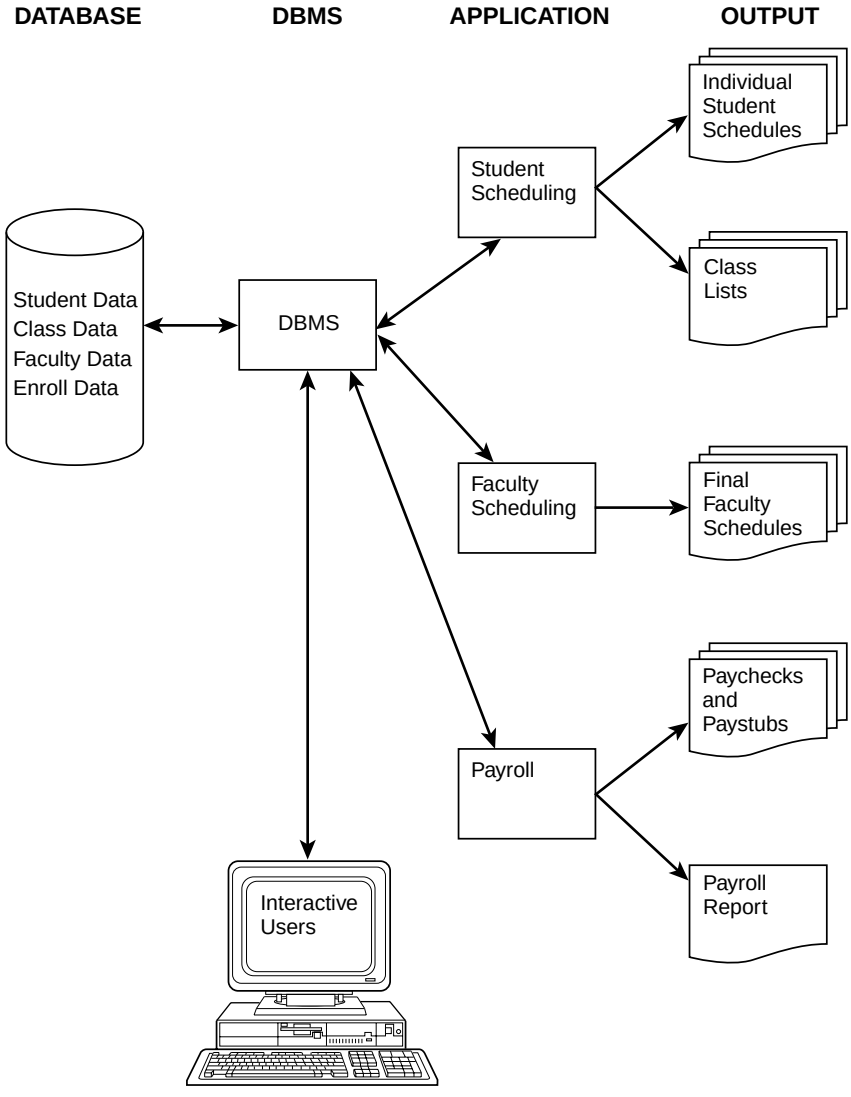

FIGURE 1.4
The Integrated Database Environment

ing queries at workstations. The flexibility of the query language allows them to perform many different operations on the database, limited only by the view they have been assigned and their authorizations. Casual users may perform retrieval, insertion, deletion, or update operations through the query language, provided they are authorized to do so. **Naive users** do not use the interactive query language, but access data through application programs that have been written for them. They invoke the programs by entering simple commands or choosing options from a menu. They do not

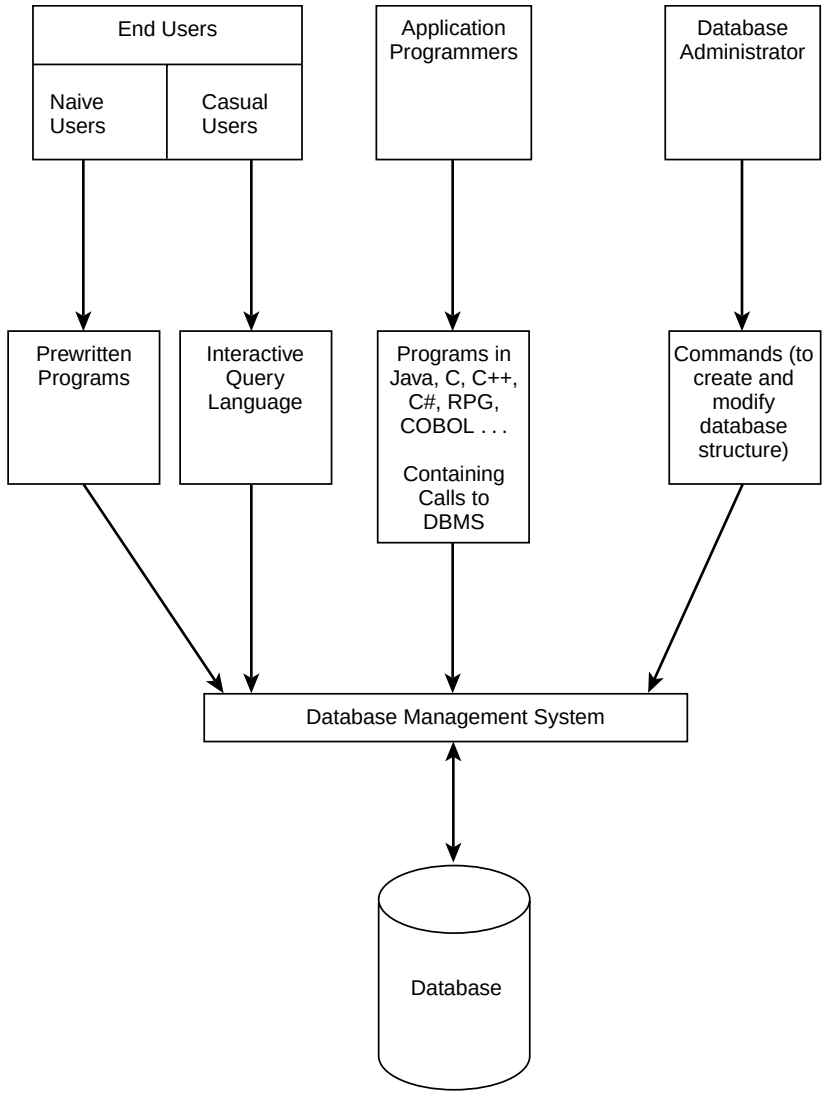

FIGURE 1.5
Roles in the Database Environment

need to know any details of the structure or language of the database system. They interact with the system in a less sophisticated way, restricting their access to operations performed by the programs. The programs themselves may perform update or retrieval operations. An even larger group of **secondary users** may use the information in the database, without interacting directly with it, by receiving output that they use in their work.

For example, in a university Registrar's Office, clerks may be naive users, while the registrar may be a casual user. The clerks perform

simple, repetitive tasks such as printing out student transcripts. They may enter the name of the transaction, TRANSCRIPT, or choose an option such as PRINT OUT TRANSCRIPT from a menu. The TRANSCRIPT program would prompt the clerk for the student ID or other identifying information, and complete its task without further instructions from the clerk. The registrar uses the query language to ask one-of-a-kind questions such as, "How many students are registered for six or more classes this semester?" If there is no pre-written program in the DBMS system to answer this question, the registrar writes statements in the query language of that particular database. The students who receive printed transcripts, and the professors who receive class rosters, are secondary users.

- Applications Programmers
  This group includes programmers who write batch, or interactive, applications for other users. Their application programs may be written in a variety of host programming languages such as Java, C, C++, C#, Visual BASIC, RPG, or COBOL. Each program that accesses the database contains statements that call the database management system to perform updates or retrievals on the database. Some sophisticated end users who have both the knowledge of the programming language, and who have permission to do so, are able to write applications for their own use.

- Database Administrator
  The database administrator is the individual or group responsible for designing, creating the structure of, and maintaining the database. In many cases the database is designed by a specialist, and the DBA takes over responsibility once the design is complete. The database designer begins the design process by interviewing users to determine their data needs. He or she examines the current system, analyzes the organization and its information needs, and develops a tentative model for the database. The model is refined and improved as the designer, in consultation with users, becomes more aware of their data needs and learns more about the functioning of the organization. When a satisfactory design is developed, the DBA implements it. Once again, users are consulted to determine whether the operational system is adequate. The design, refinement and redesign of the system are all team efforts, with the designer, DBA, and users working together to develop the best data resource for the entire organization. The DBA interacts

with the operational database as a "superuser," one who controls and accesses information about the structure and use of the database itself, as opposed to end users, who access the data within the database. Chapter 2 contains a more detailed description of the functions of the database administrator.

1.5 Advantages of the Integrated Database Approach

Before integrated databases were created, **file processing** systems were used, and data used by an organization's application programs was stored in separate files. Typically, a department that needed an application program worked with the organization's data processing department to create specifications for both the program and the data needed for it. Often the same data was collected and stored independently by several departments within an organization, but not shared. Each application had its own data files that were created specifically for the application, and that belonged to the department for which the application was written. The integrated database approach has several advantages:

1. Sharing of Data
   The database belongs to the entire organization. The DBA manages the data, but the data does not belong to any individual or department. Thus the organization has control over the data it needs to conduct its business. Many users can be authorized to access the same piece of information. Authorization to access the data is given by the DBA, not by another department.

2. Control of Redundancy
   When stored in a database, information is integrated so that multiple copies of the same data are not stored unless necessary. Some limited redundancy is permitted to keep logical connections among data items or to improve performance. For example, in the university example discussed in Section 1.2, the student ID appeared in both the Student table and the Enroll table. The database management system "knows about" that repetition. A database ordinarily does not have multiple copies of entire records, unlike a file system, where different departments may have duplicates of entire files.

3. Data Consistency
   One effect of eliminating or controlling redundancy is that the data is consistent. If a data item appears only once, any update to

its value needs to be performed only once, and all users will have access to the same new value. If the system has some controlled redundancy, when it receives an update to an item that appears more than once it can often do cascading updates. This means it will automatically update every occurrence of that item, keeping the database consistent. For example, if we change the ID of a student in the Student table, the Enroll records for that student will be updated to show the new ID automatically.

4. Improved Data Standards
   The DBA, who is responsible for designing and maintaining the database to serve the needs of all users, defines and enforces organization-wide standards for representation of data in the database. Included in this category are rules such as the format of all data items, conventions on data names, documentation standards, frequency of updates, update procedures, frequency of backups, backup procedures, and permitted usage of the database. For example, the DBA might make a rule for addresses to be stored in a particular format. In the United States, a convention might be that two-letter abbreviations are used for state names. The database can be set up so that any other representation is rejected. In other countries, postal zones might be defined to be a certain number of characters.

5. Better Data Security
   The data in an organization's database is a valuable corporate resource that should be protected from intentional or accidental misuse. Data security is the protection of the database from unauthorized access by persons or programs that might misuse or damage the data. A database system allows security restrictions to be defined and enforced on several levels. All authorized access to the database is through the DBMS, which can require that users go through security procedures or use passwords to gain access to the database. To preclude the possibility of having a user bypass the DBMS and gain access to data in an illegal manner, the DBMS can encrypt the data before storing it. Then, when an authorized user wishes to retrieve data, it will be decrypted automatically. Data retrieved in any other way will appear in its encrypted form. Authorized users may be unaware of data encryption. Each user is provided with a view of a predefined portion of the database. For

example, in a university the Registrar's Office may have access to some faculty information such as the Faculty Table in our earlier example, but not to such items as salary. Included in the view are descriptions of the data items the user is permitted to access, and the type of access allowed, whether retrieval only, update or deletion of existing records, or insertion of new records. If a user attempts to access an item that is not included in his or her view, or attempts an unauthorized operation, the DBMS automatically records the user ID in a security log that is available to the DBA.

