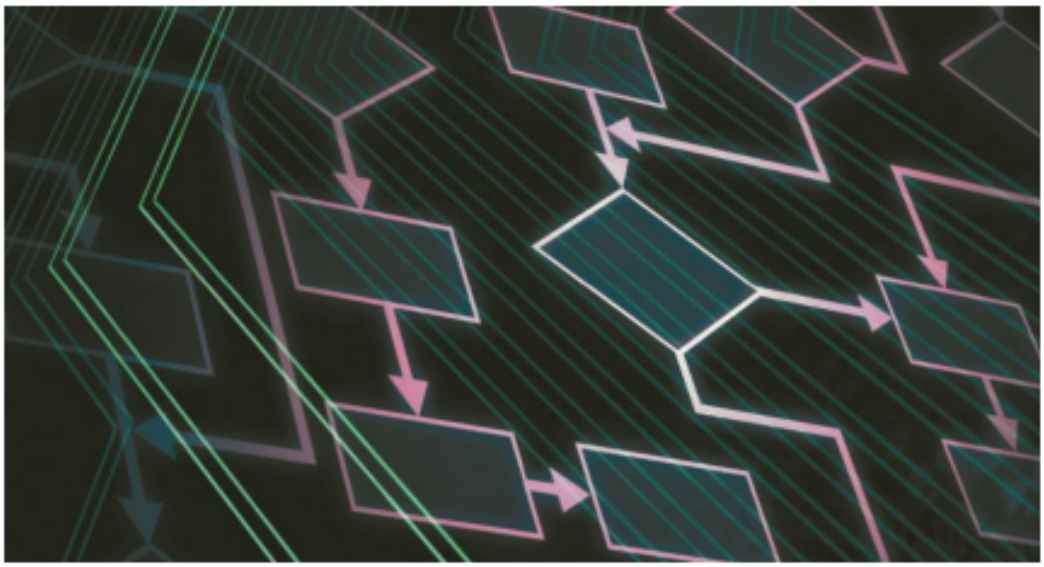
11

Building Solutions: Database, System, and Application Development Tools



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OBJECTIVES

After completing this module, you will be able to:

1. Differentiate among a character, field, record, and data file and describe validation techniques
2. Differentiate between file processing systems and the database approach
3. Describe uses of web databases, types of databases, and Big Data
4. Discuss functions common to most database management systems: data dictionary, file retrieval and maintenance, data security, and backup and recovery
5. Define system development, list the system development phases, and identify the guidelines for system development
6. Discuss the importance of project management, feasibility assessment, documentation, and data and information gathering techniques
7. Discuss the purpose of and tasks conducted in each system development phase
8. Differentiate between low-level languages and procedural languages
9. Identify the benefits of object-oriented programming languages and application development tools
10. Describe various ways to develop webpages and web applications

Databases, Data, and Information

As presented in Module 4, a **database** is a collection of data organized in a manner that allows access, retrieval, and use of that data. As discussed in previous modules, data is a collection of unprocessed items, which can include text, numbers, images, audio, and video. Information is processed data; that is, it is organized, meaningful, and useful.

Computers process data in a database to generate information for users. A database at a school, for example, contains data about its students and classes (Figure 11-1).

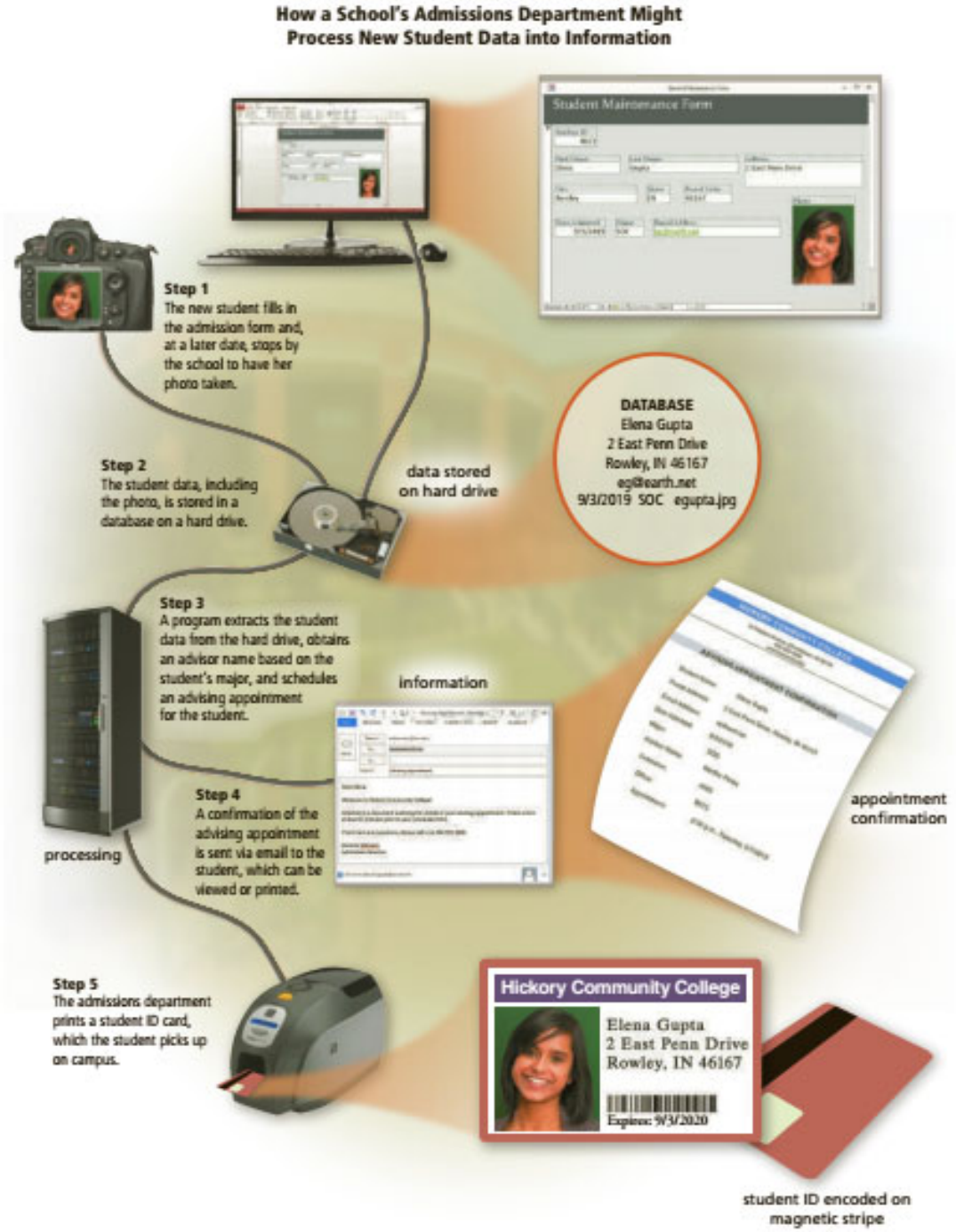


Figure 11-1 This figure shows how a school's admissions department might process new student data into information.

When students are accepted to a school, they typically complete an online admission form that is displayed as a form in a browser. Students type their personal information into an online form and, at a later date, stop by the school to have their photo taken. Upon submitting the form, the page uploads the student's personal information in a database on a server at the school. When the school takes the student's photo, it also is stored in the school's database. The school's admission system assigns an ID number to the student and stores it in the database. The system then sends the student an email message with advising information. When the student's photo is taken on campus, relevant information is sent to an ID card printer, where the student's photo, name, and address is printed on the front of the card and the ID number is encoded on a magnetic stripe on the back of the card. Figure 11-1 illustrates this process.

With **database software**, often called a **database management system (DBMS)**, users create a computerized database; add, modify, and delete data in the database; sort and retrieve data from the database; and create forms and reports from the data in the database.

The Hierarchy of Data

Data is organized in levels. Information technology (IT) professionals classify data in a hierarchy. Each higher level of data consists of one or more items from the lower level. Depending on the application and the user, different terms describe the various levels of the hierarchy.

As shown in Figure 11-2, a database contains a group of related data files. A data file contains records, a record contains fields, and a field is composed of one or more characters. This sample School database contains four data files: Student, Instructor, Schedule of Classes, and Student Schedule.

- The Student file contains records about enrolled students.
- The Instructor file contains records about current instructors.
- The Schedule of Classes file contains records about class offerings in a particular semester.
- The Student Schedule file contains records about the classes in which a student is enrolled for a given semester.

BTW

Tables

In some database programs, a data file is referred to as a table (i.e., Student table, Instructor table, etc.).

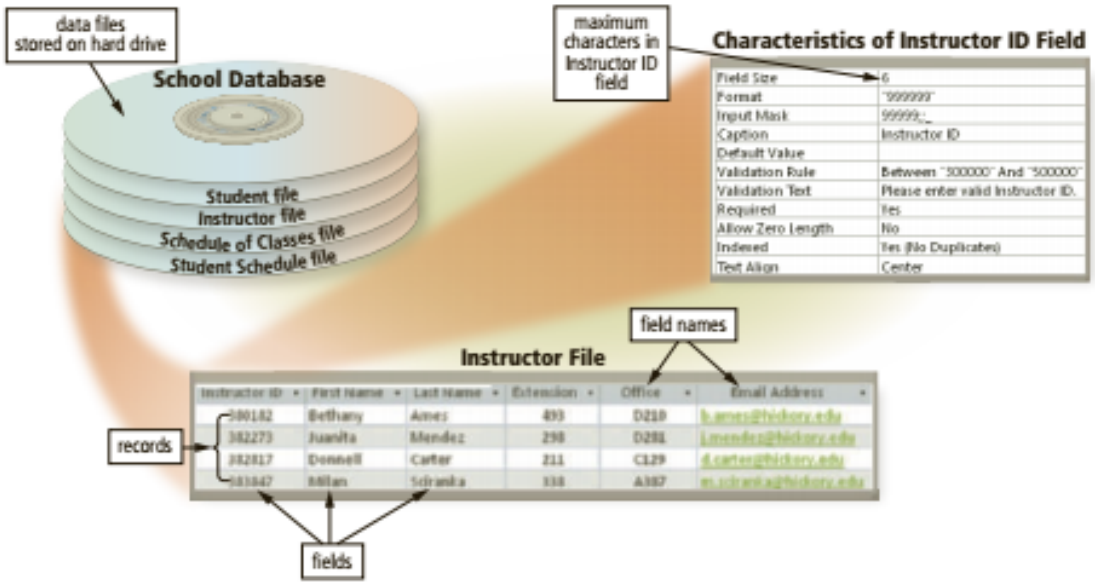


Figure 11-2 A sample school database with four data files: Student, Instructor, Schedule of Classes, and Student Schedule. The sample Instructor file contains four records. Each record contains six fields. The Instructor ID field can contain a maximum of six characters (bytes).
Source: Microsoft

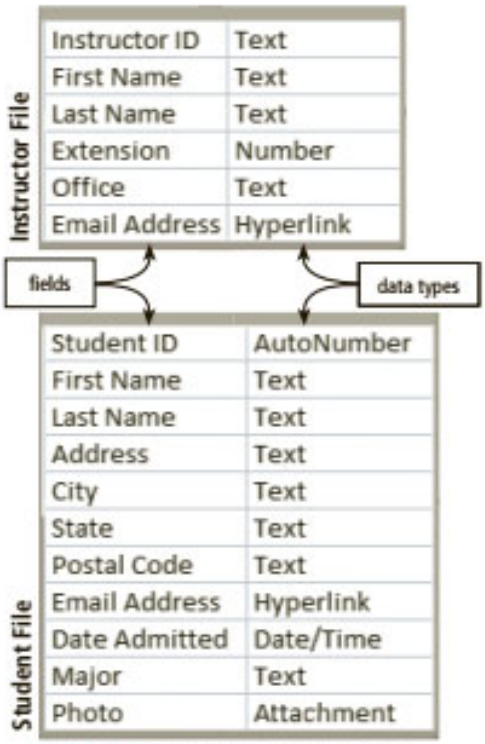


Figure 11-3 Data types of fields in the Instructor and Student files.

Characters As discussed in Module 6, a bit is the smallest unit of data the computer can process. Eight bits grouped together in a unit constitute a byte. In the ASCII coding scheme, each byte represents a single **character**, which can be a number (4), letter (R), blank space (SPACEBAR), punctuation mark (?), or other symbol (&).

Fields A **field** is a combination of one or more related characters or bytes and is the smallest unit of data a user accesses. A **field name** uniquely identifies each field. When searching for data in a database, you often specify the field name. For example, field names for the data in the Instructor file are Instructor ID, First Name, Last Name, Extension, Office, and Email Address.

A database uses a variety of characteristics, such as field size and data type, to define each field. The field size defines the maximum number of characters a field can contain. For example, the Instructor ID field contains 6 characters and thus has a field size of 6 (shown in Figure 11-2).

The **data type** specifies the kind of data a field can contain and how the field is used. Figure 11-3 identifies the data types for fields in the Instructor and Student files.

BTW

Field Names

Some database programs do not allow the use of the space character in field names. For example, you may see the Last Name field name written as LastName or last_name.

CONSIDER THIS

What are common data types?

Common data types include the following:

- Text: Letters, numeric characters, or special characters
- Number (also called numeric values): Positive or negative numbers, and the number zero, with or without decimal points
- AutoNumber: Unique number automatically assigned by the DBMS to each added record, which provides a value that identifies the record (such as a student ID)
- Currency: Dollar and cent amounts or numbers containing decimal values
- Date (also called date/time): Month, day, year, and sometimes time
- Memo (also called long text): Lengthy text entries, which may or may not include separate paragraphs
- Yes/No (also called *Boolean*): Only the values Yes or No (or True or False)
- Hyperlink: Email address or web address that links to a webpage on the Internet or document on a network
- Object (also called *BLOB*, for binary large object): Photo, audio, video, or a document created in other programs or apps, such as word processing or spreadsheet, stored as a sequence of bytes in the database
- Attachment: Document or image that is attached to the field, which can be opened in the program that created the document or image (functions similarly to email attachments)

Records A **record** is a group of related fields. For example, a student record includes a set of fields about one student. A **primary key** is a field that uniquely identifies each record in a file. The data in a primary key is unique to a specific record. For example, the Student ID field uniquely identifies each student because no two students can have the same student ID. In some files, the primary key consists of multiple fields, called a *composite key*. For example, the primary key for the Schedule of Classes file could consist of the fields Semester Code, Class Code, and Class Section, which together would uniquely identify each class listed in a schedule.

Data Files A **data file**, often simply called a file, is a collection of related records stored on a storage medium, such as a hard drive, or on cloud storage. A Student file at a school might consist of thousands of individual student records. Each student record in the file contains the same fields. Each field, however, contains different data. Figure 11-4 shows a small sample Student file that contains four student records, each with eleven fields. A database includes a group of related data files.

Sample Student File

Student ID	First Name	Last Name	Address	City	State	Postal Code	Email Address	Date Admitted	Major	Photo
2295	Milton	Brewer	54 Lucy Court	Charlestown	IN	46176		6/10/2019	EE	mbrewer.jpg
3876	Louella	Drake	33 Timmons Place	Bonner	IN	45208	lou@world.com	8/9/2019	BIO	ldrake.jpg
3928	Adelbert	Ruiz	99 Tenth Street	Sheldon	IN	46033		10/8/2019	CT	aruiz.jpg
2872	Benjamin	Tu	2204 Elm Court	Rowley	IN	46167	tu@indi.net	9/14/2019	GEN	btu.jpg

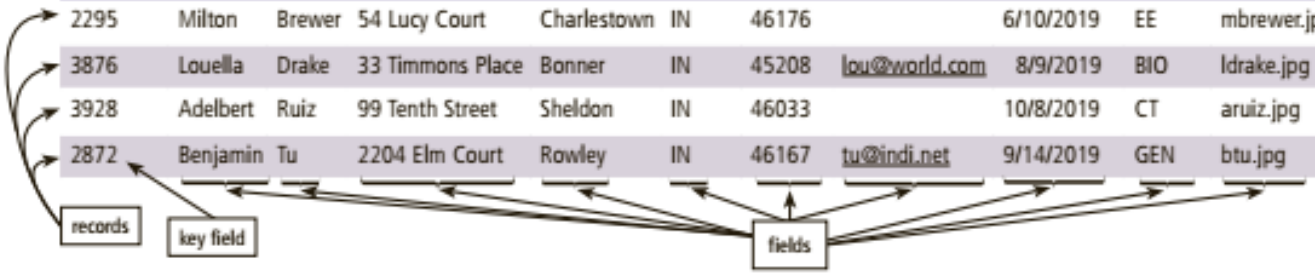


Figure 11-4 This sample data file, stored on a hard drive, contains four records, each with eleven fields.