6. Improved Data Integrity
   Some database management systems allow the DBA to define integrity constraints—consistency rules that the database must obey. These constraints apply to items within a record (intra-record constraints), or to records that are related to one another (inter-record constraints), or they might be general business constraints. For example, in class records, there may be a rule that the number of students enrolled in a class never exceeds some maximum allowed enrollment. Another rule may be that the faculty ID in a class record must correspond to an actual faculty ID in a faculty record. The DBMS is responsible for never allowing a record insertion, deletion, or update that violates an integrity constraint.

7. Balancing of Conflicting Requirements
   Each department or individual user has data needs that may be in conflict with those of other users. The DBA is aware of the needs of all users and can make decisions about the design, use, and maintenance of the database that provide the best solutions for the organization as a whole. These decisions usually favor the most important applications, possibly at the expense of the less vital ones.

8. Faster Development of New Applications
   A well-designed database provides an accurate model of the operations of the organization. When a new application is proposed, it is likely that the data required is already stored in the database. If so, the DBMS can provide data in the form required by the program. Development time is reduced because no file creation phase is needed for the new application, as it is when file processing systems were used.

9. Better Data Accessibility
   In addition to providing data for programs, most database management systems allow interactive access by users. They provide query languages that permit users to ask ad hoc questions and to obtain the desired information.

10. Economy of Scale
    When all of the organization's data requirements are satisfied by one database instead of many separate files, the size of the combined operation provides several advantages. The portion of the budget that would ordinarily be allocated to various departments for their data design, storage, and maintenance costs can be pooled, possibly resulting in a lower total cost. The pooled resources can be used to develop a more sophisticated and powerful system than any department could afford individually, providing features not available in a file processing environment. Programmer time that would ordinarily be devoted to designing files and writing programs to access them can be spent on improving the database. Any improvement to the database benefits many users.

11. More Control over Concurrency
    If two users are permitted to access data simultaneously, and at least one of them is updating data, it is possible that they will interfere with each other. For example, if both attempt to perform updates, one update may be lost, because the second might overwrite the value recorded by the first. If the updates are meant to be cumulative, this is a serious problem. Most integrated database management systems have subsystems to control concurrency so that transactions are not lost or performed incorrectly.

12. Better Backup and Recovery Procedures
    In a database environment, the database records are normally backed up (copied) on a regular basis, perhaps nightly. A tape or other medium is used to keep the backup secure. As transactions are performed, any updates are recorded to a log of changes. If the system fails, the tape and log are used to bring the database to the state it was in just prior to the failure. The system is therefore self-recovering.

1.6 Disadvantages of the Integrated Database Approach

There are also some disadvantages to an integrated database environment, compared to a file system:

1. High Cost of DBMS
   Because a complete database management system is a very large and sophisticated piece of software, it is expensive to purchase or lease.
2. Higher Hardware Costs
   Additional memory and processing power are required to run the DBMS, resulting in the need for upgrading hardware.
3. Higher Programming Costs
   Because a DBMS is a complex tool with many features, the organization's programmers need a thorough knowledge of the system in order to use it to best advantage. Whether the organization hires experienced database programmers or retrains its own programming personnel, it is paying for this expertise.
4. High Conversion Costs
   When an organization converts to a new database system, data has to be removed from existing files and loaded into the database. Because of the different formats used in files, this may be a difficult and time-consuming process. In addition, the applications programs, which contain details about the storage and structure of the old files, must be modified to work with the DBMS.
5. Slower Processing of Some Applications
   Although an integrated database is designed to provide better information more quickly than a traditional system using separate files, some applications are slower. For example, a typical payroll file is set up in a sequence that matches the payroll program, and contains only the data needed for this application. It is designed specifically to make that application as efficient as possible. In the database, the employee records may not be stored consecutively and the normal retrieval may not be in the sequence needed by the payroll program. Therefore, this program will take longer to execute.
6. Increased Vulnerability
   Whenever resources are centralized, there is an increased security risk. Since all applications depend on the database system, the fail-

ure of any system component can bring operations to a standstill. Failure of a single applications program can have an effect on other programs that may have used incorrect data created by the failed program.

7. More Difficult Recovery
   The recovery process after a database failure is complicated because many transactions could have been in progress when the system failed. As part of its recovery, the system must determine which transactions were completed and which were still in progress at the time of failure. If the database is damaged, it can be recovered by using the backup tape and the log. The fact that a database allows users to make updates concurrently further complicates the recovery process.

1.7 Historical Developments in Information Systems

The need to record data goes back to earliest recorded history. We see evidence of attempts to provide permanent records of transactions in Sumarian clay tables, in artifacts left by the Babylonians, in ancient Egyptian hieroglyphics, and even in cave paintings. Paper records or other written forms have been used for centuries to record information about family histories, treaties and other agreements, household or business inventories, school enrollment, employee records, payment for goods or services, census data, and many other facets of life.

The use of **punched cards** for data storage was introduced in 1890, when US census data was collected and stored on punched cards for the first time. The US Constitution requires that a complete census be conducted every 10 years. The 1880 census took seven years to complete because the country's population had increased so much that it was anticipated there would not be sufficient time to complete the census before 1900, when a new one would begin. The Census Bureau sponsored a competition to spur ideas about ways to make the census more efficient. Herman Hollerith, an employee at the bureau, proposed the use of punched cards to record census responses from each household and to facilitate processing of the responses. Such cards were already in use in the silk weaving industry in Lyon, France to control the Jacquard loom, which wove patterns in silk fabric. Hollerith designed a method of using the same technology to store the census data and to examine its patterns. He won the competition

and because of his design the census was completed in record time—and a new technique for data processing was invented. After that success, mechanical punched-card equipment was used for many years for storing, sorting, analyzing, and reporting data, and punched cards served as an input medium for computers for both programs and data.

Punched paper tape was used to store both computer programs and data beginning in the early 1940s, when the earliest electro-mechanical and electronic computers were developed. Starting about 1950, **magnetic tape** was developed and used for input for early computers, including the UNIVAC 1, the first commercially available computer. Decks of punched cards, loops of punched paper tape, or reels of magnetic tape were all used in essentially the same way, both for storing programs and providing a method of storing and inputting data. Data on these mediums could be read only in the order in which it was stored. This type of **sequential file processing** was extremely efficient but not very flexible. Payroll was usually the first application that a business chose to automate, because of the complex calculations and reporting requirements that were tedious for human beings to perform. Figure 1.6 provides an overview of a payroll application using sequential file processing. A **master file** containing relatively permanent payroll data for each employee was kept in order by a key field, perhaps Employee Number. The records in this file might also contain items such as the employee name, address, weekly salary, exemptions, tax deductions, year-to-date totals for gross pay, taxes, and take-home pay. Each week a **transaction file** containing new data such as the number of hours worked that week, any changes in salary, deductions or other data, and any other new information needed for this week's payroll would be prepared. Often magnetic tape was used for the master file, and punched cards for the transaction file. Both files had to be in the same order, by Employee Number. A program would read a master record, then read the transaction record for the same employee, and complete the payroll processing for that person. In the process, the information on the old master record would be changed to reflect new data, and a new record would be written to a new master tape. At the end of the program, the new tape would become the current master tape, and it would be used the following week. This is referred to as an **old master/new master** or a **father/son** system. The type of processing described here, where a set of records is submitted as a unit to a program that then operates on them without further human intervention, is referred to as **batch processing.**

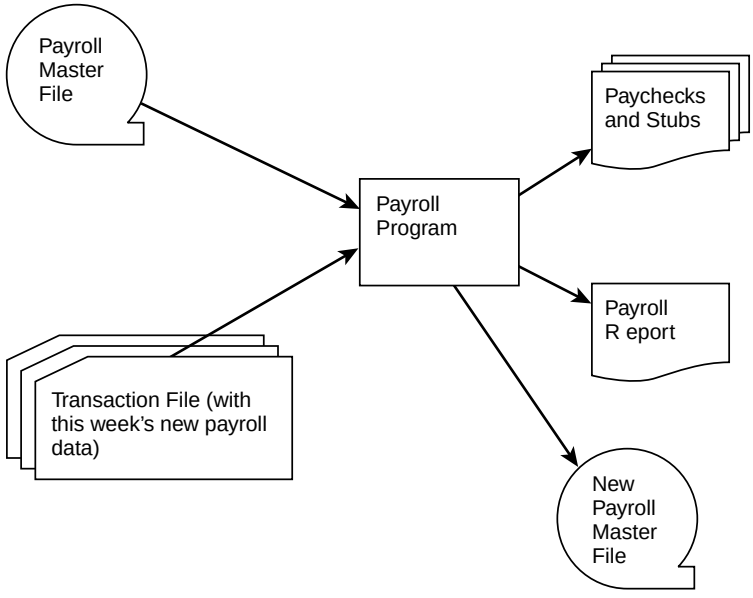

FIGURE 1.6
A Sequential File Processing System

Magnetic disk storage was available by the late 1950s, making **direct access** (nonsequential access) of records possible. Programs no longer required that the order of access match the physical order of the records. Updates could be made to the disk, without rewriting the entire file. Programming languages, including COBOL and PL/1, were developed during the 1960s for commercial data processing that used data stored on both tape and disk. Originally, simple file organizations were used to organize data on these secondary storage devices, but as applications became more complex more sophisticated methods of storing and retrieving data were needed. Two competing database models, the network and the hierarchical, were developed at this time. However, file systems continued to be used for many applications.

The **hierarchical model** for databases was developed during the 1960s as an ad hoc solution to immediate needs of real applications. The oldest hierarchical database management system, IBM's IMS, was developed to organize and store information needed by the space program for the Apollo moon landing project. North American Aviation, (which became Rockwell), and IBM worked jointly to produce the first version of IMS, which was released in 1968. Early versions of IMS were designed to be used with magnetic tape devices, but later magnetic disk became the standard. IMS

soon became the dominant hierarchical database management system in the marketplace and was for many years the most widely used of all DBMSs, until it was replaced by relational systems. Several improvements were made to IMS after 1968, resulting in new releases to take advantage of hardware and software improvements, provide new features such as data communications, and maximize performance. The SABRE airline reservation system was based on IMS. IMS was known as a "workhorse," capable of processing large amounts of data efficiently. It used a tree structure familiar to programmers who are accustomed to working with files, and provided predictable performance.

One of the oldest database management systems, Integrated Data Store (IDS) was developed at General Electric by Charles Bachman during the early 1960s using the **network model.** This database management system influenced the development of the database area for many years. The Conference on Data Systems Languages (**CODASYL),** an organization consisting of representatives of major hardware and software vendors and users, was formed to try to standardize many aspects of data processing. It had successfully written standards for the COBOL language. In the late 1960s it formed a subgroup called the Database Task Group (**DBTG**) to address the question of standardization for database management systems. Influenced by IDS, the group proposed a network-based model and specifications for data definition and data manipulation languages. The draft report was published in 1969 and resulted in many suggestions for changes from its readers. The DBTG reconsidered its proposal and published its first official report in 1971. This landmark document was submitted to the American National Standards Institute (ANSI) in the hope that its specifications would be accepted as a standard for database management systems. However, ANSI refused to accept or reject the proposed standard. The 1971 report was succeeded by several newer versions, notably in 1973, 1978, 1981 and 1984, but it remains the principal document describing a network-based model generally referred to as the CODASYL model or the DBTG model, and several popular database management systems were based on it. In addition, it provided the vocabulary and framework for discussion of database issues, establishing for the first time the notion of a layered database architecture and common terminology. The DBTG evolved in 1972 into a permanent CODASYL committee, the DDLC, or Data Description Language Committee, which continued to operate and to publish its findings periodically in its *Journals of Development* until 1984, when its function was taken over by the ANSI X3H2

committee for standardization. Despite the fact that the DBTG and DDLC continued to make changes to the CODASYL model, the 1971 proposal was used by major vendors as the basis of their database management systems. The most widely used of these network-based systems was IDMS from Cullinet. Others included PRIME DBMS from PRIME Computer, IDS II from Honeywell, DMS 170 from Control Data Corporation, DC, DMSII and DMS1100 from UNISYS, and DBMS 10 and DBMS 11 from Digital Equipment Corporation.

Although the hierarchical and network models were powerful and efficient, they were complex, requiring users to understand data structures and access paths to data. They were designed for use with programs rather than for interactive access by users, so ad hoc queries were not supported. They were not based on a solid theoretical foundation, but were solutions built on existing file systems.

The **relational model** was first proposed by E. F. Codd in 1970, in a paper called "A Relational Model of Data for Large Shared Data Banks." It was the first model based on theoretical notions from mathematics, which provided a strong theoretical base. Research on the model was done by Codd and others at the IBM Research Laboratory in San Jose, California. **System R,** a prototype relational database management system, was developed by IBM researchers during the late 1970s. DB2, IBM's relational database management system, was based on System R. **SQL,** a language developed for System R, has become the standard data language for relational-model databases, with ANSI-approved standards published in 1986, 1989, 1992, and 1999. Other early relational model research projects were the **Peterlee Relational Test Vehicle,** developed at the IBM UK Scientific Laboratory and **INGRES** developed at the University of California at Berkeley. The research led to a "university" version of INGRES, as well as a commercial product. **ORACLE** was developed and marketed using many of the System R results. The widespread use of microcomputers beginning in the 1980s led to the development of PC-based database management systems, which were all relational. Among early microcomputer-based relational database management systems were **dBase, R:Base, Foxpro,** and **Paradox.** Microsoft's Access, which uses the relational model, is now the most widely used microcomputer-based database management system. **Oracle, DB2, Informix, Sybase,** and Microsoft's **SQL Server,** all of which use the relational model, are currently the most popular enterprise database management systems.

The relational model uses simple tables to organize data. It does not allow database designers to express some important distinctions when they model an enterprise. In 1976, P. P. Chen developed a new type of model, the **entity-relationship** model. This is an example of a **semantic model,** one that attempts to capture the meaning of the data it represents. The entity-relationship model itself has been extended several times to make it semantically richer. Other semantic models for databases were developed to try to capture more of the meaning in data.

The need to store and manipulate complex data that is not easy to model using the simple tables of the relational model, as well as the development of programming languages using the object-oriented paradigm, led to the development of **object-oriented** databases in the 1990s. These databases were developed to handle the data required for advanced applications such as geographical information systems, multimedia, computer-aided design and computer-aided manufacturing (CAD/CAM), and other complex environments. Relational database management systems such as Oracle added some object-oriented capabilities to their products, resulting in hybrid **object-relational** databases.

Data warehouses were developed in the 1990s to provide a method of capturing data consolidated from many databases. A data warehouse usually stores historical data about an organization, for the purpose of **data mining,** a process of analyzing the data statistically to enable the organization to unearth the trends that may be present in its own records.

The widespread use of the Internet has had a tremendous impact on database development. The Internet connects users to a rich and constantly expanding network of databases, providing access to digital libraries, multimedia resources, educational resources, and much more. E-commerce Web sites provide access to databases of information about products and services to customers throughout the world. Wireless computing devices and thin clients such as PDAs are other developments that allow users to connect to database resources in new and flexible ways.

1.8 Chapter Summary

Databases are used in hundreds of thousands of organizations ranging from large government agencies to small businesses. The study of the theory, design, and management of databases enables us to maximize their potential benefits.

In a typical database, data is stored in a format that makes it is easy to access, either for individual queries or large reports. In an integrated database environment, all data is kept in a single repository called the database, and managed by the database administrator (DBA). All access to the database is through the database management system (DBMS), a software package that sets up storage structures, loads data, provides access for programs and interactive users, formats retrieved data, hides certain data, does updates, controls concurrency, and performs backup and recovery for the database. Data in a database is integrated, self-describing, and shared concurrently by many users. The DBMS provides a program interface and a user interface for interactive queries that are expressed in the query language of the particular DBMS. People in the integrated database environment include end users, application programmers, and the DBA, all of whom interact with the database in different ways.

Some of the advantages of the integrated database approach are sharing of data, control of redundancy, data consistency, improved data standards, better data security, improved data integrity, balancing of conflicting requirements, faster development of new applications, better data accessibility, economy of scale, more control over concurrency, and better backup and recovery procedures. Some of the disadvantages of the integrated database approach are the higher costs of DBMS, hardware, programming costs, and conversion and the slower processing of some applications, increased vulnerability, and more difficult recovery.

The development of information systems depended on technological advances in hardware and software. Starting with punched cards, storage technology moved on to paper tape, magnetic tape, magnetic disk, and newer devices. Sequential file processing, required for tape, was replaced by direct file processing once direct-access devices such as disks were developed. The hierarchical database model was developed from file processing technology, and the first hierarchical database management system, IMS, was created by IBM and North American Aviation to handle the vast amount of data needed for the Apollo moon landing project. IDS, based on the network model, was developed by Charles Bachman at General Electric, and was the inspiration for the CODASYL DBTG standardization proposals. The relational model was proposed by E. F. Codd, and a prototype called System R, was developed, along with SQL, as the standard relational data language. Most current databases, especially PC-based ones, use the relational model. The entity-relationship model was

developed by P. P. Chen to be a semantic model, capturing more of the meaning of data than the relational model. Object-oriented models were developed to allow representation of more complex data items needed for advanced database applications. Hybrid object-relational systems add some object features to relational databases. Data warehouses allow collection of data from many databases, providing an organization with a rich data resource for data mining. The widespread use of the Internet and the growth of e-commerce have made databases more accessible to the public.

Exercises

1.1 Give four examples of database systems other than those listed in Section 1.1.

1.2 Name five tasks performed by the DBMS.

1.3 List three functions that you can perform with a database that you cannot perform with a spreadsheet.

1.4 Distinguish between a database and a database management system.

1.5 List five advantages of a database system and give an example of each.

1.6 List five disadvantages of a database system and explain each.

1.7 List three responsibilities of the DBA.

1.8 Give an example of an end user and describe a typical task that a user can perform on a database.

1.9 Explain what is meant by a host programming language.

1.10 Provide an example of an application besides payroll that might use sequential batch processing and draw a diagram similar to Figure 1.6.

1.11 Briefly define each of the following terms used in database systems:

a. data integration

b. concurrency

c. query language

d. data consistency

e. integrity constraint

f. data encryption

g. economy of scale

h. recovery log

i. user view

j. security log

Lab Exercises

Lab Exercise 1.1: Exploring the Access Database for the University Example

This laboratory will provide practice in:

- Copying and using an existing database
- Examining existing tables, relationships, queries, and reports
- Designing and executing new queries
- Designing and running a new report
- Designing and using a form
- Updating tables

1. Open Access and find the UniversityDB database provided on the CD that accompanies this book. Copy the database to your own directory. Open the copy and use it for the following exercises.

Note: Access uses many of the same conventions as the rest of Microsoft Office, and provides several ways to perform tasks. There are many variations of the commands, described in this section, that work the same way. Feel free to explore those variations. If you close Access accidentally, just reopen it and continue the exercises. If you erase part of the database, delete your copy and begin again, making another copy from the CD.

2. Make sure the Tables object is chosen on the left panel of the UniversityDB window. Open the Student table by double clicking on its name in the right panel and look through the records of that table. Then close that table. Do the same for the remaining tables.

3. On the Access toolbar, find the icon for Relationships, which has three rectangles connected by lines. Click on the icon to see what relationships among the tables that Access "knows." Note that it "knows" that the facId in Class is related to the facId in Faculty, that the classNumber in Enroll matches the classNumber in Class, and that the stuId in Enroll matches the stuId in Student. Close the Relationships window.

4. Choose the Queries object on the left panel. Open Query1 by double clicking on its name. Notice the query is executed immediately. Close the Query1 results screen.

5. With the Queries object still chosen, from the UniversityDB database toolbar, choose Design. The design of Query1 is displayed. The top window shows the tables that are used in the query, along with their relationships. The bottom window shows which fields are included in the query, along with any conditions (criteria). The designer can choose "Show" or not, to indicate whether the field is to be displayed in the result. From the design screen, press the **!** icon on the Access toolbar to run the query. Close the results window.

6. Return to the design screen for Query1. Change the query: double click on the major field name in the Student table to add the major. Now add the condition History in the Criteria line for major and execute the query again, noticing the change in the results with this new condition. Close the results window without saving.

7. Choose the option "Create query in design view." In the Show Table window, highlight Class, click on the Add button, highlight Enroll, and click on the Add button again. Click on the Close button. You are now back in the query design window. Choose classNumber, schedule, room and stuId as the fields for the query, by double clicking on each one. Add the condition that stuId is S1002 in the Criteria line for stuId. Execute the query to see the class schedule for student S1002. Close and save the query.

8. Create a query that you design yourself. You can vary your design by choosing different tables from the Show Table window, choosing different fields, putting multiple conditions on the same criteria line to indicate AND, or putting conditions on different lines to indicate OR. Explore the options and create several queries. Note that if you wish to compare strings, the case must match exactly, so be careful of capitalization.

9. Choose the Reports object on the left panel. Open the report Class Lists by double clicking on its name in the right panel. Enlarge the report window to read the report. Close the report. Choose the Design icon on the UniversityDB toolbar to see the design for that report. Close the Design screen.

10. Click on "Create report by using wizard." Notice the drop-down window on the left that lists all the tables and queries. You could choose

any combination of these objects for your report. Choose the Student table. From the field list just below, highlight lastName and press the right arrow button to select it for the report (or simply double click on the field name). Also choose firstName. If you accidentally choose an incorrect field, use the back arrow to deselect it. Change the table to Enroll. Choose classNumber and grade. Change the table to Class. Choose schedule and room. Now click on the Next button at the bottom of the Report Wizard window. You have the option to view your data by Student, Enroll, or Class. Choose Student and click on the Next button. Now you can choose grouping levels. Choose lastName, then click on Next. You can choose sorting on several fields. Choose Grade, Ascending, then click on Next. Choose the Stepped layout shown, then Next. Choose the default style, then Next. Make the title Classes by Student. Designed by <your name>, putting your own name in the brackets. Choose Finish. The report should execute. Examine it to see the effects of your choices.

11. Using the report wizard, design and run a second report of your own choosing. Save your report.

12. Choose Forms from the objects panel on the left. Choose Create form by using wizard. Choose the Student table, and click on the double arrow to select all its fields. Choose all the default specifications. Make the title StudentInput and click Finish to end the form design. The form should pop up, showing each Student record. Use this form control arrow to step through the Student records one at a time by pressing the right arrow. You can also enter data using the form. After the last record, you will see a blank form. Enter your own data—make up an ID (remember its value!), and enter your name, major, and credits. Close the StudentInput form.