CONSIDER THIS

Why do some fields that store only numbers have a text data type?
Fields that contain numeric characters whose values will not be used in calculations, such as postal codes or phone numbers, usually are assigned a text data type.

File Maintenance

File maintenance refers to the procedures that keep data current. File maintenance includes adding records to, modifying records in, and deleting records from a file. Users add new records to a file when they obtain additional data that should be stored, such as data about a new student admitted to a school. Generally, users modify a record in a file for two reasons: (1) to correct inaccurate data or (2) to update old data with new data, such as replacing a student's address when she moves to a new address. When a record no longer is needed, a user deletes it from a file. For example, if a student was accepted for admission but later notifies the school that he chose to attend another college, the school might delete the student's records from its database. Read Ethics & Issues 11-1 to consider how organizations use data they collect.

ETHICS & ISSUES 11-1

What Use of Collected Data Is Fair?

A department store came under scrutiny recently for using customers' shopping habits and purchases to determine whether a customer was pregnant. The store used the data to send ads for baby products before some customers even announced that they were expecting. If you willingly purchase products at a store, can the business analyze your purchases to create a profile to use for marketing purposes? Can it sell that data to a third party?

Function creep occurs when a company uses the technology intended for one purpose for an entirely different purpose. One example of function creep is when companies use or sell customer data collected through sales transactions using customer loyalty cards or other customer tracking methods. While some companies use data for their own purposes, such as to plan inventory or identify sales trends, others sell to data brokers or businesses that perform marketing surveys or generate credit reports. Privacy advocates are concerned about any use of personal data for purposes other than what the customer intended.

Online social networks and search engines often use activities, such as posts, pages viewed, and search terms, to suggest sponsored ads. Online vendors state that the data enables them to provide custom product suggestions and streamline ordering processes. Some customers acknowledge that a company has the right to use data to enhance the customers' experience or to make business decisions.

Many consumers would like more control over their data. The FTC Fair Information Practices (FIP) attempt to address data privacy concerns. FIP states that companies must inform customers of their data use and must allow customers to provide or deny consent. Criticisms include that the FIP guidelines are not legally binding and that other countries include more restrictions, as well as laws for regulating data collection and usage.

Consider This: Have you experienced examples of a company using your personal data? For what purpose? Do you read a company's data privacy policy before using its website or service? Why or why not? How should the government enforce data privacy laws?

DBMSs use a variety of techniques to manage deleted or obsolete records. Sometimes, the DBMS removes the record from the file immediately, which means the deleted record cannot be restored. Other times, the record is flagged, or marked, so that the DBMS will not process it again. In this case, the DBMS places an asterisk (*) or some other character at the beginning of the record to indicate that it was deleted. DBMSs that maintain inactive data for an extended period commonly flag records. For example, a school might flag courses no longer offered or former employees no longer employed. When a DBMS flags a deleted record, the record remains physically on the drive. The record, however, is deleted logically because the DBMS will not process it. DBMSs will ignore flagged records unless an instruction is issued to process them.

CONSIDER THIS

Can you permanently delete flagged records?

From time to time, users should run a program that removes flagged records and reorganizes current records. For example, the school may remove from the drive the names of applicants who chose to attend other schools instead. Deleting unneeded records reduces the size of files, thereby freeing up storage space.

Validating Data

Validation is the process of comparing data with a set of rules or values to determine if the data meets certain criteria. Many programs perform a validity check that analyzes data, either as you enter the data or after you enter it, to help ensure that it is valid. For instance, when an admissions department specialist adds or modifies data in a student record, the DBMS tests the entered data to verify it meets certain criteria.

If the data fails a validity check, the computer either should not allow the invalid data to be stored, or it should display an error message that instructs the user to enter the data again. Validity checks, sometimes called validation rules, reduce data entry errors and thus enhance the data's integrity.

Alphabetic/Numeric Check An *alphabetic check* ensures that users enter only alphabetic data into a field. A *numeric check* ensures that users enter only numeric data into a field. For example, data in a First Name field should contain only characters from the alphabet. Data in a Current Enrollment field should contain integers.

Range Check A *range check* determines whether a number is within a specified range. Assume the lowest per credit hour fee at the school is $75.00 and the highest is $370.75. A range check for the Credit Hour Fee field ensures it is a value between $75.00 and $370.75.

Consistency Check A *consistency check* tests the data in two or more associated fields to ensure that the relationship is logical and their data is in the correct format. For example, the value in a Date Admitted field cannot occur earlier in time than a value in a Birth Date field.

Completeness Check A *completeness check* verifies that a required field contains data. For example, some fields cannot be left blank; others require a minimum number of characters. One completeness check can ensure that data exists in a Last Name field. Another can ensure that a day, month, and year are included in a Birth Date field.

Check Digit A *check digit* is a number(s) or character(s) that is appended to or inserted in a primary key value. A check digit often confirms the accuracy of a primary key value. Bank account, credit card, and other identification numbers often include one or more check digits.

Other Checks DBMSs that include the hyperlink and attachment data types can perform validity checks on data entered in those fields. Hyperlink entries (web addresses and email addresses) can be tested to ensure that the address follows the correct format. Similarly, an attachment entry can be validated by confirming that the file exists.

Table 11-1 illustrates some of the validity checks just discussed and shows valid data that passes the check and invalid data that fails the check.

Table 11-1 Sample Valid and Invalid Data

Validity Check	Field(s) Being Checked	Valid Data	Invalid Data
Alphabetic Check	First Name	Karen	Ka24n
Numeric Check	Current Enrollment	24	s8q
Range Check	Per Credit Hour Fee	$220.25	$2,120.00
Consistency Check	Date Admitted, Birth Date	9/19/2019 8/27/2000	9/19/2019 8/27/2020
Completeness Check	Last Name	Gupta	
Other Check	Email Address	eg@earth.net	egearth.net

File Processing Systems and Databases

Almost all applications use the file processing approach, the database approach, or a combination of both approaches to store and manage data. The next sections discuss these two approaches.

File Processing Systems

In the past, many organizations exclusively used file processing systems to store and manage data. In a typical **file processing system**, each department or area within an organization has its own set of files. The records in one file may not relate to the records in any other file. Many of these systems have two major weaknesses: redundant data and isolated data.

- **Redundant data:** Because each department or area in an organization has its own files in a file processing system, the same fields are stored in multiple files. If a file processing system is used at a school, for example, the Student file and the Student Schedule file both might store the same students' names and addresses.

  Duplicating data in this manner can increase the chance of errors. If a student changes his or her address, for example, the school must update the address in each file in which it appears. If the Address field is not changed in all the files where it is stored or is changed incorrectly in one location, then discrepancies among the files exist. This duplication also wastes resources, such as storage space and time. When new students are added or student data is modified, file maintenance tasks consume additional time because employees must update multiple files that contain the same data.
- **Isolated data:** It often is difficult to access data that is stored in separate files in different departments. Assume, for example, that the student email addresses exist in the Student files and class room numbers (locations) are in the Schedule of Classes file. To send an email message informing students about a room change, data is needed from both the Student file and the Schedule of Classes file. Sharing data from multiple, separate files to generate such a list in a file processing system often is a complicated procedure and usually requires an experienced programmer.

The Database Approach

When an organization uses a database approach, many programs and users share the data in the database. A school's database most likely, at a minimum, contains data about students, instructors, schedule of classes, and student schedules. As shown in Figure 11-5, various areas within the school share and interact with the data in this database. The database does secure its data, however, so that only authorized users can access certain data items. Read Ethics & Issues 11-2 to consider whether criminal databases are useful for law enforcement.

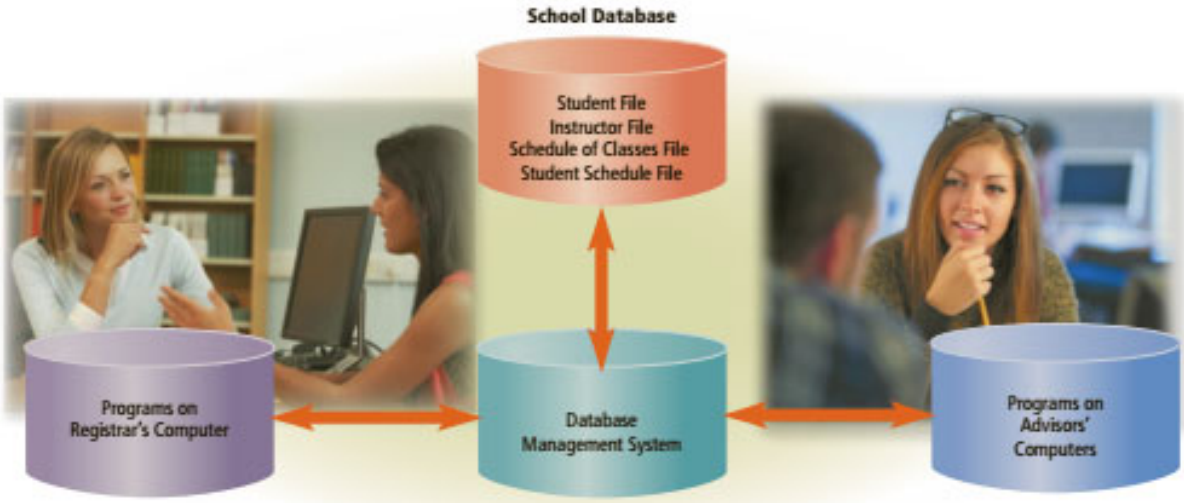


Figure 11-5 In a school's database, the computer used by the registrar and the computers used by advisors access data in the same database through the DBMS.

Monkey Business / Fotolia LLC; iStockphoto.com / sturti

ETHICS & ISSUES 11-2

Does the Use of Criminal Databases Help or Hinder Investigations?

On television, detectives use databases to quickly compile a list of suspects for a crime. In these depictions, the list is complete, accurate, and leads to a speedy conviction. In reality, criminal databases are a helpful tool in solving crimes, but they are not without limitations. As with any database, the value depends on the quality of its information. If a criminal database contains data that is incomplete, inaccurate, or outdated, is it useful for law enforcement?

Many criminal databases exist at the county, state, and federal levels. Some information is mandatory, but other contributions to databases are voluntary or require only periodic updates. States' departments of correction record and share arrest records and jail time, but county or local jail records may not be included. Some courts and law enforcement use these databases for background checks to narrow a list of suspects or when determining sentencing. Others allow the use during an investigation, but findings are not admissible in court.

Megan's Law refers to a group of U.S. laws that require law enforcement agencies to share information in a national database about criminals who commit unlawful acts on children. States decide which information to make public and how to distribute the information. Often, states release criminals' names, photos, addresses, and information about the crime on a searchable, public website. Some states share information with one another regarding almost all criminals, and a few allow citizens to search for convicted criminals by name. Privacy experts feel that publishing this information makes it impossible for an offender who has served time to lead a normal life. Proponents state that the public's right to know outweighs the rights of privacy of those convicted.

Consider This: Are criminal databases useful in law enforcement? Why or why not? Should information from criminal databases be admissible in court? Why or why not? What information should states provide to the public regarding people convicted of crimes? Why?

While a user is working with the database, the DBMS resides in the computer's memory. Instead of working directly with the DBMS, some users interact with a front end. A *front end* is a program that generally has a more user-friendly interface than the DBMS. For example, a registration department specialist interacts with the Class Registration program by filling out a form. This front-end program interacts with the DBMS, which, in turn, interacts with the database. Many programs today use forms on a webpage as their front end. An application that supports a front-end program by interacting directly with the database sometimes is called the *back end*. In this case, the DBMS is the back end.

Advantages of a Database Approach

The database approach addresses many of the weaknesses associated with file processing systems. Advantages of the database approach include the following:

- **Reduced data redundancy:** Most data items are stored in only one file, which greatly reduces duplicate data. For example, a school's database would record a student's name and address only once. When student data is entered or changed, one employee makes the change once. Figure 11-6 demonstrates the differences between how a file processing application and a database application might store data.

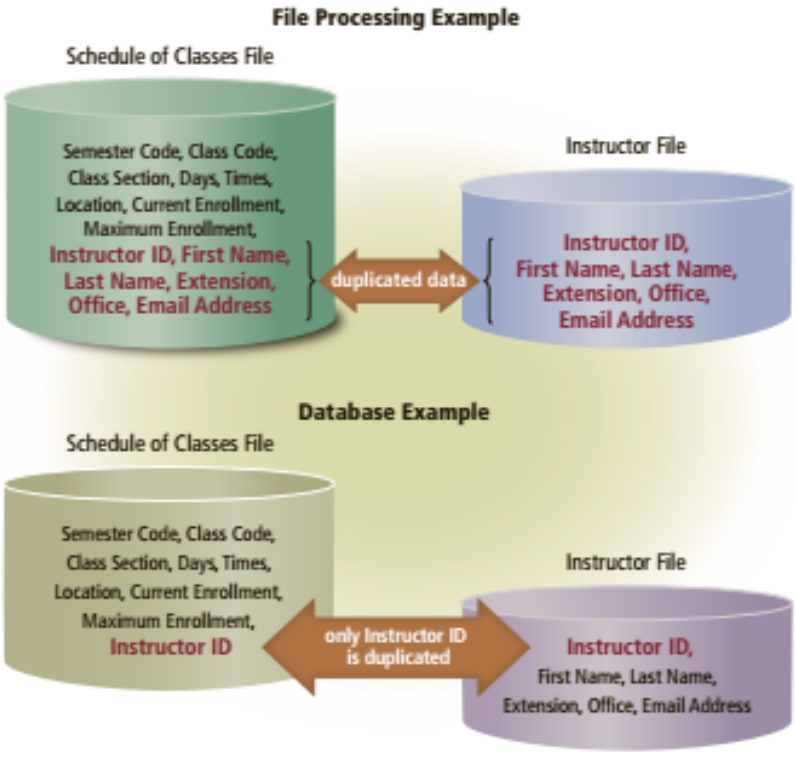


Figure 11-6 With file processing, both files contain all six instructor data fields. With a database, only the Instructor file contains the First Name, Last Name, Extension, Office, and Email Address fields. Other files, such as the Schedule of Classes file, contain only the Instructor ID — which links to the Instructor file when instructor data is needed.

- **Improved data integrity:** When users modify data in the database, they make changes to one file instead of multiple files. Thus, the database approach increases the data's integrity by reducing the possibility of introducing inconsistencies.
- **Shared data:** The data in a database environment belongs to and is shared, usually over a network, by the entire organization. This data is independent of, or separate from, the programs that access the data. Organizations that use databases typically have security settings to define who can access, add, modify, and delete the data in a database.
- **Easier access:** The database approach allows nontechnical users to access and maintain data, provided they have the necessary privileges. Many computer users also can develop smaller databases themselves, without professional assistance.
- **Reduced development time:** It often is easier and faster to develop programs that use the database approach. Many DBMSs include several tools to assist in developing programs, which further reduces the development time.

CONSIDER THIS

Can a database eliminate redundant data completely?
No. A database reduces redundant data; it does not eliminate it. Key fields link data together in a database. For example, a Student ID field will exist in any database file that requires access to student data. Thus, a student ID is duplicated (exists in more than one file) in the database.

Disadvantages of a Database Approach A database can be more complex than a file processing system. People with special training usually develop larger databases and their associated applications. Databases also require more memory and processing power than file processing systems.

Data in a database can be more vulnerable than data in file processing systems because it can store a lot of data in a single physical file. Many users and programs share and depend on this data. If the database is not operating properly or is damaged or destroyed, users may not be able to perform their jobs. Further, unauthorized users potentially could gain access to a single database file that contains several data files of personal and confidential data. To protect their database resource, individuals and companies should establish and follow security procedures.

Despite these limitations, business and home users often work with databases because of their numerous advantages.

Tech Feature 11-1: Web Databases

The web offers information about jobs, travel destinations, television programming, photos, movies, videos, local and national weather, sporting events, and legislative information. You can shop for just about any product or service, buy or sell stocks, and make airline reservations. Much of this and other information exists in databases that are stored on or are accessible through the web. Some web databases are *collaborative databases*, where users store and share photos, videos, recordings, and other personal media with other registered users.