13. Choose the Tables object again, and open the Student table. Notice that the record you entered using the form has been saved in the table. Close the Student table. Now open the Enroll table and add two records while in the normal (spreadsheet) view to show that you are enrolled in two classes. Be careful to use the same stuId you entered and to use existing classNumber values, or you will be unable to add the records. Delete the Enroll record of student S1010 in ART103A, by moving the cursor to the column before stuId to select the record and pressing the Delete key. Save your changes and close the table.

14. Choose the Reports object. Run the ClassLists report by double clicking on its name. Notice you and your new classes are listed, and the deleted record no longer appears.

15. Open the Faculty table. Change the rank of Professor Tanaka to Assistant, by typing in the new value directly in the cell. Save the change.

Laboratory Exercise 1.2: Creating and Using a New Access Database

This laboratory will provide practice in:

- Creating a new Access database
- Creating tables, specifying fields and keys
- Specifying relationships between tables
- Entering records
- Editing records
- Creating queries
- Creating simple reports
- Creating simple forms

For this lab, you will create a database that keeps track of your music collection and the friends who borrow music from you.

1. Open Access and choose New, Blank Database from the panel on the right of the opening screen. Choose your directory in the "Save in" window and change the filename from db1 to MyMusic. Make sure the filetype is set to Microsoft Access Databases, and click on the Create button.

2. Make sure the Tables object is chosen on the left panel of the MyMusic window. Double click on Create Table in Design View. In the Table1 window that pops up, enter the field names and data types for all the fields of your table. On the first line under "Field Name" type title. In the "Data Type" window on the same line, click on the down arrow to see the available data types. Choose text. Move down to the Field Properties window and type 35 as the field size. Move to the second line under field name and enter the field name artist then data type text, size 20. Make the third field dateAcquired and choose date/time as the data type. Make the fourth field status with data type of text, size 10. Then from the Access menu, choose File, Save As, and type in the table name Music. You will get a message reminding you that you did not specify a primary key and asking if you would like Access to

create one for you. Choose yes. Access will add an ID field with data type AutoNumber. Close the table.

3. Create a second table of friends who might borrow your music. The first field is lastName, data type text 20. This time you will create your own key consisting of the lastName. To do so, move the cursor to the column just to the left of lastName and click on the key icon on the Access toolbar. Continue to create the rest of the fields

   ```
   firstName text 15
   areaCode text 3
   phone text 7
   ```

   Save this table as Friend.

4. Create a third table, Borrow, with fields

   ```
   ID Number Long Integer
   lastName text 20
   dateBorrowed date/time
   dateReturned date/time
   ```

   This table needs a composite key consisting of ID and lastName. To create the composite key, move the cursor to the first column to the left of ID and, holding the mouse button down, move the mouse down one line to select both the ID and the lastName line. With both highlighted, click the key icon. Save the table as Borrow.

5. To create relationships between the tables click on the Relationships icon on the Access toolbar. It consists of three rectangles connected by lines. In the Show Table window that pops up, highlight Music, click on the Add button, highlight Borrow, click on Add, highlight Friend, click on Add, then click on Close. The Relationship window opens, showing the three tables. Click on lastName in Friend and drag to lastName in Borrow. In the Edit Relationship window that pops up, you should see both fields listed. Check the box "Enforce referential integrity" and then click on the Create button. You will see a line connecting the two tables with 1..<infinity symbol> on it. The 1 should be near the Friend table and the infinity symbol near the Borrow table. (If this is not the case, you made a mistake in designing the tables. You can click on the relationship line and press the Delete key to remove the relationship. Then you can return to the table design and correct any error.) Drag ID from Music to Borrow and create another relationship. Choose Save and close the relationship window.

6. Double click on the name of the Music table. Now you will enter data into that table. For the Music table, the system will enter an ID (1,2,3..) automatically (because you allowed it to create an AutoNumber key for you), but you should enter the names of albums you might have, the singer or artist, the date you got the album (in the United States, use the form mm/dd/yyyy; otherwise use the local convention for dates), and the status. You can leave the status blank or enter borrowed, OK, scratched, or any appropriate string value. When you have entered several albums, save the Music table and close it.

7. Enter data in your Friend table. This time lastName is the key. You must be careful not to enter two records with the same last name, and to remember the values you enter.

8. Now you can enter data in the Borrow table. Access will check to see that any ID you enter matches an ID in the Music table, and any lastName matches one in the Friend table, so be sure the values are valid. The checking is done because we informed Access of the relationships and asked it to enforce referential integrity. Save this table.

9. Now you will create a query that you design yourself. Choose the Query object. Choose the option "Create query in design view." In the Show Table window, highlight Music, click on the Add button, highlight Borrow, click on the Add button, highlight Friend and click on the Add button again. Click on the Close button. You are now in the query design window. Choose whatever fields you would like to include in your query. Remember you can choose any of the tables, choose different fields, put multiple conditions on the same criteria line to indicate AND, or put conditions on different lines to indicate OR. Explore the options and create several queries. Note that if you wish to compare strings the case must match exactly, so be careful of capitalization. Design and execute several queries, saving them under names you choose.

10. Now you should design a report. Choose the Reports object on the left panel. Click on "Create report by using Wizard." Notice the dropdown window on the left that lists all the tables and queries. You could choose any combination of these objects for your report. Choose one table. From the field list just below, highlight any field you wish to include and press the right arrow button to select it for the report (or simply double click on the field name). Remember that if you accidentally choose an incorrect field, use the back arrow to deselect it.

After you have chosen the fields you wish from the tables and/or queries, click on the Next button at the bottom of the Report Wizard window. You have the option to view your data by various orders and grouping levels, and to choose a style for your report. Add a title that includes by name. Choose Finish to end the design and run the report.

11. Choose the Forms object from the objects panel on the left. Choose Create form by using Wizard. Choose one table, and click on the double arrow to select all its fields. Choose all the default specifications. The form should pop up, showing the table's records one at a time. Remember you can also enter data using the form. After the last record, you will see a blank form, on which you should enter your own data.
12. Save all your changes and exit Access.

Note: Once you have created a table, you can always add new records by simply opening the table and entering the data. You can update an existing record by moving the cursor to the field to be changed and typing in the new value. You can delete a record by highlighting it and pressing the Delete key or using the menu options. Practice each of these operations on any table you choose. You can print the table or any other object at any time from the Access menu by choosing File, Print.

SAMPLE PROJECT: THE ART GALLERY

Purpose of the Sample Project

The sample project sections included at the end of many of the chapters of this book provide the student with models for applying the concepts covered in the chapters. The project is a continuing example that illustrates a practical application of database design and implementation techniques. Following the sample project are several student projects. Students should choose at least one of the projects and work on its development as they progress through the book. The sample project shows how each step can be done. The student should read the sample and apply the steps to the chosen project.

General Description

The Art Gallery accepts original artworks by living contemporary artists to be sold on a commission basis. It currently offers work from about a

hundred artists, and sells approximately a thousand pieces each year. The average selling price is several thousand dollars. There are about five thousand customers who have purchased pieces from the gallery. The sales staff consists of the gallery owner, Alan Hughes, and four sales associates. Their activities are supported by an office staff of two people.

Basic Operations

When an artist wishes to sell works, he or she contacts the gallery. Alan Hughes, the owner, visits the artist's studio and selects the works to be sold through the gallery. If the artist is well known to the gallery, this visit may be eliminated, and the works may be accepted automatically. An artist may submit one or several pieces for sale at a time. The artist, working with Alan, identifies an asking price for each work. The sales staff try to sell the work at that price, or as close to that price as possible. Customers may negotiate with salespeople, so that the actual selling price may be below the asking price. If it is below the asking price, the final selling price must be approved by the artist. The commission charged by the gallery is 10% of the selling price. The gallery splits the commission with the salesperson who makes the sale. Any salesperson can sell any work in the gallery. However, customers work with a single salesperson when they buy each piece, so that the salesperson's portion of the commission for a single piece goes to only one salesperson.

The gallery promotes the works by holding exhibits featuring various pieces. The exhibits are advertised in newspapers and other media, and potential customers are sent personal invitations. A showing is actually a reception that provides an opportunity for the public to see the pieces and to meet the artist or artists whose works are featured. A "one-man show" features works by a single artist, while a themed show features works by multiple artists centered on a single theme, such as "Mediterranean Seascapes." Works of art that have been featured at a showing remain on display until they are sold or returned to the artists. A piece may be purchased at the showing or at any time afterward. Occasionally, a work may be purchased from the gallery prior to the show and included in the exhibit, marked as "Sold," to provide the public with a better view of the artist's work. Not all works are promoted through showings. Some are simply displayed in the gallery. If a work has been at the gallery for six months without being sold, Alan contacts the artist and returns the work, unless both agree to continue displaying the work for an additional period of time.

At present, all data relating to artists, unsold works, shows, sales, and customers is kept in paper files. A description card is made up for each work currently on exhibit, and placed on the wall or floor stand next to the piece. A copy of the card is also placed in a file. The card lists the artist's name, title of the work, year created, type, medium, style, size, and asking price. Each work is an original, one-of-a-kind piece produced by a single artist. No two artists have the same name. The title of the work must be unique to the artist, but may not be totally unique to the gallery. For example, many artists may have works such as "Composition Number 5," but no artist has two works with that title. No prints or reproductions are sold at the gallery. An artist can produce several works in the same year. The type refers to the type of work, which may be painting, sculpture, collage, and so forth. The medium refers to the materials used in the work, such as oil, watercolor, acrylic, marble, or mixed. A piece using more than one medium is categorized as mixed. The style means the style of the work, which may be contemporary, impressionist, folk, or other. The size is expressed in units appropriate for the work; for example, for a painting, the size would be the number of inches in width and height, while a sculpture would have three dimensions.

When a purchase is made, a receipt is issued for the buyer, a payment check and stub are made out for the artist, the commission is allocated between the gallery and the salesperson, and all paper files are updated individually.

Information Needs

In addition to the data about artists, artworks, shows, sales, and customers currently kept in paper files, there are other information needs. For income tax purposes, the gallery is required to report the amount of sales for each artist each year, a task that is very time-consuming at present. Alan realizes that a database could provide more information than is available now from the paper files. He also wants to capture data not currently stored. He would like to keep track of customers who have made purchases and information about the amount of their purchases last year and so far this year. He would like to be able to send mailings to potential customers, and to record their preferences. In addition, he foresees that the gallery may begin to accept works owned by collectors as well as works directly from artists. The database design should include the possibility that the owner is not the artist.

Project Steps

- Step 1.1. Write out the format of every input document that provides information to be stored in the database.
- Step 1.2. Write out the format of every routine report to be produced using the database.
- Step 1.3. Sketch the input and output screens for every routine transaction to be performed against the database.
- Step 1.4. Write out an initial list of assumptions for the project.

Note: In real life, these steps would be preceded by meetings and interviews with the users of the present system and of the proposed system to determine the users' data needs and preferences. We will assume that these meetings have taken place and that the information that follows has been developed from them. Note that we are not making any assumptions about the internal structure of the database at this point. The reports and forms we design are based on user's needs, not on the database file structures.

- Step 1.1. Format of Input Documents

The following forms are used to provide information.