To access data in a web database, you fill in a form on a webpage. The webpage is the front end to the database. Many search engines use databases to store and index content from websites for rapid retrieval. Thus, the search engine's home page, containing a form in which to type search text, is the front end to the database. To access the search engine's database, you enter search text in a search form and then click a search button that instructs the form to send the search text to the search engine.

A web database for an organization usually resides on a database server. A *database server* is a computer that stores and provides access to a database. For smaller databases, many desktop database programs provide a variety of web publishing tools that enable users without computer programming experience to create a home or small office database. Read Tech Feature 11-1 to learn about types of web databases.

TECH FEATURE 11-1

Web Databases

A database service, or a website that acts as a portal for a database, enables government agencies, schools, and companies to share information with a wide audience. Some web databases are accessible to the public. Examples of public databases include shopping and travel databases. Other databases contain information accessible only to authorized users. Examples of protected databases include certain government databases or entertainment and research databases that are subscription based.

Government

Government web database services can provide access to information about the government, as well as information created and used by government agencies. Some information that government agencies publish in databases is available to the public. Through these database services, for example, users can locate information about current laws. Other database services, such as those for criminal databases, allow access only to those individuals with necessary clearance. Government database services also enable officials around the world to share data.

Entertainment

You can search an entertainment web database service to find out who guest-starred on your favorite television program or locate video or audio clips. Using a subscription-based entertainment web database service allows you to access media content, such as music. These database services often enable you to create and share playlists. Entertainment professionals use subscription-based web databases to view and post casting notices or update artist profiles.

Travel

Booking online travel through a travel web database service enables you to view multiple vendors and options. You can limit a search to desired locations and dates. These database services help you find deals on air travel, car rentals, hotel rooms, and vacation packages. Travel web database services can save your personal data and travel history. These services will send notifications about upcoming travel deals and communicate changes or updates to your travel plans.

Shopping

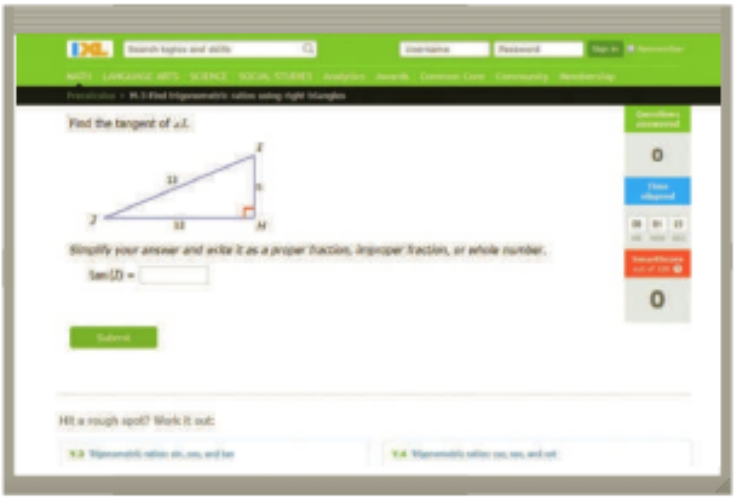
Shopping web database services enable you to locate the right size and color, sort by price or featured products, and more. Vendors can use a web database service to show photos of items they sell and to track inventory. Some shopping database services search for bargains, presenting a variety of purchasing options so that you can find the lowest price. These database services also use your search and order history to suggest products in their databases that you may be interested in buying.

Research

You can interact with web databases to research product information when shopping for a new appliance or car. Information accessible through these web database services includes costs, safety concerns, and industry and user reviews. Some research web database services provide financial information for potential investors, including company histories and stock analysis. Research web database services are available to help you find a college or university and then provide information about admission requirements, financial information, and application advice.

Education

Teachers can search education web database services to locate and share curricula, worksheets, and lesson plans. Schools use web database services to store and distribute student contact information and grades. Students interact with web database services when signing up for their courses online. Using these services during enrollment helps a school determine when a class has reached its maximum size.



Consider This: Which web database services have you used? How do web databases help you in your daily life? Would you use a web database for research? Why or why not?

Types of Databases

Every database and DBMS is based on a specific data model. A data model consists of rules and standards that define how the database organizes data. A **data model** defines how users view the organization of the data. It does not define how the operating system actually arranges the data on the storage media. A database typically is based on one data model. Three popular data models in use today are relational, object-oriented, and multidimensional.

Relational Database A *relational database* is a database that stores data in tables that consist of rows and columns. In addition to storing data, a relational database also stores data relationships. A relationship is a link within the data. Applications best suited for relational databases are those whose data can be organized into a two-dimensional table, that is, tables with rows and columns. Many organizations use relational databases for payroll, accounts receivable, accounts payable, general ledger, inventory, order entry, invoicing, and other business-related functions.

Object-Oriented Database An *object-oriented database* (*OODB*) stores data in objects. An *object* is an item that contains data, as well as the actions that read or process the data. Examples of applications appropriate for an object-oriented database include media databases that store images, audio clips, and/or video clips; groupware databases that store documents, such as schedules, calendars, manuals, memos, and reports; and CAD (computer-aided design) databases that store data about engineering, architectural, and scientific designs.

Multidimensional and Other Database Types A *multidimensional database* stores data in dimensions. Whereas a relational database is a two-dimensional table, a multidimensional database can store more than two dimensions of data. These multiple dimensions allow users to access and analyze any view of the database data. One application that uses multidimensional databases is a data warehouse. A *data warehouse* is a huge database that stores and manages the data required to analyze historical and current transactions. The database in a data warehouse often is distributed. The data in a *distributed database* exists in many separate locations throughout a network or the Internet. Although the data is accessible through a single server, the physical location of the server on which it is stored is transparent and often unknown, to the user.

Tech Feature 11-2: Big Data

Recent technology trends have resulted in activities that generate large quantities of data. These trends include the following:

- Growth of online commerce, social, and government applications
- Increased use of mobile devices
- Emergence of the Internet of Things
- Development of cloud computing
- Availability of Internet connectivity through wired and wireless networks

Online business transactions, posts on social networks, government agencies, media and text messages from tablets and smartphones, and automated sensors produce data that is stored in databases located on servers distributed across the Internet. **Big Data** refers to large-scale data sets that require advanced technologies beyond the capabilities of typical database software to gather, store, process, retrieve, or analyze. Read Tech Feature 11-2 to learn more about characteristics and sources of Big Data, and technologies that facilitate working with large-scale distributed databases.

TECH FEATURE 11-2

Big Data

Through their daily activities, consumers, businesses, and machines produce large quantities of data to be stored on the Internet. Making sense of Big Data can provide valuable information to organizations trying to improve their business processes and make intelligent business decisions.

Characteristics of Big Data

Analysts often refer to the three V's when describing characteristics of Big Data: volume, velocity, and variety. Large-scale data sets grow in volume (how much data is generated), velocity (the rate at which data is generated), and variety (the different formats in which data can appear).

Volume refers to the amount of data that individuals and organizations generate. As data formats expand from text to images, files, audio, and video, it is common to need storage for multiple terabytes (1,000 gigabytes) of data. In the future, some organizations may require storage for petabytes (1,000 terabytes) and exabytes (1,000 petabytes) of data.

Velocity refers to the rate at which data is processed. In one day, for example, Google performs more than 7 billion searches, Facebook records more than 4.5 billion "likes," Twitter receives more than 500 million Tweets, and temperature and barometric sensors located across the world gather and transmit more than 200 million observations. In one minute, YouTube processes 300 hours of uploaded video. In one second, Amazon processes almost 400 transactions from customers during the company's sale day for its Prime customers.

Variety refers to the different formats to represent or store data for use by humans and computer applications. Some data, such as census records, stock values, and corporate sales, is structured, meaning it can be organized neatly in tables. Unstructured data generally is more complex and may include items such as Tweets, media files, Wikipedia articles, and fingerprints.

Some analysts have expanded the three V's to include veracity (how accurate the data is), value (how organizations use their data), and viability (whether organizations can make predictions based on this data).

Sources and Uses of Big Data

One way businesses generate Big Data is by capturing customer behaviors. For example, in addition to storing information about a customer's purchase, some shopping websites also gather data about how much time customers spend on a webpage, how many items they view before making a purchase, and which pages on the company's website that customers visited, in order to create a more customized experience. Amazon and other retailers compile data from customer purchases in a process called collaborative filtering to recommend related products. For example, Amazon recommends that customers who purchase a digital camera might also want to purchase a storage card or a camera case.

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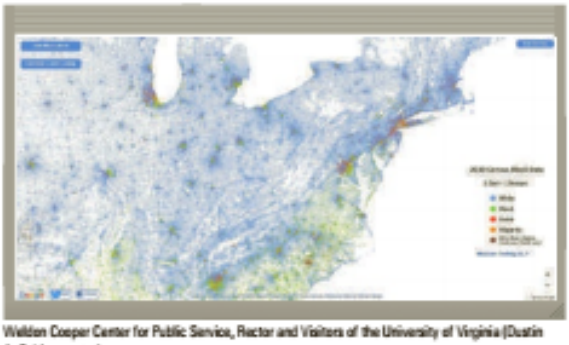
Government agencies generate large amounts of data in real time from satellite images, social media posts, and media. By analyzing this data, they can monitor transportation systems, dispatch first responders in emergencies, and provide consumers with information to make informed choices about health care, schools, and community services.

Temperature and barometric sensors, wearable devices, and buses and trains equipped with GPS capability all transmit data over the Internet to be used in a variety of web and mobile applications.

Data Visualization

Data visualization is the process of presenting data graphically as charts, maps, or other pictorial formats in order to understand the resulting information easily. As the size of databases grows, data visualizations make it possible to interpret complex data sets, find relationships among data items, and discover patterns that can provide useful information. The "Racial Dot Map" shown in the figure is a visualization that displays one dot per person in the United States. Each dot is colored by ethnicity. The figure shows the map zoomed in on the Boston area.



Weldon Cooper Center for Public Service, Rector and Visitors of the University of Virginia (Dustin A. Cable, creator).

Consider This: What websites or apps do you use that generate or take advantage of Big Data? How have cloud computing, online social networks, and the Internet of Things contributed to and enabled the growth of Big Data? What visualizations have you seen that help make sense of complex data sets?

Database Management Systems

As previously discussed, a database management system (DBMS), or database program, is software that allows you to create, access, and manage a database. Managing a company's databases requires a great deal of coordination. The *database administrator* (*DBA*) is the person in the organization who is responsible for managing and coordinating all database activities, including development, maintenance, and permissions.

DBMSs are available for many sizes and types of computers. Whether designed for a small or large computer, most DBMSs perform common functions. The following pages discuss these functions.

BTW

Metadata

Because the data dictionary contains details about data, some call it *metadata* (meta means more comprehensive).

Data Dictionary

A **data dictionary**, sometimes called a *repository*, contains data about each file in the database and each field in those files. For each file, it stores details such as the file name, a description, the file's relationship to other files, and the number of records in the file. For each field, it stores details such as the field name, description, field type, field size, default value, validation rules, and the field's relationship to other fields. Figure 11-7 shows how a data dictionary might list data for a Student file.

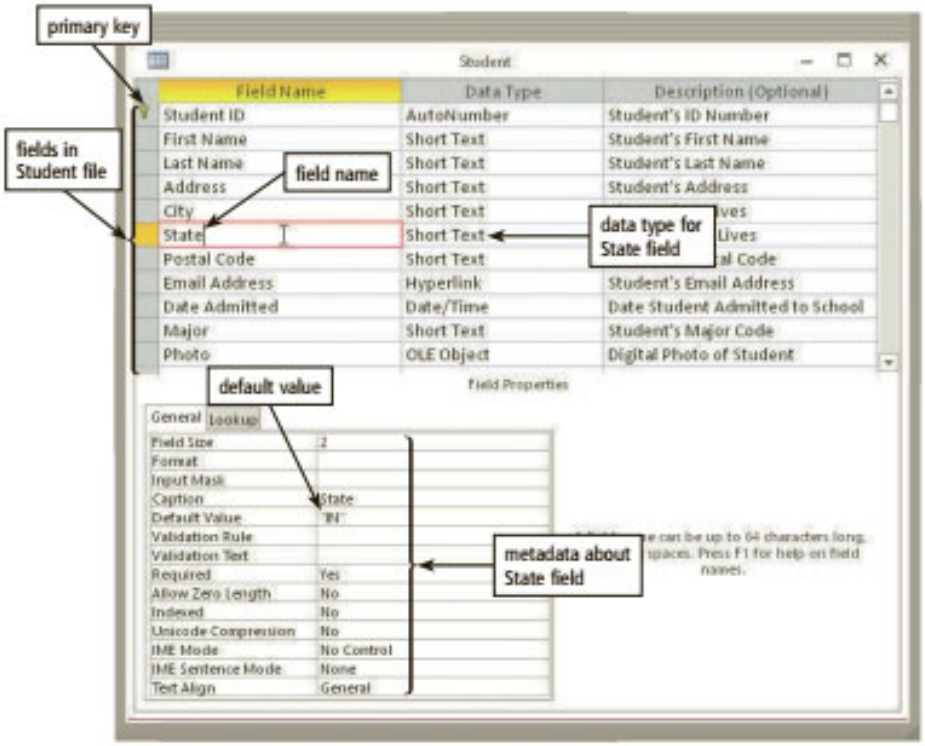


Figure 11-7 A sample data dictionary entry shows the fields in the Student file and the properties of the State field.

Source: Microsoft

A DBMS uses the data dictionary to perform validation checks to maintain the integrity of the data. When users enter data, the data dictionary verifies that the entered data matches the field's data type. For example, the data dictionary allows only dates to be entered in a Date Admitted field. The data dictionary also can limit the type of data that can be entered, often allowing a user to select from a list. For example, the data dictionary ensures that the State field contains a valid two-letter state code, such as IN, by presenting a list of valid state codes to the user.

File Retrieval and Maintenance

A DBMS provides several tools that allow users and programs to retrieve and maintain data in the database. To retrieve or select data in a database, you query it. A **query** is a request for specific data from the database. Users can instruct the DBMS to return or store the results of a query. The capability of querying a database is one of the more powerful database features.

A DBMS offers several methods to retrieve and maintain its data. The four more commonly used are query languages, query by example, forms, and report writers. Another method is by importing data.

Query Language A **query language** consists of simple, English-like statements that allow users to specify the data they want to display, print, store, update, or delete. Each query language has its own formats and vocabulary.

Structured Query Language (SQL pronounced S-Q-L or sequel) is a popular query language that allows users to manage, update, and retrieve data. SQL has special keywords and rules that users include in SQL statements. Figure 11-8a shows an SQL statement that creates the results shown in Figure 11-8b.

Figure 11-8a (SQL statement)

```
SELECT CLASS_TITLE, CLASS_SECTION,
 MAXIMUM_ENROLLMENT - CURRENT_ENROLLMENT AS SEATS_REMAINING
FROM SCHEDULE_OF_CLASSES, CLASS_CATALOG
WHERE SCHEDULE_OF_CLASSES.CLASS_CODE = CLASS_CATALOG.CLASS_CODE
ORDER BY CLASS_TITLE
```

Figure 11-8b (SQL statement results)

Class Title	Class Section	Seats Remaining
Algebra 1	51	14
Art Appreciation	52	19
English Composition 1	02	5
Introduction to Sociology	01	14

Figure 11-8 A sample SQL statement and its results. Notice that the query results show meaningful column headings instead of the actual SQL field names.
Source: Microsoft

Query by Example Most DBMSs include *query by example* (*QBE*), a feature that has a graphical user interface to assist users with retrieving data. Figure 11-9 shows a sample QBE screen for a query that searches for and lists students majoring in sociology; that is, their Major field value is equal to SOC.