THE ART GALLERY

Artist Information Form

Date of Interview _____ Name of Interviewer _____

Artist Last Name _____ Artist First Name _____

Street _____

City_____ State ___ Zip _____

Telephone: Area Code ____ Number _____

Social Security Number _____

Usual Type _____

Usual Medium _____

Usual Style _____

FIGURE 1.7

Artist Information Form

1. **Artist Information Form.** When Alan interviews an artist, he collects contact information and data about the artist's usual works, as shown on the form in Figure 1.7. To allow for the possibility that in future Alan's associates may do the interviews, the interviewer's name is listed.
2. **Collector Information Form.** When the gallery begins to offer works owned by people other than the artist, these collectors will also be interviewed. They may own one or many artworks, and their collections may or may not have works that are predominately by a single artist or of a single type, style, or medium. The form shown in Figure 1.8 will be filled out by the interviewer.
3. **Artwork Information Form.** For each artwork to be considered, the interviewer fills in the basic information needed for the description card, as shown in Figure 1.9. If the piece is chosen to be offered for sale by the gallery, the date listed and the asking price are filled in.

THE ART GALLERY

Collector Information Form

Date of Interview _____ Name of Interviewer _____

Collector Last Name _____ First Name _____

Street _____

City_____ State ___ Zip _____

Telephone: Area Code ____ Number _____

Social Security Number _____

If the collection is predominately by one artist, or has a distinguishing type, medium, or style, fill in this section.

Artist Last Name _____ Artist First Name _____

Collection Type _____

Collection Medium _____

Collection Style _____

FIGURE 1.8

Collector Information Form

THE ART GALLERY

Artwork Information Form

Artist Last Name _____ Artist First Name_____

Title _____

Year Completed _____

Type _____

Medium _____

Style _____

Size _____

If owned by someone other than the artist, please complete this section with the owner information.

Owner Last Name _____ Owner First Name _____

Street _____

City_____ State ___ Zip _____

Telephone: Area Code ____ Number _____

Owner Social Security Number _____

If the piece is chosen to be offered by the gallery, please complete this section.

Date Listed _____

Asking Price _____

FIGURE 1.9
Artwork Information Form

4. **Sale Invoice.** When a work is sold, the sales associate fills out the form shown in Figure 1.10. Currently, a copy is given to the buyer, and the original is placed in the files. The unique invoice number is preprinted on the form. When the database is created, the invoice will be produced by the system.
5. **Mailing List Form.** The form shown in Figure 1.11 is left in various locations for potential customers to sign up for a mailing list.

- Step 1.2 Format of Routine Reports

The following reports are either currently produced or would be produced by the new system.

THE ART GALLERY

Sale Invoice

Invoice Number 99999

Title of Artwork _____

Artist: Last Name _____ First Name_____

Owner: Last Name _____ First Name_____

Street _____

City_____ State ___ Zip _____

Telephone: Area Code ____ Number _____

Buyer: Last Name _____ First Name_____

Street _____

City_____ State ___ Zip _____

Telephone: Area Code ____ Number _____

Owner Social Security Number _____

Price _____

Tax _____

Total Paid _____

Salesperson Signature _____ Date _____

FIGURE 1.10

Sale Invoice

6. **Active Artists Summary Report.** The report shown in Figure 1.12 lists summary data about all active artists, including the total amount of each one's sales for last year and this year.

7. **Individual Artist Sales Report.** The report shown in Figure 1.13 would be generated for a period starting with whatever date is selected (e.g., January first of the current year) and ending with another selected date (e.g., today's date). It lists all the works of the artist that the gallery has received from the listing date specified to the date of the report. The status of the work can be sold, returned, or for sale. If the work was sold, the date sold and selling price are listed. If the work was returned, the return date is listed. If the work is for sale as of the date of the report, the asking price is listed. The total amount of sales of the artist's works during the period is displayed. The total value of asking prices of the artist's

THE ART GALLERY

Mailing List

Date _____

Last Name _____ First Name _____

Street _____

City_____ State ___ Zip _____

Telephone: Area Code ____ Number _____

Please indicate preferences (if any) below:

Preferred Artist _____

Preferred Style (e.g., contemporary, impressionist, folk) _____

Preferred Type (e.g., painting, sculpture, collage) _____

Preferred Medium (e.g., oil, watercolor, marble, mixed) _____

FIGURE 1.11

Mailing List Form

REPORT OF ACTIVE ARTISTS

Date of Report: mm/dd/yyyy

Name	Address	Phone	Type	Medium	Style	Sales Last Year	Sales YTD
XXXXX	XXXXX	XXX XXX XXXX	XXXXX	XXXXX	XXXXX	999999.99	999999.99
XXXXX	XXXXX	XXX XXX XXXX	XXXXX	XXXXX	XXXXX	999999.99	999999.99
XXXXX	XXXXX	XXX XXX XXXX	XXXXX	XXXXX	XXXXX	999999.99	999999.99

FIGURE 1.12

Active Artists Summary Report

INDIVIDUAL ARTIST SALES REPORT

Date of Report: mm/dd/yyyy

Last Name_____ First Name_____

Address: Street _____

City _____State ____ Zip_____

Telephone: Area Code_____ Number _____

Report for Works beginning with Date Listed

Works Sold:

Title	Date Listed	Type	Medium	Style	Year	Asking Price	Sell Price	Date Sold
XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	yyyy	9999.99	9999.99	mm/dd/yyyy
XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	yyyy	9999.99	9999.99	mm/dd/yyyy
. . .								
XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	yyyy	9999.99	9999.99	mm/dd/yyyy

Total of Sales: 999999.99

Works Returned:

Title	Date Listed	Type	Medium	Style	Year	Asking Price	Date Returned
XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	9999	9999.99	mm/dd/yyyy
XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	9999	9999.99	mm/dd/yyyy
. . .							
XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	9999	9999.99	mm/dd/yyyy

Works for Sale:

Title	Date Listed	Type	Medium	Style	Year	Asking Price
XXXXX	99/99/9999	XXXXX	XXXXX	XXXXX	9999	9999.99
XXXXX	99/99/9999	XXXXX	XXXXX	XXXXX	9999	9999.99
. . .						
XXXXX	99/99/9999	XXXXX	XXXXX	XXXXX	9999	9999.99

Total of Asking Prices 999999.99

FIGURE 1.13

Individual Artist Sales Report

COLLECTORS SUMMARY REPORT

Name	Address	Phone	Pref. Artist	Pref. Type	Pref. Medium	Pref. Style	Sales Last Year	Sales YTD
XXXXX	XXXXX	XXX XXX XXXX	XXXXX	XXXXX	XXXXX	XXXXX	999999.99	999999.99
XXXXX	XXXXX	XXX XXX XXXX	XXXXX	XXXXX	XXXXX	XXXXX	999999.99	999999.99
. . .								
XXXXX	XXXXX	XXX XXX XXXX	XXXXX	XXXXX	XXXXX	XXXXX	999999.99	999999.99

FIGURE 1.14
Collectors Summary Report

works currently for sale is also given. By choosing dates that cover the entire year, the total sales data on this report can also be used for the end-of-year tax reporting required by the government.

8. **Collectors Summary Report.** The Art Gallery plans to begin selling works owned by collectors, in addition to works owned by the artist who created them. When works owned by people other than the artist are made available, the report shown in Figure 1.14 will be needed.

9. **Individual Collector Sales Report.** This report, shown in Figure 1.15, is similar to the one for individual artists. It will be needed when the gallery begins to sell works owned by collectors. It gives information about works the collector has offered for sale through the gallery. It lists all works sold, works returned, and works for sale for that collector for the period specified. The total sales for each collector is sent to the government for tax reporting purposes at the end of the year.

10. **Works for Sale.** This report lists data about each work that is currently offered for sale in the gallery. The date of the showing to promote the work, if any, is given. The total of all asking prices is given. It is shown in Figure 1.16.

INDIVIDUAL COLLECTOR SALES REPORT

Date of Report: mm/dd/yyyy

Last Name_____ First Name_____

Address: Street _____

City _____State ____ Zip_____

Telephone: Area Code_____ Number _____

Report for Works beginning with Date Listed of mm/dd/yyyy

Works Sold:

Title	Artist	Date Listed	Type	Medium	Style	Year	Asking Price	Sell Price	Date Sold
XXXXX	XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	yyyy	9999.99	9999.99	mm/dd/yyyy
XXXXX	XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	yyyy	9999.99	9999.99	mm/dd/yyyy
. . .									
XXXXX	XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	yyyy	9999.99	9999.99	mm/dd/yyyy

Total of Sales: 999999.99

Works Returned:

Title	Artist	Date Listed	Type	Medium	Style	Year	Asking Price	Date Returned
XXXXX	XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	9999	9999.99	mm/dd/yyyy
XXXXX	XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	9999	9999.99	mm/dd/yyyy
. . .								
XXXXX	XXXXX	mm/dd/yyyy	XXXXX	XXXXX	XXXXX	9999	9999.99	mm/dd/yyyy

Works for Sale:

Title	Artist	Date Listed	Type	Medium	Style	Year	Asking Price
XXXXX	XXXXX	99/99/9999	XXXXX	XXXXX	XXXXX	9999	9999.99
XXXXX	XXXXX	99/99/9999	XXXXX	XXXXX	XXXXX	9999	9999.99
. . .							
XXXXX	XXXXX	99/99/9999	XXXXX	XXXXX	XXXXX	9999	9999.99

Total of Asking Prices 999999.99

FIGURE 1.15

Individual Collector Sales Report

WORKS FOR SALE

Date of Report: _____

Title	Artist	Type	Medium	Style	Owner's Name	Asking Price	Date Shown	Date Listed
XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	9999.99	mm/dd/yyyy	mm/dd/yyyy
XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	9999.99	mm/dd/yyyy	mm/dd/yyyy
. . .								
XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	9999.99	mm/dd/yyyy	mm/dd/yyyy
						_____		
						Total Asking Prices: 999999.99		

FIGURE 1.16
Works for Sale

11. **Sales This Week.** This report, shown in Figure 1.17, lists data about all sales of works during the current week. It is divided by salesperson, showing the works that each salesperson, sold this week, and his or her total sales. At the end, it gives the grand total of all sales for the week.

12. **Buyer Sales Report.** The buyer sales report is shown in Figure 1.18. Buyer data comes from invoices. The report shows buyers in alphabetical order by last name. Works they purchased this year are listed in order by date of purchase.

13. **Preferred Customer Report.** Alan would like to target potential customers, as well as current ones, by keeping information about all those who attend showings, or whose names are gathered from the potential customer information form. For each present and potential customer, he would like to keep identifying data and information about the customer's preferences, such as the name of a preferred artist, type, medium, and style for each customer. He hopes to increase sales and hold down costs by using this information to make up targeted invitation lists for showings of works that match customer preferences. For example, he would like to be able to get a report such as the one shown in Figure 1.19. This report could be run for the artist or artists being featured in a show. It lists potential customers whose stated preferences list the same artist, type, medium, or style as the works shown.

SALES FOR WEEK ENDING MM/DD/YYYY

Salesperson	Artist	Title	Owner	Buyer	Sale Date	Selling Price	Comm
XXXX							
	XXX	XXX	XXX	XXX	mm/dd	9999.99	999.99
		XXX	XXX	XXX	mm/dd	9999.99	999.99
	. . .						
	XXX	XXX	XXX	XXX	mm/dd	9999.99	999.99
					TOTAL	9999.99	999.99
XXXX							
	XXX	XXX	XXX	XXX	mm/dd	9999.99	999.99
	XXX	XXX	XXX	XXX	mm/dd	9999.99	999.99
	. . .						
	XXX	XXX	XXX	XXX	mm/dd	9999.99	999.99
. . .					TOTAL	9999.99	999.99
XXXX							
	XXX	XXX	XXX	XXX	mm/dd	9999.99	999.99
		XXX	XXX	XXX	mm/dd	9999.99	999.99
	. . .						
	XXX	XXX	XXX	XXX	mm/dd	9999.99	999.99
					TOTAL	9999.99	999.99

Total of all Sales for Week 99999.99

FIGURE 1.17

Sales This Week

BUYERS SALES REPORT

Date mm/dd/yyyy

Last Name	First Name	Address	Phone	Total Purchases Last Year
XXXX	XXXX	XXXX	XXXX	9999.99

	Purchases This Year				
	Date Purchased	Artist	Title	Asking Price	Selling Price
	mm/dd/yyyy	XXX	XXX	9999.99	9999.99
	mm/dd/yyyy	XXX	XXX	9999.99	9999.99
	. . .				
	mm/dd/yyyy	XXX	XXX	9999.99	9999.99
	Total Purchases This Year			9999.99	9999.99

XXXX	XXXX	XXXX	XXXX	9999.99

	Purchases This Year				
	Date Purchased	Artist	Title	Asking Price	Selling Price
	mm/dd/yyyy	XXX	XXX	9999.99	9999.99
	mm/dd/yyyy	XXX	XXX	9999.99	9999.99
	. . .				
	mm/dd/yyyy	XXX	XXX	9999.99	9999.99
	Total Purchases This Year		9999.99	9999.99	

. . .
. . .
. . .

XXXX	XXXX	XXXX	XXXX	9999.99

	Purchases This Year				
	Date Purchased	Artist	Title	Asking Price	Selling Price
	mm/dd/yyyy	XXX	XXX	9999.99	9999.99
	mm/dd/yyyy	XXX	XXX	9999.99	9999.99
	. . .				
	mm/dd/yyyy	XXX	XXX	9999.99	9999.99
	Total Purchases This Year		9999.99	9999.99	

FIGURE 1.18

Buyers Sales Report

PREFERRED CUSTOMER REPORT

Artist	Title	Type	Medium	Style	Cust Name	Address	Pref Artist	Pref Type	Pref Medium	Pref Style
XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
					XXX	XXX	XXX	XXX	XXX	XXX
					. . .					
					XXX	XXX	XXX	XXX	XXX	XXX
	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
					XXX	XXX	XXX	XXX	XXX	XXX
					. . .					
					XXX	XXX	XXX	XXX	XXX	XXX
	. . .									
	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
					XXX	XXX	XXX	XXX	XXX	XXX
					. . .					
					XXX	XXX	XXX	XXX	XXX	XXX
XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
					XXX	XXX	XXX	XXX	XXX	XXX
					. . .					
					XXX	XXX	XXX	XXX	XXX	XXX
	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
					XXX	XXX	XXX	XXX	XXX	XXX
					. . .					
					XXX	XXX	XXX	XXX	XXX	XXX
	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
					XXX	XXX	XXX	XXX	XXX	XXX
					. . .					
					XXX	XXX	XXX	XXX	XXX	XXX

FIGURE 1.19

Preferred Customer Report

SALESPERSON PERFORMANCE REPORT

Report Starting Date mm/dd/yyyy **Report Ending Date mm/dd/yyyy**

Salesperson		SocSecNo	Artist	Title	Asking Price	Selling Price	Date Sold
Name	Add						
XXX	XXX	999-99-9999	XXX	XXX	9999.99	9999.99	mm/dd/yyyy
				XXX	9999.99	9999.99	mm/dd/yyyy
		. . .					
			XXX	XXX	9999.99	9999.99	mm/dd/yyyy
					Total Sales for Period	9999.99	
					Total Commission for Period:	9999.99	
XXX	XXX	999-99-9999	XXX	XXX	9999.99	9999.99	mm/dd/yyyy
				XXX	9999.99	9999.99	mm/dd/yyyy
		. . .					
			XXX	XXX	9999.99	9999.99	mm/dd/yyyy
					Total Sales for Period	9999.99	
					Total Commission for Period:	9999.99	

FIGURE 1.20
Salesperson Performance Report

14. **Salesperson Performance Report.** The report shown in Figure 1.20 would be generated for a period starting with whatever date is selected (e.g., January first of the current year) and ending with another selected date (e.g., today's date). It provides an individual listing of each of the works sold by that person during the period, as well as his or her total sales for the period chosen. Typically, it would be run once a month, to allow Alan to evaluate each salesperson's performance.

15. **Aged Artworks Report.** This report shown in Figure 1.21, is generated at the end of each month. It lists the works of art that have been for sale in the gallery for six months or more. Alan uses it to contact the artist or collector to determine whether the works should be returned, or remain for sale for an additional period of time.

16. **Owner Payment Stub.** When an artwork is sold, a check is sent to the owner for 90% of the selling price. The stub that accompanies the check is shown in Figure 1.22.

ARTWORKS HELD OVER SIX MONTHS

Report Date mm/dd/yyyy

Owner Name	Owner Telephone	Artist Name	Title	Date Listed	Asking Price
XXX	XXX XXX XXXX	XXX	XXX	mm/dd/yyyy	9999.99
			XXX	mm/dd/yyyy	9999.99
		. . .			
		XXX	XXX	mm/dd/yyyy	9999.99
XXX	XXX XXX XXXX	XXX	XXX	mm/dd/yyyy	9999.99
		XXX	XXX	mm/dd/yyyy	9999.99
		. . .			
		XXX	XXX	mm/dd/yyyy	9999.99
. . .					
XXX	XXX XXX XXXX	XXX	XXX	mm/dd/yyyy	9999.99
			XXX	mm/dd/yyyy	9999.99
		. . .			
		XXX	XXX	mm/dd/yyyy	9999.99

FIGURE 1.21

Aged Artworks Report

THE ART GALLERY

Payment for Sale of Artwork

Owner Name _____

Owner Address _____

City_____ State ___ Zip _____

Telephone: Area Code ____ Number _____

Owner Social Security Number _____

Artist Name _____ Title _____

Type _____ Medium _____ Style _____ Size _____

Salesperson _____

Selling Price 9999.99 Tax 9999.99 Total Amount of Sale 9999.99

Amount Remitted to Owner 9999.99

FIGURE 1.22

Payment Stub

ART SHOW REPORT

Title of Show _____

Opening Date _____ Closing Date _____

Featured Artist _____ or Theme _____

Works Included:

Artist	Title	Asking Price	Status (sold or for sale)
XXX	XXX	9999.99	XXX
	XXX	9999.99	XXX
	. . .		
XXX	XXX	9999.99	XXX
	XXX	9999.99	XXX
	. . .		
. . .			
XXX	XXX	9999.99	XXX
	XXX	9999.99	XXX
	. . .		

FIGURE 1.23
Art Show Report

17. **Art Show Details.** For each show, this report provides information about the dates, featured artist or theme, and works shown. It appears in Figure 1.23.

- Step 1.3 Sketch of Screens for Routine Transactions

For all transactions, the user is prompted to choose from a menu of possible transactions, and is provided with instructions for filling in the information needed. The screen displays the results, which may also be printed out.

15. **Adding a new artist.** A member of the office staff enters the data from the Artist Information Form. The screen has the same layout as that form. The results screen informs the user that the artist has been added, or that the artist is already in the database.

16. **Adding a new collector.** Similarly, an office worker enters data from the Collector information form, using a screen with the same layout as the form. The results screen informs the user that the person has been entered or is already in the database.

17. **Adding a new work of art.** Information about new artworks is taken directly from the information form and entered in a screen with the same layout as the form. The database is checked to ensure that the combination of artist name and title is unique, and then displays a screen saying the work has been added.

18. **Sale Transaction.** The data shown in the invoice, Figure 1.10, is entered on a sales transaction screen that has the same layout as the invoice. The receipt, which omits the owner's address and telephone number, is displayed as a response, and a clerk prints out the receipt.

19. **Adding a Potential Customer.** The data shown on the Mailing List form is entered for each potential customer. People who purchase an artwork, and collectors of artwork in the gallery are also automatically added to the customer file, using the information from sale invoices and information forms. The response screen confirms that the person was added, or that he or she was already in the database.

- Step 1.4 Initial List of Assumptions for The Art Gallery Project

1. Artist names are unique, but customer names and collector names are not.

2. For privacy reasons, only people who receive payments from the gallery are asked to provide their social security numbers, because these payments have to be reported for income tax purposes. Therefore, the gallery keeps social security numbers for salespersons, collectors, and artists, but not for buyers or potential customers.

3. An artist might have many works for sale in the gallery.

4. Each work is an original, one-of-a-kind piece. No prints or reproductions are sold.

5. Two works of art can have the same title, but the combination of title and artist name is unique.

6. A work of art can be owned either by the artist who created it or by another person, referred to here as a collector.

7. Even if the work of art is owned by a collector, it is important to keep information about the artist who created it, since that is a factor in determining its value.

8. A work of art is sold by the gallery only once. The gallery does not re-sell its own works.
9. A work of art might appear in more than one show. Some works do not appear in any show.
10. Payment for all sales is made immediately and in full at the time of purchase. Payment may be by credit, cash, or check. The owner is paid the balance and the salesperson is paid the commission at the end of the week.
11. The database does not include payroll information, except for the commission to be paid to salespeople for sales of artwork.
12. There are lists of valid values for type, style, and medium of artworks. Each has a value "other" for works that do not fit existing values.
13. Information about works not selected to be listed by the gallery is discarded.
14. Lists of artists, collectors, buyers, and potential customers are evaluated periodically to determine whether they should be dropped.

STUDENT PROJECTS: INTRODUCTION TO STUDENT PROJECTS

Several projects are described on the next few pages. You should study the project you will work on, read the preceding sample project, and use it as a model in carrying out the steps for your project. If you can do so, interview people who are familiar with the environment described in the project. Based on your interviews, the written description, and your own analysis of the project you have chosen, do the following steps. Remember that you should not make any assumptions about the internal structure of the database at this point. Your reports and forms should be based on user's needs, not on the database file structures.

- Step 1.1. Write out the format of every input document that provides information to be stored in the database.
- Step 1.2. Write out the format of every routine report to be produced using the database.
- Step 1.3. Sketch the input and output screens for every routine transaction to be performed against the database.
- Step 1.4. Write out an initial list of assumptions for the project.

Project One: Beta University Annual Fund

General Description

The Development Office of Beta University seeks to obtain donations for its Annual Fund from a variety of donors. The fund collects over $10 million each year. Donors include graduating seniors, alumni, parents, faculty, administrators, staff, corporations, or friends of the university. There are approximately 100,000 potential donors. The Annual Fund is directed by Suzanne Hayes, who is responsible for raising funds and keeping track of donations. Suzanne wishes to create a database to help with both of these major responsibilities.

Basic Operations

Suzanne tries to raise funds in several ways during each fiscal year, which extends from July 1 to June 30. Each fall, all potential donors to the Annual Fund receive personalized letters from her, emphasizing their close ties to Beta University. The letters contain reply envelopes and forms on which the donors can fill in the amount they are pledging to contribute that year, and the method of payment they choose. Payment can be sent as a single check in the envelope, donors can choose deferred payments over a period of a year, or they can provide their credit card numbers to pay in a single lump sum. Often, the employer of the donor or of the donor's spouse has a program to make a matching gift to the university, and the donor provides the contact information on the envelope. A letter acknowledging the gift and thanking the donor is sent as soon as the pledge is received. Suzanne is responsible for following up with the employer to collect the matching gift, which is paid in a single lump sum by the corporation.