Figure 11-9a (all records in Student table)

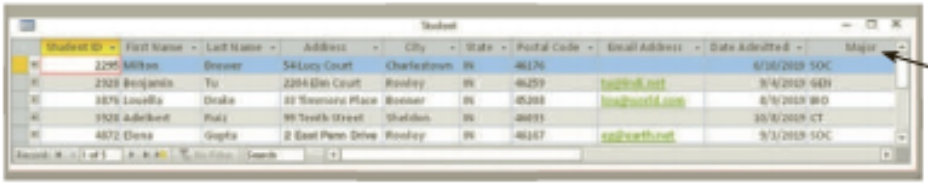


Figure 11-9b (query by example screen showing query that will search for students whose Major is equal to SOC, for sociology)

Figure 11-9c (query results list students whose Major is equal to SOC)

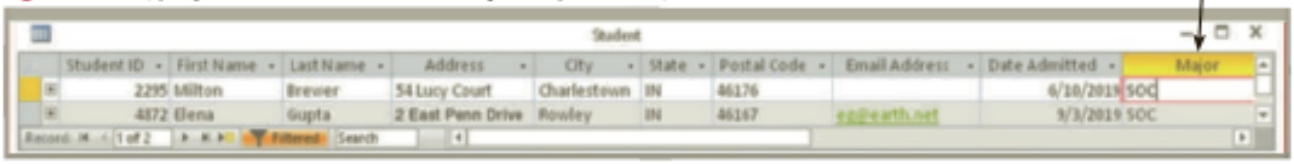


Figure 11-9 Shown here is a Microsoft Access QBE, which searches for students whose major is sociology.
Source: Microsoft

Form A **form**, sometimes called a *data entry form*, is a window on the screen that provides areas for entering or modifying data in a database. You use forms (such as the Student Maintenance Form in Figure 11-1 at the beginning of this module) to retrieve and maintain the data in a database. To reduce data entry errors, well-designed forms should validate data as it is entered.

BTW
E-Form
A form that sends entered data across a network or the Internet is called an *e-form*, short for electronic form.

Figure 11-10 This report, created in Microsoft Access, displays student information by major.
Source: Microsoft

Report Writer A **report writer**, also called a *report generator*, allows users to design a report on the screen, retrieve data into the report design, and then display or print the report (Figure 11-10). Unlike a form, you use a report writer only to retrieve data. Report writers usually allow you to format page numbers and dates; titles and column headings; subtotals and totals; and fonts, font sizes, color, and shading; and to include images. Some report writers allow you to create a report as a webpage.

Data Security

Most organizations and people realize that data is one of their more valuable assets. To ensure that data is accessible on demand, an organization must manage and protect its data just as it would any other resource. Thus, it is vital that the data is kept secure. For example, data in a database often is encrypted to prevent unauthorized users from reading its contents, and its access is restricted to only those who need to process the data.

A DBMS provides means to ensure that only authorized users can access data. In addition, most DBMSs allow different levels of access privileges to be identified for each field in the database. Access privileges define the actions that a specific user or group of users can perform on the data. For example, in the Schedule of Classes file, the student would have read-only privileges. That is, the student could view the list of classes offered in a semester but could not change them. A department head, by contrast, would have full-update privileges to classes offered during a particular semester, meaning he or she can view and modify the data. Finally, some users have no access privileges to the data; that is, they cannot view or modify any data in the database. Read How To 11-1 for ways to secure and maintain a database. Read Ethics and Issues 11-3 to consider issues surrounding governments' use of databases to track citizens' identities. Read Secure IT 11-1 for steps to take if you become a victim of identity theft due to your personal data being compromised.

BTW

Principle of Least Privilege
Many organizations adopt a *principle of least privilege policy*, where users' access privileges are limited to the lowest level necessary to perform required tasks to prevent accidental or intentional misuse of the data.

HOW TO 11-1

Secure and Maintain a Database
As you add and delete tables and records from your database, you should secure and maintain the database so that it can continue operating securely and efficiently. If you neglect to secure and maintain a database, chances increase that the data can become compromised or inaccessible. The following guidelines describe how to secure and maintain a database.

Secure the Database

- Each person accessing the database should have a profile that includes a user name, a strong password that must be changed frequently, and limits on database system-level access.
- Only administrators should have access to create and delete tables.
- Consider allowing typical users only to view or modify records.
- Restrict users to accessing only database tables and records that are necessary to perform their job function(s).
- Limit the number of unsuccessful sign-in attempts in a specified period, and record when users access the database.

Maintain the Database

- If the database contains a table that you do not need (and you do not foresee a future need for the data in that table), remove the table from the database.
- Evaluate the fields in all remaining tables and make sure they are assigned the proper data type. Make any necessary adjustments.
- Remove fields you no longer need from the tables in your database.
- If the database contains a large number of records, consider deleting records you no longer need.
- Navigate to and then click the command to compact and repair the database (if available).
- If you want to protect the data in the database, consider selecting the option to encrypt the database.

Consider This: What problems may arise from individuals or companies failing to properly secure and maintain their databases?

ETHICS & ISSUES 11-3

Should Governments Use Databases to Track and Identify Citizens?

Government agencies collect citizens' information through many methods, using data from the Social Security Administration, fingerprints captured for military or law enforcement use, and other legal methods. Governments across the world justify this type of information gathering as protection against terrorism, identity fraud, and criminal activity. What is more important — a government's obligation to protect its citizens, or an individual's right to privacy?

With global terrorism a threat and individual identity theft on the rise, many governments argue that using collected information to create national identification (ID) cards is essential to providing national security. Privacy advocates express concerns about the effect ID cards have on civil liberties. The United States, Australia, and the United Kingdom are among countries that have resisted making national ID cards mandatory.

National ID cards can be used to verify a citizen's rights to employment, purchasing property, voting, and receiving benefits. If a citizen does not provide an ID card, he or she can then be denied those basic rights. Opponents argue not only that individual's civil rights are at risk, but that the risks of security breaches if a card is lost or stolen, or if the database itself is hacked, can lead to more problems. National ID card processes are expensive, and the regulations around distributing and securing the cards raise further questions. The collection of biometric data, including fingerprints, DNA, iris scans, and facial or voice recognition are seen by some as security methods against fraud, and by others as invasions of privacy.

Consider This: Would you submit your DNA or other biometric data to an employer or government official? Why or why not? Are you in favor of national ID cards? Why or why not? If you were proposing legislation for ID cards, what restrictions might you impose, and what reasons would you give for their necessity?

SECURE IT 11-1

Recovering from Identity Theft

Every two seconds, someone becomes a new identity fraud victim, according to Javelin Strategy & Research. Data breaches in businesses, banks, medical centers, and schools have affected nearly 39 percent of Americans. This crime is the complaint most often reported to the Federal Trade Commission (FTC).

On average, victims of identity theft spend 25 hours settling the resulting issues. Experts recommend that people who have experienced identity theft should follow this advice as part of their resolution efforts:

- **Request a fraud alert.** Contact the fraud department at the three national credit reporting companies: Experian, Equifax, and TransUnion. (Refer to the How To: Your Turn student assignment in this module for details about contacting these agencies.) One agency should report the theft to the other two companies, but you might want to contact all three to be certain the fraud has been noted. Request that a fraud alert be placed on your accounts to help prevent credit accounts from being opened in your name. This free service requires lenders to contact the account owners if a new request for credit is submitted. This fraud alert must be renewed every 90 days.
- **Order credit reports.** Once you file a fraud alert, you are entitled to receive a free credit report. Wait at least 30 days from the theft to obtain the report, however, because creditors may report activity on a monthly basis, and your most current report may not include current information. Request that only the last four digits of your Social Security number are shown on the report.
- **Obtain an FTC affidavit and file it with law enforcement agencies.** The FTC's Identity Theft Victim's Complaint and Affidavit is accepted as proof of your identity. Download the form from the FTC's website and then file it with the police. The form also can be used to dispute claims with creditors.
- **Report Internet crime to the Internet Crime Complaint Center.** Report stolen finances or identities and other cybercrime to the Internet Crime Complaint Center. This organization is a partnership between the Federal Bureau of Investigation and the National White Collar Crime Center.
- **Keep records of your actions.** Create a journal that records the names of people you called, phone numbers, dates, and correspondence sent.
- **Review financial accounts.** Look for unusual activity, and check to see if any accounts were opened recently. Continue reviewing the accounts even if you do not see any questionable transactions.
- **Enroll in a credit monitoring service.** Each of the three national credit reporting agencies and many credit card companies provide this service. The companies send messages to subscribers when unusual activity is detected on a credit card account to alert consumers to possible identity theft. This service can be useful for people who have large balances in savings and checking accounts, travel frequently, or fail to check their bank statements and credit reports regularly.

Consider This: Do you know someone who has been a victim of identity theft? If so, which type of fraud occurred? What activity did this person take to report this crime and to restore personal records and accounts?

Backup and Recovery

Occasionally, a database is damaged or destroyed because of hardware failure, a problem with the software, human error, or a catastrophe, such as fire or flood. A DBMS provides a variety of techniques to restore the database to a usable form in case it is damaged or destroyed.

- A backup, or copy, of the entire database should be made on a regular basis. Some DBMSs have their own built-in backup tools. Others require users to purchase a separate backup program, or use one included with the operating system.

- More complex DBMSs maintain a **log**, which is a listing of activities that modify the contents of the database. If a registration department specialist modifies a student's address, for example, the change appears in the log.
- A DBMS **recovery utility** uses logs and/or backups, and either a rollforward or a rollback technique, to restore a database when it becomes damaged or destroyed. In a *rollforward*, also called *forward recovery*, the DBMS uses the log to reenter changes made to the database since the last save or backup. In a *rollback*, also called *backward recovery*, the DBMS uses the log to undo any changes made to the database during a certain period. The rollback restores the database to its condition prior to the failure. Depending on the type of failure, the DBMS determines which type of recovery technique to use.
- **Continuous backup** is a backup plan in which changes are backed up as they are made. This backup technique can cost more than other backup strategies but is growing in popularity for businesses whose data must be available at all times, because it provides recovery of damaged data in a matter of seconds. Organizations such as hospitals, communications companies, and financial institutions often use continuous backup.

Tech Feature 11-3: Forensic Databases

The collection and analysis of biometric and other data used in criminal investigations is called *digital forensics*. By accessing data — such as fingerprints, facial and voice recognition, and handwriting analysis — stored in a structured database, investigators can significantly reduce time spent wading through hard copy files.

Databases also can increase accuracy and widen the scope of an investigation by pooling data from other counties and states into national databases. In addition to biometric data, forensic databases can include crime statistics, criminal profiles, connections among known criminals, and more. Read Tech Feature 11-3 to learn more about how scientists use forensic databases to solve crimes.

TECH FEATURE 11-3

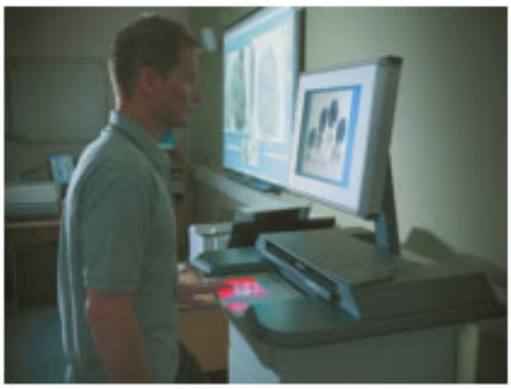
Forensic Databases

Mega Pixel/Shutterstock.com

The first time a fingerprint at a crime scene was used to link a suspect to a crime occurred in 1879 in Tokyo, Japan. A hospital had been burglarized, and the police had a suspicion of who had committed the crime. The swirls on a fingerprint left on a wall, however, did not match the alleged criminal's fingertip, and he was released.

The process of matching fingerprints now is performed through the FBI's Next Generation Identification (NGI) System. This system provides more accurate biometric recognition and quicker response times than the Integrated Automated Fingerprint Identification System (IAFIS) it is predicted to replace. Detectives will scan fingerprints they find at crime scenes, and the NGI computer will search the database of more than one million fingerprints from criminal and civil subjects and attempts to find similarities in the loops, arches, and whorls. The NGI's Rap Back function gives criminal justice entities, such as law enforcement agencies and parole offices, updated status notifications of crimes committed by people holding positions of trust, such as caregivers and teachers. In addition, the Interstate Photo System (IPS) facial recognition service permits police to search photo images of people associated with criminal identities.

At times, forensic scientists cannot locate fingerprints, but they do find palmprints, which burglars can leave on windows, doorknobs, window ledges, paper, and weapons. The Royal Canadian Mounted Police (RCMP) are adding palmprints to its fingerprint database. RCMP forensic experts locate palmprints in 30 percent of the crime scenes they investigate. They are hopeful the expanded database, along with their use of sensitive Vacuum Metal Deposition (VMD) technology, will help them to recover prints from evidence in cold cases. The VMD instrument creates a vacuum, allowing metal to vaporize and adhere to fingerprint or palmprint residue on fabrics, firearms, plastic, and other nonporous and partially porous objects.



Cultura Creative (RF) / Alamy Stock Photo

Consider This: In what other scenarios might forensic databases be useful? What additional fields could be added to forensic databases to assist criminal justice entities in their crime investigations?

System Development

An *information system* is a collection of hardware, software, data, people, and procedures that work together to produce information. As a user of technology in a business, you someday may participate in the modification of an existing information system or the development of a new one. Thus, it is important that you understand system development.

System development is a set of activities used to build an information system. System development activities often are grouped into larger categories called *phases*. This collection of phases sometimes is called the **system development life cycle (SDLC)**. Many traditional SDLCs contain five phases (Figure 11-11):

1. Planning
2. Analysis
3. Design
4. Implementation
5. Support and Security

Each system development phase consists of a series of activities, and the phases form a loop. In theory, the five system development phases often appear sequentially, as shown in Figure 11-11. In reality, activities within adjacent phases often interact with one another, making system development a dynamic, iterative process.

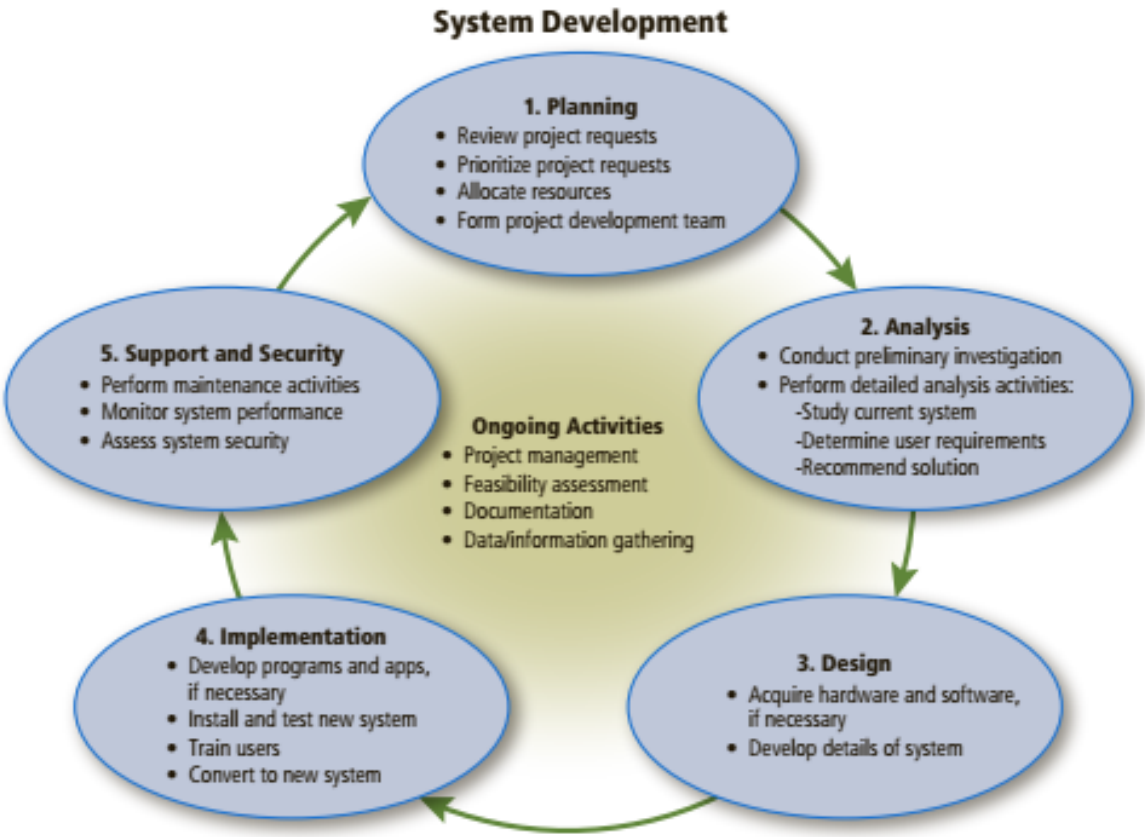


Figure 11-11 System development often consists of five phases that form a loop. Several ongoing activities also take place throughout system development.

System Development Guidelines

System development should follow three general guidelines: group activities into phases, involve users, and define standards.