Several fundraising events are held during the year. Suzanne solicits donations at a fall carnival, a holiday dinner dance, and a spring golf outing, among other events. Each class year has a class coordinator who helps by contacting members of his or her graduating class. An additional letter from the class coordinator is made to ask for larger donations from reunion classes, those who are marking an important anniversary of graduation—whether five years, 10 years, or higher—prior to their reunion celebration weekend. Each spring there is a phonothon during which current students and volunteers call other potential donors and solicit pledges. All alumni who have not contributed by the end of May receive telephone calls from their class coordinator asking them for a

donation. If the class coordinator is unable to contact his or her classmates, Suzanne or a volunteer makes these calls instead.

The donations are categorized by the group they are from, by the year of the donor (if applicable) and by size. There are 10 "donor circles," which are categorized by the size of the gift—President's Circle for gifts over $50,000, Platinum Circle for gifts over $25,000, and so on. Gifts under $100 are not listed as belonging to a circle. An annual report listing all donors by category, year, and donor circle is published and mailed to all actual and potential donors during the summer. The report does not list the actual amount each person contributed.

Information Needs

At present, Suzanne has a mailing list on a word processor that is used to generate labels and letters to potential donors. She would like to be able to personalize each letter by adding a line about the amount of money the donor gave the previous year. A spreadsheet is used to keep track of pledges and donations. Large pledges from individual donors are ordinarily paid in monthly installments rather than in one payment, but currently there is no way to keep track of those payments. When a database is developed, Suzanne would like to be able to send reminders if payments are over a month late.

An Annual Fund Gift form is sent with all letters soliciting funds, with blanks for the donor to fill in the applicable information, as follows:

> **Beta University Annual Fund Gift** Donor Name, Donor Address, Category (a check list specifying senior, alumnus/alumna, parent, administrator, etc.), Year of Graduation, Date of Pledge/Gift, Amount Pledged, Amount Enclosed, Payment Method, Number of Payments Chosen, Credit Card Number, Matching Corporation Name, Matching Corporation Address, Name of Spouse (if matching gift is from spouse's employer).

When pledges are received by class representatives or during the phonothon, the same information is collected on similar forms. Reports needed include:

1. **Annual Report to Donors.** This report was described previously. It lists names only, not amounts. However, the names have to be categorized as indicated. The report also has summaries, including the total amount raised from all sources, the total for each

class, the percent participation for each class, the total for each category, the grand total for each donor circle, and the class total for each donor circle. It is an important fundraising tool for the following year's drive, since it is mailed to each potential donor.

2. **Monthly Report.** This is an internal report that Suzanne uses to evaluate the progress of the fundraising for the year so far. It gives the totals and percentages of pledges and gifts received for the current month in all categories.
3. **Payments Due Report.** Suzanne would like a report each month listing the pledge payments that were due that month but were not received. It would list the donor's name and address, the amount due, the date due, the amount of the pledge, the amount received so far, and the date of the previous payment, if any.
3. **Event Report.** Suzanne would like to generate reports showing who attends each of the fundraising events, and what pledges and gifts were received from the attendees.
4. **Class Representative Contact List.** For each class representative, Suzanne would like a list of classmates to be contacted, including the name, address, telephone number, last year's donation information, and this year's donation information.
4. **Phonothon Volunteer Contact List.** Each volunteer caller is given a list with information about the potential donors he or she is expected to call, including the name, telephone number, address, category, year (if applicable), and last year's donation information.

In addition to the forms and reports listed here, there are several others that would be useful. Do Steps 1.1–1.4 based on the information provided and any additional applicable assumptions you need to make about the operations of the Annual Fund.

Project Two: Pleasantville Community Theater Group

General Description

The Pleasantville Community Theater Group is a nonprofit organization of about two hundred members, amateurs who enjoy producing and performing in plays. Members pay dues of $50 per year. The group produces two plays each year but not all members are active workers every year.

Basic Operations

The group produces plays in the fall and spring. Some members of the group have roles in the plays, while others work on scenery, costumes, publicity, programs, and other tasks. The group has two general meetings per year. Each fall they meet to elect officers—a president, vice president, secretary, treasurer, and house manager, who serve for the entire year. At the end of the spring season, the group meets again to evaluate the previous year's activities and to select the two plays and their producers for the following year. The producer of each play is then responsible for managing all aspects of that production, including recruiting volunteers, promotion, casting, and more. The group sometimes obtains sponsorship from local businesses for a production, and always prints a program with advertisements that help defray some of the production costs. The program also lists the cast, crew, and credits for the show. Most of the production work is done by the members, but skilled craftsmen are contracted as needed for specific tasks, such as electrical wiring. No professional actors are used. For a theater, the group uses the local high school auditorium, which has about a thousand seats.

Information Needs

The group wishes to have a database to keep track of members and productions. They also need to compile names and addresses of potential playgoers (patrons) so they can mail announcements about each production, to help sell tickets. In the past, open seating has been used, but they would now like to use assigned seats, since the auditorium identifies seats with row letters and seat numbers. There are 26 rows (A–Z) with 40 seats per row. This would allow the company to have subscriptions with assigned seating. The database should keep track of plays that are suitable for production by such a company. They also need to compile information about potential or past corporate sponsors. Some of the forms or reports that would be helpful are:

1. **Play Listing.** Plays that could be produced by the company are identified by title, author, type (drama, comedy, musical, and such), and number of acts.
2. **Program—Cast and Credits.** The program for each production should list the names of the actors and the jobs each member had for the production.

3. **Program—Sponsors.** The program should list all the corporations and individuals who donated money, goods, or services for each production.
4. **Report of Patrons.** This internal report lists mailing information for patrons, as well as a list of the productions they bought tickets for in the past.
5. **Ticket Sales Report.** This internal report should list the tickets, along with price and seat numbers, that patrons have ordered for productions.
6. **Admission Ticket.** The database should be able to print tickets when a patron orders them. The ticket should list the name of the play, the date, time, price, and seat.
7. **Member Dues Payment Report.** The treasurer needs a report that shows which members have paid dues and which members still owe them. Contact information for those who have not yet paid dues should be provided.
8. **Balance Sheet.** The treasurer is responsible for maintaining all information about income and expenditures for the year. Income comes from dues, sponsors, ticket sales, and other sources. Expenditures include costs for the productions, such as contractor's fees, equipment rental, auditorium rental fee, and other services. At the end of the year the sheet should show at most a modest profit, but never a loss. Therefore, the treasurer must be able to report on the current financial condition at any time, so that expenditures can be evaluated before funds are spent.
9. **Ticket Sales Transaction.** The ticket sales process requires an interactive transaction. The user should be able to input a request for one or more seats for a particular performance, and the return screen should display sufficient information to allow the user to determine whether the seats are available. If so, the transaction should be completed by reserving the seats and printing the tickets. If not, it should be possible to find alternate seats, if they exist.

In addition to the forms and reports listed here, there are several others that would be useful. Do steps 1.1–1.4 based on the information provided here and any additional applicable assumptions you need to make about the operations of the Pleasantville Community Theater Group.

Project Three: Friendly Cars Dealership

General Description

Friendly Cars is a dealership that offers new cars from a single manufacturer. The dealership is located in a suburb of a large city. Its gross sales exceed $1 million per year. It has 10 employees—Jim Friendly (the owner/manager), eight salespeople, and an office manager. Most of its customers are from the surrounding area, and they learn about the dealership by word of mouth; from newspaper, radio, and television advertisements; via the Internet; or by referral from buying services.

Basic Operations

Potential customers usually come in person to the showroom to browse and test drive the cars. They comparison shop, visiting many dealerships of several manufacturers. They usually have a list of features they want, and some knowledge of the models the dealership offers. They are greeted by whichever salesperson is free when they walk into the showroom. In a few cases, they specify which salesperson they wish to deal with. They work with a single salesperson until the deal is completed, because all sales are done on a commission basis. There is a sticker price on each car, prominently displayed in the side window. Customers negotiate with the salesperson to get a better price. If the proposed price is significantly below the sticker price, the salesperson has to get Jim's approval before agreeing to the deal. Financing can be arranged with the manufacturer through the dealership, or the customer can get financing through his or her own bank. All taxes and license fees are paid through the dealership. The customer can have additional customization of the car, including special trim, alarm system, audio system, and other features done at the dealership before picking up the car. All the new cars come with a standard warranty, but customers can opt for an extended warranty at an additional cost. Trade-ins are accepted as partial payment for new cars. The dealership also sells these trade-ins as used cars, which can be models from a variety of manufacturers. No maintenance is done on the trade-ins; they are sold "as-is," with a limited 30-day warranty.

Information Needs

The dealership has a database management system that currently keeps track of the cars and sales information. However, Jim wishes to develop a

new database that can provide more information more efficiently than the current system. The current system stores information about the cars, the customers, the salespeople, and the sales of cars. The following forms and reports are used:

1. **Price Sticker.** The price sticker that comes with the car when it is shipped from the manufacturer contains all the basic information about the car itself. It includes a vehicle ID that identifies the car uniquely, and is physically embedded in the car's body. The sticker also gives the list price, model, date of manufacture, place of manufacture, number of cylinders, number of doors, weight, capacity, options, color, and other specifications. The dealership adds the date the car was delivered and the mileage at the time of delivery.
2. **Customer Data.** Basic contact information about customers is obtained by salespeople when they greet them at the showroom. Additional customer information is gathered when a sale is made. Jim also seeks to gather names and addresses of potential customers using referrals, reply cards from newspapers and magazines, and other sources. These are used to mail promotional material to prospective customers.
3. **License, Tax, and Insurance Documents.** The dealership is required to submit information about each sale to the state prior to issuing a license plate for the car. They must also remit the state sales tax and license fee on each sale directly to the state. They are required to obtain and submit proof of insurance coverage to the state before releasing the car to the new owner.
4. **Bill of Sale.** When the car is delivered to the customer, a completed bill of sale—showing the customer information, salesperson name, Vehicle ID, current mileage, and all specifications including any extra customization, financing, warrantee information, license and insurance information, price, and all other details—is provided to the customer, with a copy kept in the dealership. This bill of sale is the same whether the car is new or used.
5. **Salesperson Performance Report.** Jim would like a monthly report summarizing each salesperson's sales for the previous month. The amount of commission earned is also shown on the report.
6. **Customer Satisfaction Survey.** Within a month after each sale, the dealership sends a survey to the new owner, asking questions

about the customer's opinion of the car, the dealership, and the salesperson.

In addition to these forms and reports, there are several others that would be useful. Do Steps 1.1–1.4 based on the information provided here and any additional applicable assumptions you need to make about the operations of Friendly Cars.

Project Four: Images Photography Studio

General Description

Images Photography Studio is a small business that provides custom photography services to individual and corporate clients. The services include photographing weddings, graduations, awards ceremonies, business conferences, receptions, and other events. The studio also offers sittings for individual, family, or group portraits, which may be taken in the studio or at a location specified by the client. The studio photographs about two hundred events and takes about a thousand portraits per year. The staff consists of the manager/owner, Liz Davis, who is a professional photographer, five additional staff photographers, and an office manager.

Basic Operations

The client usually contacts the studio to make an appointment to meet with Liz or her representative. At the first meeting, the representative shows samples of the studio's work, and answers any questions the client might have. The client provides information including the services desired, location, date, time, and the name of the photographer requested, if any. Most events require two photographers, a primary one and an assistant, but portraits require only one. In addition to the six regular photographers, the studio maintains a list of freelance photographers to use for events when the staff photographers are booked or unavailable. The representative provides an estimate and makes a tentative booking. After the initial meeting, a contract is prepared and mailed to the client for a signature. The client returns the signed contract with a deposit, and the booking is finalized. The photographers cover the event or sitting, the film is developed, and proofs are produced. Each proof is assigned a unique identifying number, and a package of proofs is presented to the client. The client selects the pictures desired, and places the final order along with any

special instructions, such as retouching, desired. The pictures or albums are produced and the final package is delivered to the client.