1. **Group activities into phases.** Many SDLCs contain the same phases shown in Figure 11-11. Others have more or fewer phases. Regardless, all system development cycles have similar activities and tasks.
2. **Involve users.** Users include anyone for whom the system is being built. Customers, employees, students, data entry specialists, accountants, sales managers, and owners all are examples of users. Users are more apt to accept a new system if they contribute to its design.
3. **Define standards.** *Standards* are sets of rules and procedures an organization expects employees to accept and follow. Standards help people working on the same project produce consistent results.

Who Participates in System Development?

System development should involve representatives from each department in which the proposed system will be used. This includes both nontechnical users and IT professionals. Although the roles and responsibilities of members of the system development team may change from organization to organization, this module presents general descriptions of tasks for various team members.

BTW
Steering Committee
A *steering committee* is a decision-making body in an organization.

During system development, the systems analyst meets and works with a variety of people. A **systems analyst** is responsible for designing and developing an information system. The systems analyst is the users' primary contact person. Depending on the size of the organization, the tasks performed by the systems analyst may vary. Smaller organizations may have one systems analyst or even one person who assumes the roles of both systems analyst and software developer. Larger organizations often have multiple systems analysts who discuss various aspects of the development project with users, management, other analysts, database analysts, database administrators, network administrators, web developers, software developers, vendors, and the steering committee.

For each system development project, an organization usually forms a *project team* to work on the project from beginning to end. The project team consists of users, the systems analyst, and other IT professionals.

Project Management

Project management is the process of planning, scheduling, and then controlling the activities during system development. The goal of project management is to deliver an acceptable system to the user in an agreed-upon time frame, while maintaining costs.

In smaller organizations or projects, one person manages the entire project. For larger projects, the project management activities often are separated between a project manager and a project leader. In this situation, the *project leader* manages and controls the budget and schedule of the project, and the *project manager* controls the activities during system development. Project leaders and/or project managers are part of the project team. If the systems analyst is not the project manager, he or she works closely with the project manager.

To plan and schedule a project effectively, the project leader identifies the following elements:

- Goals, objectives, and expectations of the project, collectively called the *scope*
- Required activities
- Time estimates for each activity
- Cost estimates for each activity
- Order of activities
- Activities that can take place at the same time

After these items are identified, the project leader usually records them in a project plan. Project leaders can use **project management software** to assist them in planning, scheduling, and controlling development projects. One aspect of managing projects is to ensure that

everyone submits deliverables on time and according to plan. A *deliverable* is any tangible item, such as a chart, diagram, report, or program file.

Gantt and PERT Charts Popular tools used to plan and schedule the time relationships among project activities are Gantt and PERT charts (Figure 11-12).

- A *Gantt chart*, developed by Henry L. Gantt, is a bar chart that uses horizontal bars to show project phases or activities. The left side, or vertical axis, displays the list of required activities. A horizontal axis across the top or bottom of the chart represents time.
- Developed by the U.S. Department of Defense, a *PERT chart*, short for Program Evaluation and Review Technique chart, analyzes the time required to complete a task and identifies the minimum time required for an entire project.

PERT charts, sometimes called network diagrams, can be more complicated to create than Gantt charts, but are better suited than Gantt charts for planning and scheduling large, complex projects.

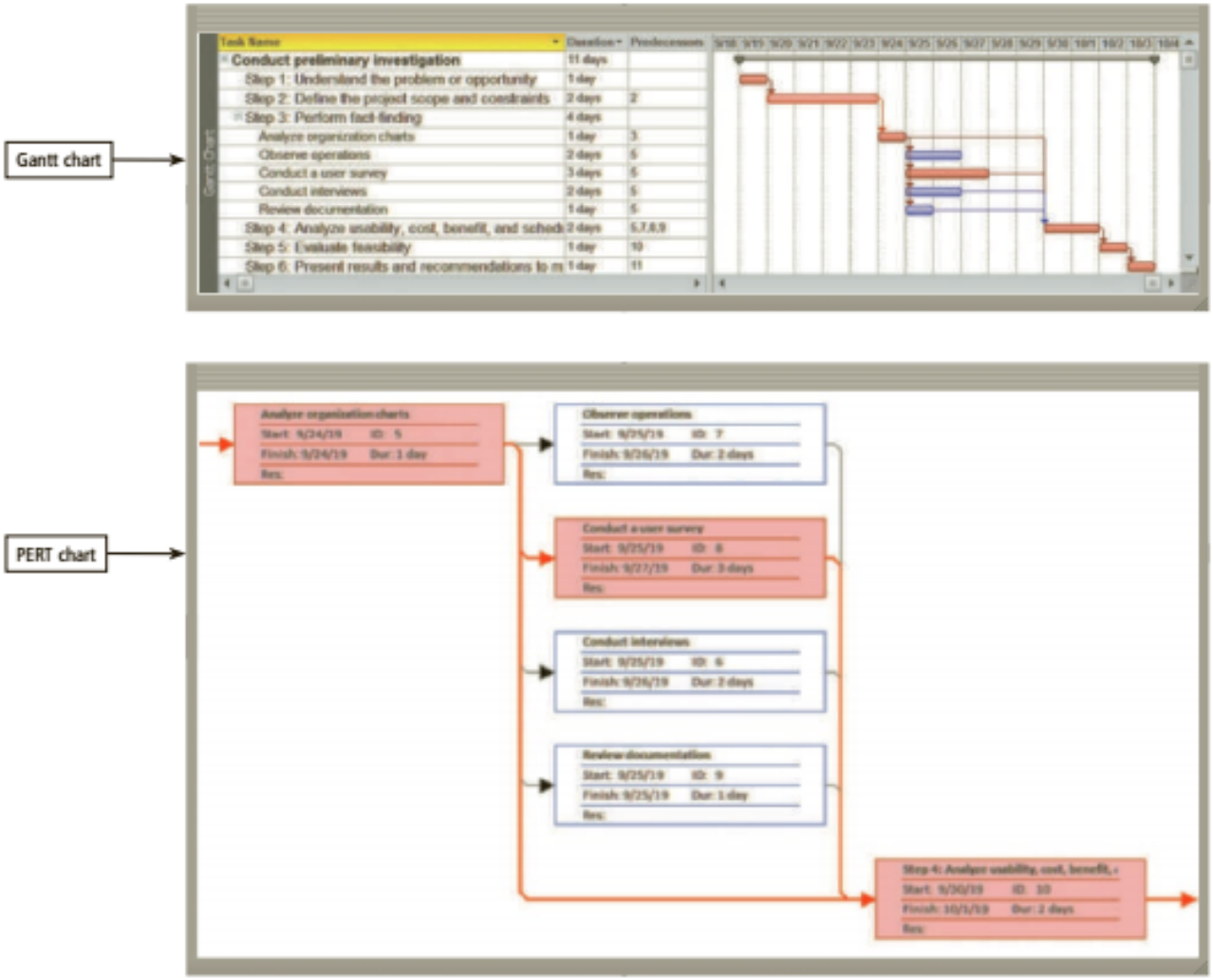


Figure 11-12 Project managers use software to create Gantt charts, PERT charts, and other charts and diagrams.

CONSIDER THIS

How do project leaders adjust when a project changes?

After the project features and deadlines have been set, the project leader monitors and controls the project. Some activities take less time than originally planned. Others take longer. The project leader may realize that an activity is taking excessive time or that scope creep has begun. *Scope creep*, also called *feature creep*, occurs when one activity has led to another that was not planned originally; thus, the scope of the project now has grown.

Project leaders should use *change management*, which is the process of recognizing when a change in the project has occurred, taking actions to react to the change, and planning for opportunities because of the change. For example, the project leader may recognize the team will not be able to meet the original deadline of the project due to scope creep. Thus, the project leader may extend the deadline or may reduce the scope of the system development. If the latter occurs, the users will receive a less comprehensive system at the original deadline. In either case, the project leader revises the first project plan and presents the new plan to users for approval. It is crucial that everyone is aware of and agrees on any changes made to the project plan.

Feasibility Assessment

Feasibility is a measure of how suitable the development of a system will be to the organization. A project that is feasible at one point during system development might become infeasible at a later point. Systems analysts, therefore, frequently reevaluate feasibility during the system development project.

A systems analyst typically uses at least four tests to evaluate feasibility of a project: operational feasibility, schedule feasibility, technical feasibility, and economic feasibility.

- *Operational feasibility* measures how well the proposed information system will work. Will the users like the new system? Will they use it? Will it meet their requirements? Will it cause any changes in their work environment? Is it secure?
- *Schedule feasibility* measures whether the established deadlines for the project are reasonable. If a deadline is not reasonable, the project leader might make a new schedule. If a deadline cannot be extended, then the scope of the project might be reduced to meet a mandatory deadline.
- *Technical feasibility* measures whether the organization has or can obtain the computing resources, software services, and qualified people needed to develop, deliver, and then support the proposed information system. For most information system projects, hardware, software, and people typically are available to support an information system. An organization's choice for using computing resources and software services in-house or on the cloud may impact a system's technical feasibility.
- *Economic feasibility*, also called *cost/benefit feasibility*, measures whether the lifetime benefits of the proposed information system will be greater than its lifetime costs. A systems analyst often consults the advice of a business analyst, who uses many financial techniques, such as return on investment (ROI) and payback analysis, to perform a cost/benefit analysis.

Documentation

During system development, project members produce a large amount of documentation. *Documentation* is the collection and summarization of data, information, and deliverables. It is important that all documentation be well written, thorough, consistent, and understandable. The final information system should be reflected accurately and completely in documentation developed throughout the development project. Maintaining up-to-date documentation should be an ongoing part of system development. Too often, project team members put off documentation until the end of the project because it is time consuming, but these practices typically result in lower-quality documentation. Read How To 11-2 to learn how you can manage a project using project management software.

HOW TO 11-2

Oversee a Project Using Project Management Software

Several project management programs and apps are available, some for free and others fee based. These programs and apps are designed for projects of specific sizes, so be sure to research the various programs and apps on the market and choose one that best suits your needs. To manage a project using project management software, follow these steps:

1. Make sure you understand the project in its entirety, as well as the steps you must take to bring the project to completion.
2. Determine the date by which the project must be completed.
3. Verify you have the appropriate resources (people and materials) to complete the project. If you do not have the necessary resources, obtain them, if possible.
4. Determine the order of the steps that must be taken to bring the project to completion. Identify steps that must be taken before other steps, as well as steps that can be completed at the same time as other steps.
5. Verify the feasibility of the plan.
6. During the project, it will be necessary to update the progress and possibly adjust dates. Changes to the project and its dates should be communicated to the entire project team.

Consider This: Do you think project management software can help individuals complete a project more quickly? Why or why not?

CONSIDER THIS

How do team members collaborate?

Conferencing software includes tools that enable users to share documents via online meetings and communicate with other connected users. When a meeting takes place on the web, it is called a *web conference*. In an online meeting, the facilitator may share a document for all participants to see at the same time. This allows the participants to edit a document and see the changes being made. Many conferencing software apps allow the facilitator to share his or her computer's desktop screen to demonstrate software apps or show webpages in real time to meeting participants. During the online meeting, participants have the ability to open a chat window and type messages to one another. Conferencing software also usually includes audio and video capabilities.

Data and Information Gathering Techniques

During system development, members of the project team gather data and information. They need accurate and timely data and information for many reasons. They must keep a project on schedule, evaluate feasibility, and be sure the system meets requirements. Systems analysts and other IT professionals use several techniques to gather data and information. They review documentation, observe, survey, interview, conduct joint-application design sessions, and research.

- **Review documentation:** By reviewing documentation such as organization charts, memos, and meeting minutes, systems analysts learn about the history of a project. Documentation also provides information about the organization, such as its operations, weaknesses, and strengths.
- **Observe:** Observing people helps systems analysts understand exactly how they perform a task. Likewise, observing a machine allows you to see how it works.
- **Survey:** To obtain data and information from a large number of people, systems analysts distribute surveys.
- **Interview:** The interview is the most important data and information gathering technique for the systems analyst. It allows the systems analyst to clarify responses and probe during face-to-face feedback.
- **JAD sessions:** Instead of a single one-on-one interview, analysts often use joint-application design sessions to gather data and information. A *joint-application design (JAD) session*, or *focus group*, consists of a series of lengthy, structured group meetings in which users and IT professionals work together to design or develop an application (Figure 11-13).
- **Research:** Newspapers, technology magazines and journals, reference books, trade shows, the web, vendors, and consultants are excellent sources of information. These sources can provide the systems analyst with information, such as the latest hardware and software products and explanations of new processes and procedures. In addition, systems analysts often collect website statistics, such as the number of visitors and most-visited webpages, etc., and then evaluate these statistics as part of their research.

Figure 11-13 During a JAD session, the systems analyst is the moderator, or leader of the discussion. Another member, called the *scribe*, records facts and action items assigned during the session.
Nyul / Dreamstime.com

CONSIDER THIS

What circumstances initiate system development?

A user may request a new or modified information system for a variety of reasons. The most obvious reason is to correct a problem, such as an incorrect calculation or a security breach. Another reason is to improve the information system. Organizations may want to improve hardware, software, or other technology to enhance an information system.

Sometimes, situations outside the control of an organization require a modification to an information system. Corporate management or some other governing body may mandate a change. Mergers, reorganizations, and competition also can lead to change.

A user may request a new or modified information system verbally in a phone conversation or written as an email message. In larger organizations, users write a formal request for a new or modified information system, which is called a *project request* or *request for system services*. The project request becomes the first item of documentation for the project. It also triggers the first phase of system development: planning.

Planning Phase

The planning phase for a project begins when the steering committee receives a project request. This committee usually consists of five to nine people and typically includes a mix of vice presidents, managers, nonmanagement users, and IT personnel.

During the **planning phase**, four major activities are performed: (1) review and approve the project requests, (2) prioritize the project requests, (3) allocate resources, such as money, people, and equipment to approved projects, and (4) form a project development team for each approved project.

CONSIDER THIS

How are projects prioritized?

The projects that receive the highest priority are those mandated by management or some other governing body. These requests are given immediate attention. The steering committee evaluates the remaining project requests based on their value to the organization. The steering committee approves some projects and rejects others. Of the approved projects, it is likely that only a few will begin system development immediately. Others will have to wait for additional funds or resources to become available.

Analysis Phase

The **analysis phase** consists of two major activities: (1) conduct a preliminary investigation and (2) perform detailed analysis.

The Preliminary Investigation The main purpose of the **preliminary investigation**, sometimes called the *feasibility study*, is to determine the exact nature of the problem or improvement and decide whether it is worth pursuing. Should the organization continue to assign resources to this project? To answer this question, the systems analyst conducts a general study of the project.

The first task in the preliminary investigation is to interview the user who submitted the project request. Depending on the nature of the request, project team members may interview other users, too. In addition to interviewing, members of the project team may use other data gathering techniques, such as reviewing existing documentation. Often, the preliminary investigation is completed in just a few days.

Upon completion of the preliminary investigation, the systems analyst writes the feasibility report. This report presents the team's findings to the steering committee.

CONSIDER THIS

Does the feasibility report always recommend that the project be continued?

In some cases, the project team may recommend to cancel the project. If the steering committee agrees, the project ends at this point. If the project team recommends continuing and the steering committee approves this recommendation, then detailed analysis begins.

Detailed Analysis *Detailed analysis* involves three major activities: (1) study how the current system works, (2) determine the users' wants, needs, and requirements, and (3) recommend a solution. Detailed analysis sometimes is called *logical design* because the systems analysts develop the proposed solution without regard to any specific hardware or software. That is, they make no attempt to identify the procedures that should be automated and those that should be manual.

While studying the current system and identifying user requirements, the systems analyst collects a great deal of data and information. A major task for the systems analyst is to document these findings in a way that can be understood by everyone. Systems analysts use diagrams to describe the processes that transform inputs into outputs and diagrams that graphically show the flow of data in the system. Both users and IT professionals refer to this documentation.

The System Proposal After the systems analyst has studied the current system and determined all user requirements, the next step is to communicate possible solutions for the project in a system proposal. The purpose of the system proposal is to assess the feasibility of each alternative solution and then recommend the most feasible solution for the project, which often involves modifying or expanding the current system. The systems analyst presents the system proposal to the steering committee. If the steering committee approves a solution, the project enters the design phase.

When the steering committee discusses the system proposal and decides which alternative to pursue, it considers whether to modify the existing system, buy retail software from an outside source, use web apps, build its own custom software, and/or outsource some or all of its IT needs to an outside firm. The final decision often is a mix of these options. Read Secure IT 11-2 for issues related to outsourcing.