Payments are made for jobs at various times. Usually, a deposit is given at the time of the booking, and additional payments are made on the day of the event or sitting, on presentation of the proofs to the client, and when the final package is delivered. Many package options are available, including combinations of pictures of various sizes, several types of albums, and digital packages. The packages are described in a printed booklet, and are identified by number. The final package might differ from the original request, so the last payment needs to be adjusted accordingly. In the event the client is not pleased with the proofs, he or she has the option of refusing a final package, but the deposit and payments for the sitting are not refunded. Clients keep proofs, but the studio owns the copyright for the images and it keeps all negatives and digital files for six months, during which time the client may order additional photographs. At the end of six months, the negatives and files are discarded unless the client requests additional time.

Information Needs

The company currently keeps records by hand, but its business has grown enough so that a database is needed to help control its operations. The current manual system is unwieldy and inefficient, and the owner wishes to develop a database system that the office manager will be able to maintain. The system will be used to keep information about clients, jobs, and photographers. It will not include information about supplies, equipment, office expenses, or payroll. The forms used to provide information are:

1. **Inquiry Form.** This document is filled in when the client meets with the manager. It lists such items as contact information, services requested, and package chosen. During the interview, the manager checks to see what photographer(s) are available at the requested time, and chooses one to put on the form. Entries are considered tentative and subject to change before a contract is drawn up.
2. **Contract.** The contract contains data from the inquiry form, as well as the name of the photographer(s) assigned to the job, planned payment data, and any additional requests from the client. Each contract form has a unique number, and it contains some pre-printed matter, such as the studio's name and address, and notices concerning cancellation, liability, and notice of copyright.

3. **Package Order Form.** The package order form is filled out when the client selects the proofs and decides on the final package. If the client orders additional pictures or albums during the six-month period following the final order, an additional order form is filled out. Each order form has a unique number. The following reports are needed:
4. **Photographer Schedule.** A schedule is printed for any period desired, typically a week or a month, for each photographer. It provides basic information about the scheduled events or sittings, and refers to the contract number, which can be used by the photographer to get complete information about each scheduled event or sitting.
5. **Weekly Schedule.** The weekly schedule summarizes the scheduled activities for each day of the week, for all photographers. For each day, it lists the activities in order by time. The report can be run for any week desired, not only for the current week.
6. **Accounts Receivable.** This report summarizes payments that are due each month.
7. **Client Report.** This report can be run as desired to provide information about individual clients. It is typically run for corporate clients, to provide a summary of the services provided to them.
8. **Photographer Availability Transaction.** The database must be able to support a transaction in which the user enters the photographer's name and the date, and the output screen tells the hours he or she is available on that date.

In addition to the forms and reports listed here, there are several others that would be useful. Do Steps 1.1–1.4 based on the information provided here and any additional applicable assumptions you need to make about the operations of Images Photography Studio.

Project Five: Wellness Clinic—Medical Group

General Description

The Wellness Clinic is a facility providing medical care in a rural area of the country. Its professional staff consists of five medical doctors (physicians), two nurse-practitioners who provide non-acute care and can prescribe medication, two registered nurses, two midwives who provide

pre-natal care and supervise delivery except in cases with complications, a pharmacist, and a medical technician. The non-professional staff members include an office administrator, a receptionist, and a bookkeeper who works part-time. The clinic serves several thousand patients, each of whom may visit the clinic any number of times per year, both for preventative care such as checkups or immunizations, and for treatment of illness. Its facilities consist of a waiting room with a reception desk, an administrative office, a nurses' station, 10 examining rooms with adjoining consultation rooms, a small operating room, a birthing room, a recovery room, a pharmacy, and a small laboratory.

Basic Operations

The clinic has regular hours of operation weekdays, Saturday mornings, and two evenings per week. Normally two physicians or one physician and one nurse practitioner, one registered nurse, and one midwife are in the clinic during regular hours. In addition, the professional staff members rotate responsibility for covering emergency calls 24 hours per day, seven days a week. At the end of each day, the administrator or receptionist sets up call forwarding so that emergency calls are automatically directed to the telephone number of the person providing emergency coverage. When the clinic opens in the morning, the call forwarding is halted. Two of the physicians are surgeons who perform routine surgery not requiring general anesthesia at the clinic one morning a week, assisted by a nurse. Others have specialties in pediatrics and internal medicine. However, all of the physicians can provide general and acute care for any of the patients. Patients who require major surgery or other hospital care must go to a hospital located outside the immediate area served by the clinic. The clinic staff members do not normally visit their patients who are in the hospital, instead leaving their care to the hospital staff with whom the clinic communicates during the hospitalization. However, the clinic provides both pre- and post-hospital care for the patients.

Hours of operation are divided into scheduled appointments and unscheduled hours that are open for walk-ins. Patients usually schedule checkups and immunizations well in advance. Patients suffering from chronic or acute illness can usually schedule appointments promptly, or they may come in during the unscheduled hours. The administrator is responsible for setting up all schedules, both for the staff and for patients, and for keeping records updated. Prior to the beginning of each month, the administrator

makes up complete coverage schedules for all staff. The bookkeeper is responsible for doing all billing, and recording payments. The receptionist is responsible for making appointments, handling traffic, and making the patient's medical records available in a folder during the visit. The nurse prepares the patient, takes medical history, performs some medical routines or tests, takes samples for lab tests, updates the folder, and assists the practitioner (the physician, nurse practitioner, or midwife) during the visit. During the visit, the practitioner examines the patient, administers medical treatment, can perform some tests, can take samples for lab tests, and write prescriptions for medications or orders for additional lab tests. Each visit results in one or more diagnoses, which the practitioner adds to the patient's folder, along with any comments or observations. Prescriptions can be filled at the clinic's pharmacy at the patient's request. Some laboratory tests are performed at the clinic by the medical technician, using samples taken by one of the professionals. More specialized tests are performed at a medical laboratory at the hospital outside the region. Whenever possible, specimens such as blood samples are taken at the clinic and then sent to the hospital laboratory. If the lab test requires the presence of the patient and equipment that is not available at the clinic, the patient is sent to the hospital laboratory for the test, and results are sent back to the clinic.

Medical care is provided for all patients, regardless of their ability to pay. Bills are generated based on the services provided, not on the payment method. Private patients who can afford to pay out of pocket can do so at the time of service or be billed at the end of each month. Those who have medical insurance provide information about their insurance policies, and the insurance companies are billed. Usually in that case patients pay a small amount of co-insurance (co-pay), which is determined by the type of policy they hold, at the time of the visit. Those who cannot afford to pay normally have government-provided healthcare, for which they have a government-issued medical card. They pay nothing and the clinic is reimbursed by the government for the entire cost of the visit, including any lab tests performed and medications dispensed there. A small number of indigent patients who do not have health coverage are treated and the cost is absorbed by the clinic until the patient qualifies for government-provided coverage.

Information Needs

Currently all information about patients and their care is kept manually, and billing is done using a spreadsheet kept on a personal computer.

Physicians use standard mail, fax, or telephone communications to provide information to the hospital and receive information about patients who need hospital care. The clinic recently upgraded its computer and it will have access to hospital records for its patients, as well as on-line systems provided by insurance companies and the government for third-party billing. The clinic needs a database that keeps track of all the patient-related activities of the clinic, and to provide information about billing and payments. The database will not keep track of medical supplies, plant maintenance, or payroll information.

The following forms or reports are needed.

1. **Weekly Coverage Schedule.** This schedule needs to list the daily hours and the professional and non-professional staff who are scheduled to be in the clinic at specific times each day of the week. It also needs to list the name and telephone number of the person who is covering for emergencies during all hours each week. (Recall that the administrator provides the coverage information each month.)

2. **Daily Master Schedule.** This is a master schedule for all practitioners for each day. It should list each of the practitioners who are in that day, with all patient appointments scheduled. Most appointments are allocated 10 minutes, so each hour has six time slots. However, some appointments are given more than one time slot, depending on the nature of the care needed. Each professional has hours dedicated to walk-ins during which no pre-scheduled appointments are made. As walk-ins sign in for care, they are assigned to a practitioner and the patient's name is added to the schedule. The registered nurses do not have appointments scheduled, and are available to assist the practitioners with visits, or to administer tests or take samples on an unscheduled basis. The lab technician also does not have an appointment schedule.

2. **Individual Practitioner's Daily Schedule.** Each of the practitioners should receive an individualized printed copy of the schedule for any day he or she is in the clinic. Appointments list the patient's name and the reason given for the visit. The copy is updated manually by the nurse as visits for walk-ins are conducted.

3. **Physician's Statement for Insurance Forms.** This is a pre-printed form that is used as a receipt primarily for insurance purposes. It

lists the clinic name, address, and telephone number, along with the names and tax identification numbers of all the professionals on the staff. It also lists all the types of visits, the procedures that can be performed with a code for each, and some blank lines for "other," along with a line to enter the fee for each. It also has a list of the common diagnoses and codes, with a few blank lines for "other." At the bottom are lines for Total Charge, Amount Paid, and Balance Due. The provider uses this form during a visit to record visit type, procedures performed, and diagnosis. When the patient checks out after the visit, the receptionist fills in the fee for each service using a fee schedule, calculates the total, and writes in the amount paid, if any, and the Balance Due. One copy is kept by the clinic and another is given to the patient. At present, a third copy is mailed to the insurance company or government health agency, but in future the required information will be submitted electronically.

4. **Patient Monthly Statement.** Any patient who has an unpaid balance receives a statement that is compiled at the end of each month, listing all the services provided that month, any payments received, and the balance due.

5. **Precription Label and Receipt.** This form consists of two parts. The top part is gummed and used as a label for the container in which medication is dispensed. The label shows the Rx number, doctor name, patient name, patient address, directions, drug name, form, strength, quantity, pharmacist's name, date filled, original date, and number of refills remaining. The bottom part repeats the information on the label, and also lists the total price of the medication, the amount covered by insurance or the government, and the balance due from the patient, as well as more information about the drug, complete directions for use, and warnings about possible side effects and drug interactions. The receipt can be used for submitting claims for insurance coverage. In the future, this information will also be submitted electronically to insurance companies and the government medical care agency.

6. **Daily Laboratory Log.** This log is used to record all lab tests performed each day.

7. **Operating Room Schedule.** This schedule provides information about all scheduled surgeries for the day.
8. **Operating Room Log.** This records information about the surgeries actually performed on a given day, including identification of the patient, surgeon, and nurse, and notations and observations about the surgery.
9. **Daily Delivery Room Log.** This records information about all the deliveries performed each day.
10. **Recovery Room Log.** This report records information about the use of the recovery room, including the patient's name, attending practitioner, bed, date in, time in, date out, time out, and signature of the practitioner who signs the patient out. A nurse records the times and results of any medical checks performed while the patient is in recovery.
11. **Monthly Activity Report.** This is an internal report summarizing the clinic's activity each month. It shows such items as the number of visits conducted by each provider, the number of surgeries performed, the number of deliveries, the number of lab tests broken down by type, the number of prescriptions dispensed, the average time per visit, and so on.

These are just a few of many reports and forms that would be helpful to the staff of the clinic. In addition to the forms and reports listed here, there are several others that would be useful. Do Steps 1.1–1.4 based on the information provided here and any additional applicable assumptions you need to make about the operations of The Wellness Clinic.