SECURE IT 11-2

Security Issues Arising from Outsourcing

Businesses outsource noncore functions because third-party vendors may be more efficient and more cost effective than the businesses trying to perform the functions on their own. Noncore functions often include general business tasks, such as maintaining and supporting an organization's information systems and processing customer payments on websites.

Sometimes, however, when a business outsources, the external vendors are not as careful with security and customer information as the business itself might be. The business that outsources this task has spent time and effort to cultivate and then forge a relationship with its customers, and it is in the company's best interest to treat its customers well. The outside vendor, however, has no such bond with the customers.

Security breaches might occur when work is contracted to third parties. For example, personal and confidential information about customers and employees, payroll, credit card numbers, and health records can be transferred to external hard drives or other storage media and taken outside the building. Companies should develop a computer security plan that requires safeguards on the part of the outside vendors. These procedures might include running background checks on personnel, closely monitoring the level of database access and email messages, replacing Social Security numbers with another unique identifier, and conducting security audits. The plan also should include penalties if a security breach occurs.

Consider This: Does outsourcing lead to a lower level of security and privacy for customers? Why or why not? What can an organization do to ensure that vendors practice the same level of care with customer information as the organization practices? Should customers hold organizations or their vendors responsible for leaks of private customer information? Why?

Design Phase

The **design phase** consists of two major activities: (1) if necessary, acquire hardware and software and (2) develop all of the details of the new or modified information system. The systems analyst often performs these two activities at the same time instead of sequentially.

When the steering committee approves a solution, the systems analyst begins the activity of obtaining additional hardware or software or evaluating cloud providers that offer the computing services to meet the organization's needs. The systems analyst may skip this activity if the approved solution does not require new hardware or software. If this activity is required, it consists of four major tasks: (1) identify technical specifications, (2) solicit vendor proposals, (3) test and evaluate vendor proposals, and (4) make a decision.

Identify Technical Specifications The first step in acquiring necessary hardware and software is to identify all the hardware and software requirements of the new or modified system. To do this, systems analysts use a variety of research techniques. They talk with other systems analysts, visit vendors' stores, and search the web. Many trade journals, newspapers, and magazines provide some or all of their printed content online.

After the systems analyst defines the technical requirements, the next step is to summarize these requirements for potential vendors. The systems analyst can use three basic types of documents for this purpose: an RFQ, an RFP, or an RFI.

- A *request for quotation* (*RFQ*) identifies the required product(s). With an RFQ, the vendor quotes a price for the listed product(s).
- With a *request for proposal* (*RFP*), the vendor selects the product(s) that meets specified requirements and then quotes the price(s).
- A *request for information* (*RFI*) is a less formal method that uses a standard form to request information about a product or service.

Solicit Vendor Proposals Systems analysts send the RFQ, RFP, or RFI to potential hardware and software vendors. Another source for hardware and software products is a value-added reseller. A *value-added reseller* (*VAR*) is an organization that purchases products from

manufacturers and then resells these products to the public — offering additional services with the product (Figure 11-14).

Instead of using vendors, some organizations hire an IT consultant or a group of IT consultants. An *IT consultant* is a professional who is hired based on technical expertise, including service and advice.

Figure 11-14 Many VARs provide complete systems, often called turnkey solutions.
Source: Magal Security Systems Ltd.

Test and Evaluate Vendor Proposals After sending RFQs, RFPs, or RFIs to potential vendors, the systems analyst will receive completed quotations and proposals. Evaluating the proposals and then selecting the best one often is a difficult task.

Systems analysts use many techniques to test the various software products from vendors. They obtain a list of user references from the software vendors. They also talk to current users of the software to solicit their opinions. Some vendors will provide a demonstration of the product(s) specified. Others supply demonstration copies or trial versions, allowing the organizations to test the software themselves.

Sometimes it is important to know whether the software can process a certain volume of transactions efficiently. In this case, the systems analyst conducts a benchmark test. A *benchmark test* measures the performance of hardware or software. For example, a benchmark test could measure the time it takes a payroll program to print 50 paychecks. Comparing the time it takes various accounting programs to print the same 50 paychecks is one way of measuring each program's performance.

Make a Decision Having rated the proposals, the systems analyst presents a recommendation to the steering committee. The recommendation could be to award a contract to a vendor or to not make any purchases at this time.

Detailed Design The next step is to develop detailed design specifications for the components in the proposed solution. The activities to be performed include developing designs for the databases, inputs, outputs, and programs.

- During database design, the systems analyst works closely with the database administrators to identify those data elements that currently exist within the organization and those that are new. The systems analyst also addresses user access privileges.
- During detailed design of inputs and outputs, the systems analyst carefully designs every menu, screen, and report specified in the requirements. The outputs often are designed first because they help define the requirements for the inputs.

  The systems analyst may develop a mock-up and/or a layout chart for each input and output. A *mock-up* is a sample of the input or output that contains actual data (Figure 11-15). The systems analyst shows mock-ups to users for their approval. After users approve the mock-up, the systems analyst develops a layout chart for the software

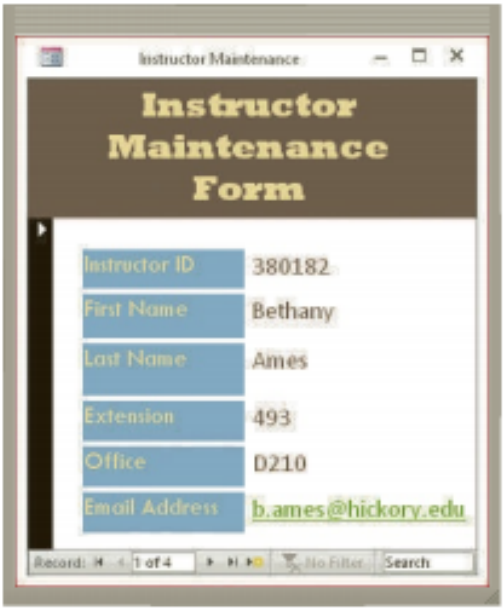


Figure 11-15 Users provide their approval on inputs and outputs. This input screen is a mock-up (containing actual sample data) for users to review.
Source: Microsoft

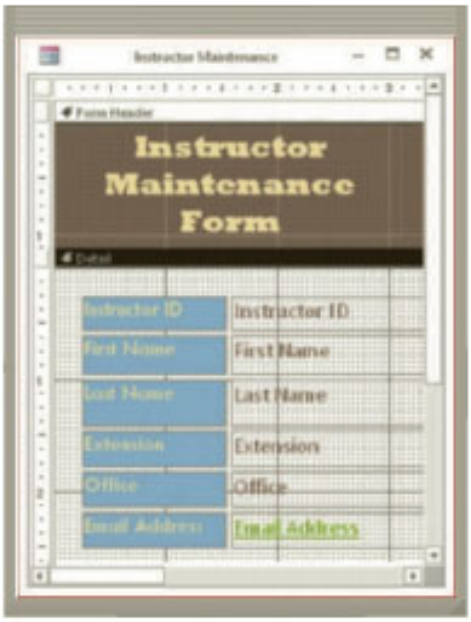


Figure 11-16 Shown here is a technical view in Access of the mock-up in Figure 11-15.
Source: Microsoft

developer. A layout chart is more technical and contains programming-like notations. Many database programs provide tools for technical design (Figure 11-16).

Other issues that must be addressed during input and output design include the types of media to use (paper, video, or audio); formats (graphical or narrative); and data entry validation techniques, which include making sure the entered data is correct (for example, a state code has to be one of the fifty valid two-letter state abbreviations).

- During program design, the systems analyst prepares the *program specification package*, which identifies required programs and the relationship among each program, as well as the input, output, and database specifications.

CONSIDER THIS

How can systems analysts build relationships with users?

Systems analysts have much more credibility with users if the analysts understand user concerns and have empathy for how the workers are feeling. If users are involved, they are more likely to accept and use the new system — called *user buy-in*. One reason systems fail is because some systems analysts create or modify systems with little or no user participation.

Prototyping Many systems analysts today use prototypes during detailed design. A **prototype**, sometimes called a *proof of concept*, is a working model of the proposed system's essential functionality. The systems analyst actually builds a functional form of the solution during design. The main advantage of a prototype is users can work with the system before it is completed to make sure it meets their needs. As soon as users approve a prototype, systems analysts can implement a solution more quickly than without a prototype.

CONSIDER THIS

Who reviews the detailed design?

Many people should review the detailed design specifications before they are given to the programming team. The purpose of their review is to ensure the design represents a finished product that will work for the user and the development is feasible. Reviewers should include users, systems analysts, managers, IT staff, and members of the system development team. If the steering committee decides the project still is feasible, which usually is the case, the project enters the implementation phase.

Implementation Phase

The purpose of the **implementation phase** is to construct, or build, the new or modified system and then deliver it to the users. Members of the system development team perform four major activities in this phase: (1) develop programs and apps, (2) install and test the new system, (3) train users, and (4) convert to the new system.

Develop Programs and Apps If the organization purchases retail software or no modifications to existing custom software are required, the development team may skip this activity. For custom software that is new or requires modification, however, programs and apps are developed or modified either by an outside firm or in-house.

Software developers write or modify programs and apps from the program specification package created during the analysis phase. Just as system development follows an organized set of activities, so does program development. These program development activities are known as the *program development life cycle*.

CONSIDER THIS

What is a sandbox?

A *sandbox* is an environment that allows software developers to test their programs with fictitious data without adversely affecting other programs, information systems, or data. Sandboxes are used for testing purposes both by developers and users. Users often work with a sandbox to familiarize themselves with a new program or information system before they use it.

Install and Test the New System If the organization acquires new hardware or software, someone must install and test it. The systems analysts should test individual programs. They also should be sure that all the programs work together in the system.

Systems analysts and users develop test data so that they can perform various tests.

- A *unit test* verifies that each individual program or object works by itself.
- A *systems test* verifies that all programs in an application work together properly.
- An *integration test* verifies that an application works with other applications.
- An *acceptance test* is performed by end users and checks the new system to ensure that it works with actual data.

Train Users **Training** involves showing users exactly how they will use the new hardware and software in the system. Some training takes place as one-on-one sessions or classroom-style lectures (Figure 11-17). Other organizations use web-based training, which is a self-directed, self-paced online instruction method. Whichever technique is used, it should include hands-on sessions with realistic sample data. Users should practice on the actual system during training. Users also should be provided access to printed or online user manuals for reference. It is the systems analyst's responsibility to create user manuals.

Figure 11-17 Organizations must ensure that users are trained properly on the new system. One training method uses hands-on classes to learn the new system.
Goodluz / Shutterstock.com

Convert to the New System The final implementation activity is to change from the old system to the new system. This change can take place using one or more of the following conversion strategies: direct, parallel, phased, or pilot.

- With *direct conversion*, the user stops using the old system and begins using the new system on a certain date. The advantage of this strategy is that it requires no transition costs and is a

quick implementation technique. The disadvantage is that it is extremely risky and can disrupt operations seriously if the new system does not work correctly the first time.

- *Parallel conversion* consists of running the old system alongside the new system for a specified time. Results from both systems are compared. The advantage of this strategy is that you can fix any problems in the new system before you terminate the old system. The disadvantage is that it is costly to operate two systems at the same time.
- In a *phased conversion*, each location converts at a separate time. For example, an accounting system might convert its accounts receivable, accounts payable, general ledger, and payroll sites in separate phases. Each site can use a direct or parallel conversion. Larger systems with multiple sites may use a phased conversion.
- With a *pilot conversion*, only one location in the organization uses the new system — so that it can be tested. After the pilot site approves the new system, other sites convert using one of the other conversion strategies.

Support and Security Phase

The purpose of the **support and security phase** is to provide ongoing assistance for an information system and its users after the system is implemented. The support and security phase consists of three major activities: (1) perform maintenance activities, (2) monitor system performance, and (3) assess system security.

Information system maintenance activities include fixing errors in, as well as improving, a system's operations. To determine initial maintenance needs, the systems analyst should meet with users. The purpose of this meeting, often called the *post-implementation system review*, is to discover whether the information system is performing according to the users' expectations. In some cases, users would like the system to do more. Maybe they have enhancements or additional requirements that involve modifying or expanding an existing information system.

During this phase, the systems analyst monitors performance of the new or modified information system. The purpose of performance monitoring is to determine whether the system is inefficient or unstable at any point. If it is, the systems analyst must investigate solutions to make the information system more efficient and reliable — back to the planning phase.

Most organizations must deal with complex technology security issues. All elements of an information system — hardware, software, data, people, and procedures — must be secure from threats both inside and outside the enterprise. Read Secure IT 11-3 for information about an organization's technology security plan.

SECURE IT 11-3

Technology Security Plan Components

If an organization experiences a major information system disaster, a computer security plan will guide the recovery process. The document should identify all the security risks that may cause an information system asset loss and include all possible safeguards to detect, prevent, and recover from losses. It should identify all of the organization's information assets, which include hardware, software, documentation, procedures, people, data, facilities, and supplies. Key components should include securing equipment, especially laptops and mobile devices, creating a strong disaster recovery strategy, developing a security breach detection and response plan, and providing for ongoing training.

One of the responsibilities of a chief security officer (CSO) is to protect the organization's information assets. The goal of the computer security plan is to match an appropriate level of safeguards against the identified risks. The CSO must realize that some degree of risk is unavoidable and that the more secure a system is, the more difficult it is for everyone to use. The security plan should be evaluated annually, or more frequently if information assets have changed dramatically. Microsoft has developed a Security Development Lifecycle to guide the development, implementation, and review process. Its seven security practices phases — training, requirements, design, implementation, verification, release, and response — help increase security while reducing costs.

Consider This: What method should be used to communicate the plan to all employees and provide adequate training to ensure continued compliance? How can a CSO be assured that employees will comply with the computer security plan?

Application Development Languages and Tools

The previous sections discussed the system development phases. One activity during the implementation phase is to develop programs and apps. Although you may never write a program or app, information you request may require a software developer to create or modify a program or app. Thus, you should understand how software developers, sometimes called programmers, create programs and apps to meet information requirements.

To create a program, software developers sometimes write a program's instructions using a programming language. A **programming language** is a set of words, abbreviations, and symbols that enables a software developer to communicate instructions to a computer or mobile device. Other times, software developers use a program development tool to create a program or app. Software that provides a user-friendly environment for building programs and apps often is called an *application development tool*. An application development tool provides a means for creating, designing, editing, testing, and distributing programs and apps. Software developers use a variety of programming languages and application development tools to create programs and apps.

Several hundred programming languages exist today. Each language has its own rules, or *syntax*, for writing the instructions. Languages often are designed for specific purposes, such as scientific applications, business solutions, or webpage development. When solving a problem or building a solution, software developers often use more than one language; that is, they integrate the languages.

Procedural Languages

With a **procedural language**, a software developer writes instructions using English-like words that tell the computer what to accomplish and how to do it. For example, ADD stands for addition, or PRINT means to print. Many procedural languages also use arithmetic operators, such as * (asterisk) for multiplication and 1 (plus sign) for addition. Hundreds of procedural languages exist. Only a few, however, are used widely enough for the industry to recognize them as standards.

One example of a widely used procedural language is C. The **C** programming language, developed in the early 1970s by Dennis Ritchie at Bell Laboratories, originally was designed for writing system software. Today, many programs are written in C (Figure 11-18). C runs on almost any type of computer with any operating system, but it is used most often with the UNIX and Linux operating systems.

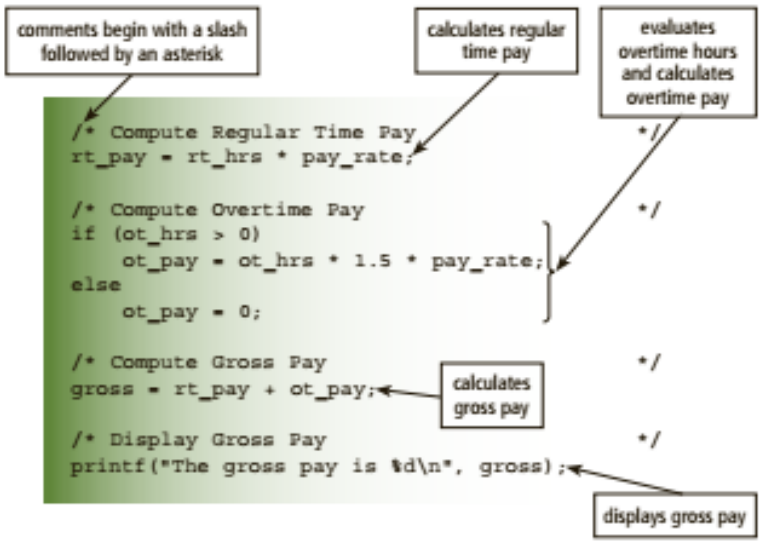


Figure 11-18 An excerpt from a C payroll program. The code shows the computations for regular time pay, overtime pay, and gross pay; the decision to evaluate the overtime hours; and the output of the gross pay.

Compilers and Interpreters Before a computer or mobile device can run (execute) a program or app created with a procedural language, system developers must convert the program into *machine language*, which is the only language the computer directly recognizes. That is, the computer cannot execute the procedural language source program. A *source program* contains the language instructions, or *code*, to be converted to machine language. For procedural languages, software developers typically use either a compiler or an interpreter to perform the conversion.

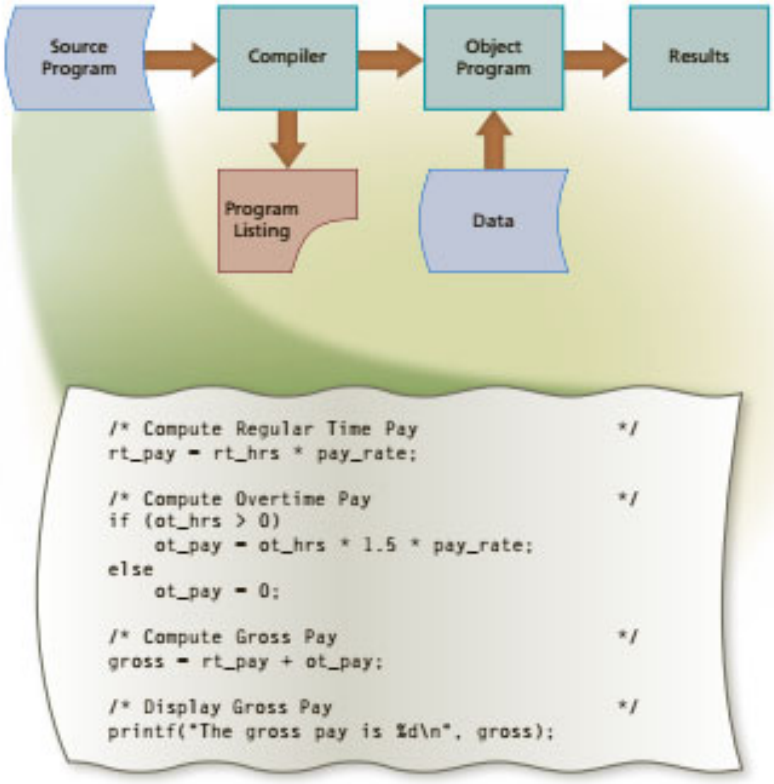


Figure 11-19 A compiler converts the source program (C, in this example) into a machine language object program.

- A *compiler* is a separate program that converts the entire source program into machine language before executing it. The machine language version that results from compiling the procedural language is called the *object program* or *object code*. The compiler stores the object program on storage media for execution later.

  While it is compiling the source program into the object program, the compiler checks the source program for errors. The compiler then produces a program listing that contains the source code and a list of any errors. This listing helps the software developer make necessary changes to the source code and correct errors in the program. Figure 11-19 shows the process of compiling a source program.
- An *interpreter*, by contrast, translates and executes one instruction at a time. An interpreter reads an instruction, converts it to one or more machine language instructions, and then executes those machine language instructions. It does this all before moving to the next instruction in the program. Each time the source program runs, the interpreter translates and executes it, instruction by instruction. An interpreter does not produce an object program. Figure 11-20 shows the process of interpreting a program.

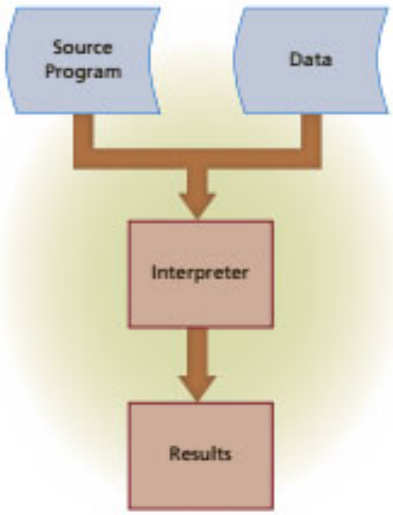


Figure 11-20 With an interpreter, one instruction of the source program at a time is converted into machine language and then immediately executed by the computer or mobile device.

One advantage of an interpreter is that when it finds errors, it displays feedback immediately. The software developer can correct any errors before the interpreter translates the next instruction. The disadvantage is that interpreted programs do not run as fast as compiled programs.

Object-Oriented Programming Languages and Application Development Tools

System developers use an **object-oriented programming (OOP) language** or object-oriented application development tool to implement objects in a program. Recall that an object is an item that can contain both data and the procedures that read or manipulate that data. An object represents a real person, place, event, or transaction.

A major benefit of OOP is the ability to reuse and modify existing objects. For example, once a system developer creates an Employee object, it is available for use by any other existing or future program. Thus, system developers repeatedly reuse existing objects. For example, a payroll

program and health benefits program both would use an Employee object. That is, the payroll program would use it to process employee paychecks, and the health benefits program would use it to process health insurance payments.

Programs developed using the object-oriented programming languages and application development tools have several advantages. The objects can be reused in many systems, are designed for repeated use, and become stable over time. In addition, developers create applications faster because they design programs using existing objects. Programming languages, such as Java and C++, and the latest versions of Visual Basic are complete OOP languages. Most object-oriented application development tools, such as Visual Studio, are referred to as an *integrated development environment* (*IDE*) because they include tools for building graphical interfaces, an editor for entering program code, a compiler and/or interpreter, and a debugger (to remove errors). Some work with a single programming language, and others support multiple languages. Read How To 11-3 for instructions about selecting the object-oriented programming language and application development tools best suited to your needs.

HOW TO 11-3

Determine Which Object-Oriented Programming Language or Application Development Tool to Use

Software developers can choose from a variety of object-oriented programming languages and application development tools to write a program or app for a computer or mobile device. The following guidelines describe how to determine which language or tool to use:

- Determine the types of devices on which your program or app will run. For example, if you are writing an app for a mobile device, limited languages and tools may be available for you to use. If you are writing a program or app that will run on a computer, more options will be available. Perform research and determine which types of programming languages can be used for various devices and operating systems.
- Determine the capabilities of the programming languages you are considering using. Some programming languages have greater capabilities than others.
- Consider the speed at which programs and apps run that are written in a particular programming language. For example, a program or app might run faster if it is written in one language as opposed to another.
- Consider whether you want to write a program using a text editor or an IDE. If you want to use an IDE, your choices of programming languages may be limited.
- Solicit recommendations from other developers. Explain the type of program or app you plan to write, and consider suggestions they might offer.

Consider This: If you are forced to write a program or app using a programming language with which you are not very familiar, what resources can you utilize to obtain assistance?

CONSIDER THIS

What is rapid application development?

RAD (*rapid application development*) is a method of developing software in which the software developer writes and implements a program in segments instead of waiting until the entire program is completed. An important concept in RAD is the use of prebuilt components. For example, software developers do not have to write code for buttons and text boxes on Windows forms because they already exist in the programming language or application development tools provided with the language. Object-oriented programming languages and application development tools work well in a RAD environment.

CONSIDER THIS

What is agile development?

Agile development guidelines for program development emphasize adaptation of goals and continuous improvement of the software or app. Its focus is on creating a working version of software that addresses user needs, collaboration with users and stakeholders, and response to changes in technology and market needs.

Java **Java** is an object-oriented programming language developed by Sun Microsystems. Figure 11-21 shows a portion of a Java program and the window that the program displays. When software developers compile a Java program, the resulting object program is machine independent. Software developers use various Java Platform implementations, which provide application development tools for creating programs for all sizes of computers and mobile devices.

```
public class BodyMassApplet extends Applet implements ActionListener
{
        //declare variables
        Image logo; //declare an Image object
        int inches, pounds;
        double meters, kilograms, index;

        //construct components
        Label companyLabel = new Label("THE SUN FITNESS CENTER BODY MASS INDEX CALCULATOR");
        Label heightLabel = new Label("Enter your height to the nearest inch  ");
            TextField heightField = new TextField(10);
        Label weightLabel = new Label ("Enter your weight to the nearest pound  ");
            TextField weightField = new TextField(10);
        Button calcButton = new Button("Calculate");
        Label outputLabel = new Label(
        "Click the Calculate button to see your Body Mass Index.");

            inches = Integer.parseInt(heightField.getText());
            pounds = Integer.parseInt(weightField.getText());
            meters = inches / 39.36;
            kilograms = pounds / 2.2;
            index = kilograms / Math.pow(meters,2);
            outputLabel.setText("YOUR BODY MASS INDEX IS " + Math.round(index) + ".");
        }

        public void paint(Graphics g)
        {
            g.drawImage(logo,125,160,this);
        }
}
```

Figure 11-21 A portion of a Java program and the window the program displays.

C++ Developed in the 1980s by Bjarne Sroustrup at Bell Laboratories, **C++** (pronounced SEE-plus-plus) is an object-oriented programming language that is an extension of the C programming language. C++ includes all the elements of the C language, plus it has additional features for working with objects. Software developers commonly use C++ to develop database and web applications.

Visual Studio Developed by Microsoft, **Visual Studio** contains a suite of object-oriented application development tools that assists software developers in building programs and apps for Windows or any operating system that supports the Microsoft .NET Framework. Visual Studio also includes a set of tools for developing programs and apps that work with Microsoft's Office suite. OOPs included in the Visual Studio suite are Visual Basic, Visual C++, and Visual C#.

CONSIDER THIS

What is .NET?

The Microsoft .NET Framework, or *.NET* (pronounced dot net), is a set of technologies that allows almost any type of program to run on the Internet or an internal business network, as well as stand-alone computers and mobile devices. Similarly, *ASP.NET* is a web application framework that provides the tools necessary for the creation of dynamic websites.

CONSIDER THIS

What is a visual programming language?

A *visual programming language* is a language that uses a visual or graphical interface for creating all source code. The graphical interface, called a *visual programming environment* (*VPE*), allows system developers to drag and drop objects to build programs and apps.

BTW

Visual Basic

Visual Basic is based on the BASIC programming language, which was developed in the early 1960s. Because this language is easy to learn and use, beginning programmers often use it.

Other Languages and Application Development Tools

The following sections discuss a variety of other programming languages and application development tools.

4GLs A **4GL** (*fourth-generation language*) is a nonprocedural language that enables users and software developers to access data in a database. With a *nonprocedural language*, the software developer writes English-like instructions or interacts with a graphical environment to retrieve data from files or a database. Many object-oriented application development tools use 4GLs. One popular 4GL is SQL. As discussed earlier in this module, SQL is a query language that allows users to manage, update, and retrieve data in a relational DBMS.

Classic Programming Languages In addition to the programming languages discussed on the previous pages, software developers sometimes use the languages to maintain legacy systems. These languages, which include BASIC, COBOL, FORTRAN, and RPG, were more widely used in the past than they are today.

Application Generators An application generator is a program that creates source code or machine code from a specification of the required functionality. When using an application generator, a software developer or user works with menu-driven tools and graphical user interfaces to define the desired specifications. Application generators most often are bundled with or are included as part of a DBMS. An application generator typically consists of a report writer and forms (discussed earlier in this module), and a menu generator. A menu generator enables you to create a menu for the application options.

Macros A **macro** is a series of statements that instructs a program or app how to complete a task. Macros allow users to automate routine, repetitive, or difficult tasks in application software, such as word processing, spreadsheet (Figure 11-22), or database programs. That is, users can create simple programs within the application by writing macros. You usually create a macro in one of two ways: (1) record the macro or (2) write the macro.

CONSIDER THIS

Why and how would you record a macro?

If you want to automate a routine or repetitive task such as formatting or editing, you would record a macro. A macro recorder is similar to a movie camera because both record all actions until turned off. To record a macro, start the macro recorder in the software. Then, perform the steps to be part of the macro, such as clicks or keystrokes. Once the macro is recorded, you can run it any time you want to perform that same sequence of actions. For example, if you always print three copies of certain documents, you could record the actions required to print three copies. To print three copies, you would run the macro called PrintThreeCopies. When you become familiar with programming techniques, you can write your own macros instead of recording them. Read Secure IT 11-4 for security issues related to macros.

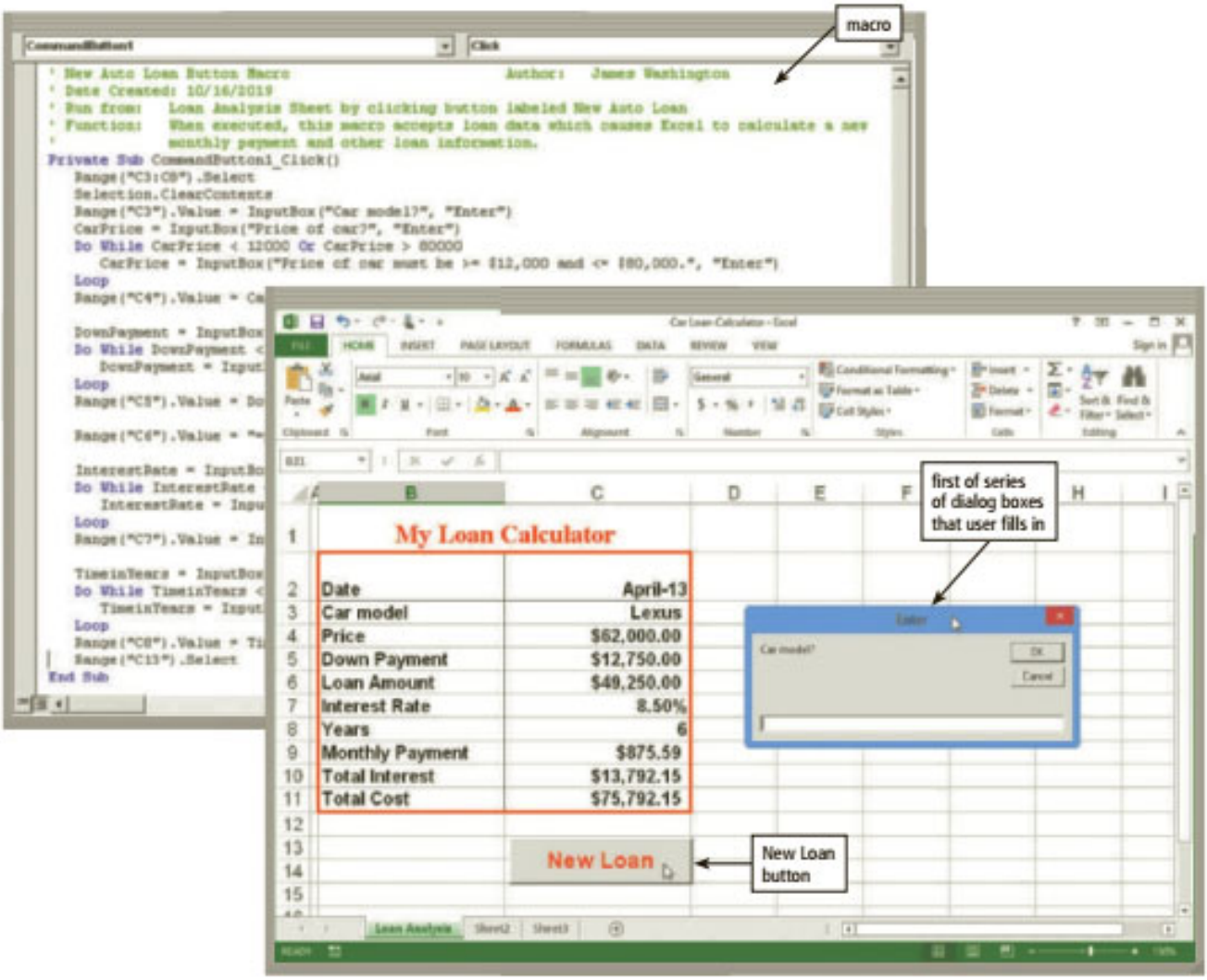


Figure 11-22 The top screen shows a macro used to automate an auto loan. After this macro is written, the user taps or clicks the New Loan button to run the macro. The bottom screen shows the macro guiding the user through part of the data entry process.
Source: Microsoft

SECURE IT 11-4

Protection from Macro Viruses

More than 20 years ago, the first macro viruses wreaked havoc with personal computers. Now, the same macro coding techniques are being used to create malware infecting smartphones. For example, the Selfmite worm sends text messages with malicious links to the owner's contacts.

As the name implies, a macro virus hides in a program's macro language. Malware authors find that one of the easiest methods of spreading viruses and worms is by distributing apps and files containing macro viruses. This type of virus is easy to write, and the damage that results from infecting smartphones and computers can exceed millions of dollars.

Because many computers and smartphones have acquired damaging macro viruses, antivirus and productivity software companies have strengthened their efforts to prevent this malware from infecting their products. One method, for example, disables the macros, which prohibits users from running once-automated tasks on their computers. The users, however, are frustrated when they now must perform routines manually. Other prevention measures include setting the software's macro security level to high, not installing apps from unknown sources, not opening unexpected file attachments, and holding down the shift key when opening a file that may be infected by a macro virus so that any automatic macros are prevented from running.

Many smartphone and computer users claim the software companies should make it impossible for malware authors to take advantage of security problems in the software. The software companies, however, place the blame on users who install apps and open files from unknown sources.

Consider This: Should users or software companies be held accountable for macro security threats? Why? How can smartphone and computer users best be educated about opening text messages and documents from unknown sources?

Web Development

The designers of webpages, known as *web developers*, use a variety of techniques to create and publish webpages. The following sections discuss these techniques.

HTML **HTML** (*Hypertext Markup Language*) is a special formatting language that software developers use to format documents for display on the web. You view a webpage written with HTML in a browser, such as Edge, Safari, Firefox, Opera, or Chrome. Figure 11-23a shows part of the HTML code used to create the webpage shown in Figure 11-23b.

Figure 11-23a (portion of HTML code)

Figure 11-23b (portion of resulting webpage)

Figure 11-23 The portion of the HTML code in Figure 11-23a generates a portion of the Cengage Learning CengageBrain webpage shown in Figure 11-23b.

CONSIDER THIS

Is HTML a programming language?

HTML is not actually a programming language. It is, however, a language that has specific rules for defining the placement and format of text, graphics, video, and audio on a webpage. HTML uses tags or elements, which are words, abbreviations, and symbols that specify links to other documents and indicate how a webpage is displayed when viewed on the web.

XML **XML** (*Extensible Markup Language*) is an increasingly popular format for sharing data that allows web developers to create tags that describe the structure of information. XML separates the webpage content from its format, allowing the browser to display the contents of a webpage in a form appropriate for the display device. For example, RSS feeds (web feeds) are represented as XML. A webpage can read the feed's content as described by XML and then apply styles and consistent formatting to each element (title, link, description) to display it within a browser.

Wireless devices use a subset of XML called WML. *WML* (*wireless markup language*) allows web developers to design pages specifically for microbrowsers. Many smartphones and other mobile devices use WML as their markup language.

CONSIDER THIS

What are some applications of XML?

Two applications of XML are the RSS 2.0 and ATOM specifications. *RSS 2.0*, which stands for Really Simple Syndication, and *ATOM* are specifications that content aggregators use to distribute content to subscribers. The online publisher creates an RSS or ATOM document, called a web feed, that is made available to websites for publication. News websites, blogs, and podcasts often use web feeds to publish headlines and stories. Most browsers can read web feeds, meaning they can display titles, links, descriptions, and other information about pages identified in the feed.

Scripting and Other Web Development Languages To add interactivity on webpages and to add special media effects, such as animated graphics, scrolling messages, calendars, and advertisements, web developers write small programs called scripts using a variety of scripting languages. Although some use languages previously discussed, such as Java and C++, many developers instead use scripting languages. A *scripting language* is an interpreted language that typically is easy to learn and use. Popular scripting and other web development languages include JavaScript (Figure 11-24), Perl, PHP, Python, and Ruby.

Figure 11-24a (JavaScript code)

Figure 11-24b (webpage)

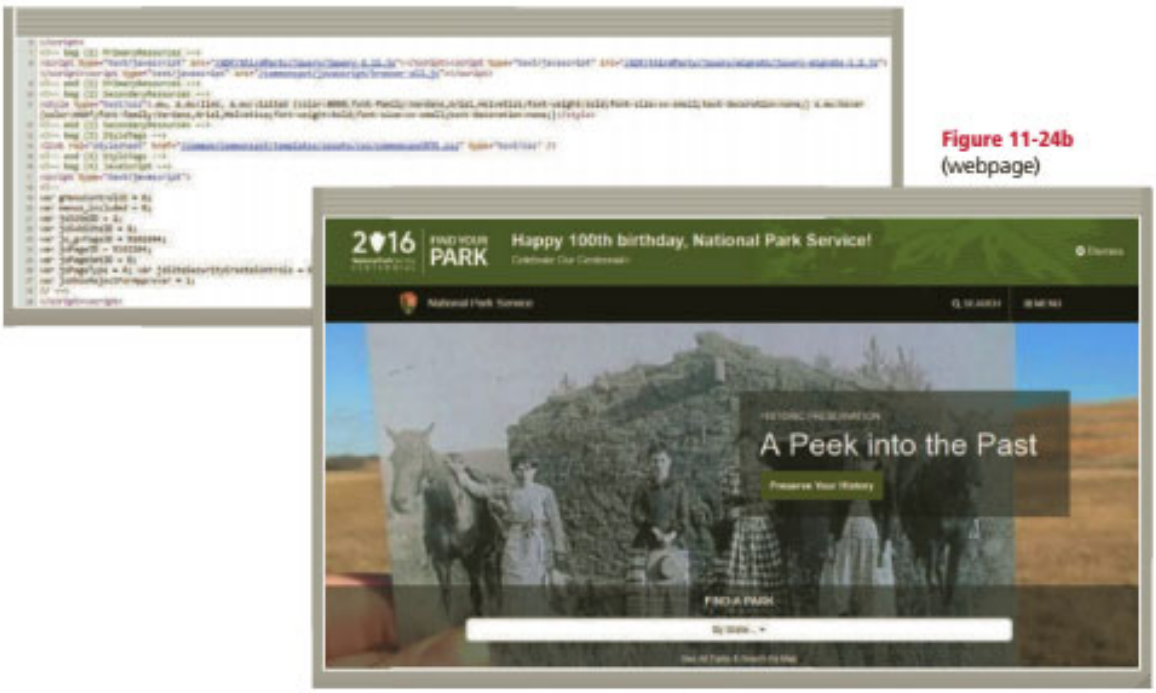


Figure 11-24 Shown here is a portion of the JavaScript code and its associated National Park Service webpage.
Source: National Park Service U.S. Department of the Interior

Tech Feature 11-4: Web Application Development

Three technologies form the foundation for many web applications: HTML5 specifies the structure of content displayed on a webpage; CSS (cascading style sheets) describes the design and appearance of information on a webpage; and *JavaScript* is a scripting language that allows users to interact with a webpage's content. Many web applications also access applications running on a server, connect to a database, or access third-party content from online sources. Together, these technologies enable developers to create browser-independent web applications that run on a variety of devices.

As discussed in an earlier module, the W3C (World Wide Web Consortium) is an international organization that sets the standards for the technologies and operation of the web. In addition, it defines the standards for HTML5 and CSS. Read Tech Feature 11-4 to learn about technologies that enable developers to create browser-independent web applications.

TECH FEATURE 11-4

Web Application Development

To develop a web application, web developers use HTML5, CSS, and JavaScript.

HTML5

HTML5 is the current HTML standard for creating websites and applications. HTML uses a set of codes called tags to instruct a browser how to structure a webpage's content. HTML tags specify the structure of content on a webpage, such as headings, paragraphs, links, or images. HTML5 includes tags for playing audio and video files without relying on the use of third-party plug-ins or modules, such as Adobe Flash, to perform these tasks. Some mobile devices and computers, such as Apple's iPhone and iPad, do not support displaying media content that requires Flash. Instead, they rely on HTML5-compliant browsers, which are capable of interpreting HTML5 tags, to handle these tasks.

Source: HTML5 Logo by World Wide Web Consortium

Additional HTML5 features include recognizing gestures, such as swipe or drag-and-drop, on mobile devices; dynamically creating graphics, such as progress bars, charts, and animations; *geolocation* (determining a user's location based on a device's GPS or connection to a cell tower); and offline storage. For example, Google Drive uses HTML5's drag-and-drop feature so that you can organize documents and uses its offline storage feature to allow you to work with your documents when you do not have an Internet connection. Twitter makes use of HTML5's geolocation feature when users search for Tweets that originate near a specific location.

These HTML5 features enable web developers to build applications that address the needs of how people use the web today and provide richer user experiences. Each browser implements the HTML5 specification differently and may not support all of its features.

CSS

While HTML describes the structure of a webpage's content as a collection of elements (such as headings, paragraphs, images, and links), CSS allows web designers to separate the code that specifies a webpage's content from the code that specifies the webpage's appearance. For example, a webpage may contain two paragraphs of text that are presented using a variety of fonts and sizes, styles, colors, borders, thicknesses, columns, or backgrounds. CSS provides web designers with precise control over a webpage's layout and allows the designers to apply different layouts to the same information for printing or for viewing in browsers on smartphones, tablets, or computers with varying screen sizes. The current version of CSS is known as CSS3 (cascading style sheets, version 3).

JavaScript

JavaScript is a programming language that adds interactivity to webpages. It often is used to check for appropriate values on web forms, display alert messages, display menus on webpages, control the appearance of a browser window, read and write cookies, display alert boxes, and detect the browser version in order to display a webpage especially designed for that browser. JavaScript code is loaded with a webpage and runs in the browser.

Developing Websites and Applications with HTML5, CSS, and JavaScript

Web developers often use tools, such as the one shown in the figure, to create their code and visualize

(continued)

what it will look like in a browser. In this example, HTML5 specifies a heading, a paragraph, and a link; CSS specifies the page background color and fonts, while JavaScript instructs the page to display an alert box when it loads.

Consider This: What are two advantages and two disadvantages of writing mobile apps using HTML5, CSS, and JavaScript? Before HTML5's geolocation features, how might a web app have determined a user's approximate location? Some web-based email services, such as Gmail, use HTML5, CSS, and JavaScript. Name a feature of Gmail that might demonstrate a characteristic of each of these technologies.

Source: Liveweave

Summary

This module discussed the hierarchy of data, ways to validate data, the advantages of the database versus the file processing approach, and characteristics of database management systems. It also discussed the system development phases and the guidelines for system development, along with activities that occur during system development, including project management, feasibility assessment, documentation, and data and information gathering. This module also reviewed various programming languages and application development tools used to create and modify computer programs. Finally, it described a variety of web development tools.

The Study Guide reinforces material you should know after reading this module.

Study Guide

Instructions: Answer the questions below using the format that helps you remember best or that is required by your instructor. Possible formats may include one or more of these options: write the answers; create a document that contains the answers; record answers as audio or video using a webcam, smartphone, or portable media player; post answers on a blog, wiki, or website; or highlight answers in the book/e-book.

1. Define the terms, database and database software. Identify the role of a file, record, and field in database hierarchy.
2. Define these terms: field, field name, and data type. List common data types.
3. Identify what is stored in a record. Explain the importance of a primary key.
4. Define the term, data file. Identify what is involved in file maintenance.
5. Explain the issues surrounding fair use of collected customer data.
6. Explain how a DBMS might manage deleted or obsolete records.
7. Define the term, validation. List types of validity checks and explain what occurs in each.
8. Explain the disadvantages of typical file processing systems. Describe the database approach to storing data.
9. Explain the issues surrounding use of criminal databases.
10. Differentiate between a front-end and back-end program. Explain the advantages and disadvantages of the database approach.
11. Explain how you access data in a web database. Describe the role of a database server.
12. Identify uses of web databases for government, entertainment, travel, shopping, research, and education.
13. A(n) _____ defines how users view the organization of the data. List popular examples.
14. List possible uses of an object-oriented database.
15. Explain the characteristics, sources, and uses of Big Data. Describe what occurs during data visualization.
16. Describe the role of the database administrator.
17. Define the term, data dictionary. Explain how a data dictionary helps ensure data integrity.
18. A(n) _____ is a request for specific information from a database.
19. Define the terms, query language, SQL, and QBE.
20. Define the terms, form and report writer.
21. Explain how access privileges contribute to data security. List steps to secure and maintain a database.
22. List methods to recover from identity theft. Explain issues surrounding use of national ID cards.
23. List methods to restore or backup a database. Differentiate between rollforward and rollback recovery.
24. Identify the five phases in the SDLC. Name three guidelines for system development.
25. Identify who participates in system development. Describe the responsibilities of a systems analyst.
26. Define the term, project management. List elements the project leader must identify.
27. A(n) _____ is any tangible item, such as a chart, diagram, report, or program file. List the steps involved in using project management software.
28. Describe how Gantt and PERT charts are used.
29. Define the terms, scope creep and change management.
30. Identify tests used to evaluate feasibility of a project. Explain the importance of documentation.
31. Describe ways that team members collaborate.
32. Identify data and information gathering techniques. A(n) _____ session also is called a focus group.
33. Describe circumstances that can initiate system development.
34. List the four activities of the planning phase. Explain how projects are prioritized.
35. Describe the activities of the analysis phase. List the three activities of the detailed analysis phase.
36. Explain security issues surrounding outsourcing.
37. List the two activities of the design phase. Describe how a systems analyst obtains hardware or software.
38. Differentiate among an RFQ, RFP, and RFI. Describe the roles of VARs and IT consultants when soliciting vendor proposals.
39. Explain what occurs when vendor proposals are tested and evaluated. A(n) _____ test measures the performance of hardware or software.
40. Explain the activities and users involved in the detailed design phase. Define the term, prototype.
41. List the four activities of the implementation phase.
42. List the three activities of the support and security phase. Describe components of a technology security plan.
43. Define the following terms: programming language, application development tool, and syntax.
44. Define the terms, procedural language, machine language, compiler, and interpreter. List benefits of OOP languages.
45. Describe the following: 4GLs, classic programming languages, application generators, and macros. Explain how to protect yourself from macro viruses.
46. Explain how web developers use HTML5, XML, WML, CSS, and JavaScript.
47. Describe uses of forensic databases.

STUDENT ASSIGNMENTS

Key Terms

You should be able to define the Primary Terms and be familiar with the Secondary Terms listed below.

Primary Terms (shown in **bold-black** characters in the module)

4GL (11-35)
analysis phase (11-25)
Big Data (11-12)
C (11-31)
C++ (11-34)
character (11-4)
continuous backup (11-18)
data dictionary (11-14)
data file (11-5)
data model (11-12)
data type (11-4)
database (11-2)
database management system (DBMS) (11-3)
database software (11-3)
design phase (11-26)
feasibility (11-20)
field (11-4)
field name (11-4)
file maintenance (11-5)
file processing system (11-8)
form (11-15)
HTML (11-37)
Implementation phase (11-28)
Java (11-34)
log (11-18)
macro (11-35)
object-oriented programming (OOP) language (11-32)
planning phase (11-24)
preliminary investigation (11-25)
primary key (11-5)
procedural language (11-31)
programming language (11-31)
project management (11-20)
project management software (11-20)
prototype (11-28)
query (11-14)
query language (11-15)
record (11-5)
recovery utility (11-18)
report writer (11-16)
Structured Query Language (SQL) (11-15)
support and security phase (11-30)
system development (11-19)
system development life cycle (SDLC) (11-19)
systems analyst (11-20)
training (11-29)
validation (11-6)
Visual Studio (11-34)
XML (11-37)

Secondary Terms (shown in *italic* characters in the module)

.NET (11-34)
acceptance test (11-29)
agile development (11-33)
alphabetic check (11-7)
application development tool (11-31)
ASP.NET (11-34)
ATOM (11-38)
back end (11-9)
backward recovery (11-18)
benchmark test (11-27)
BLOB (11-4)
Boolean (11-4)
change management (11-22)
code (11-31)
collaborative databases (11-10)
compiler (11-32)
completeness check (11-7)
composite key (11-5)
conferencing software (11-23)
consistency check (11-7)
cost/benefit feasibility (11-22)
data entry form (11-15)
data warehouse (11-12)
database administrator (DBA) (11-14)
database server (11-10)
deliverable (11-21)
detailed analysis (11-25)
digital forensics (11-18)
direct conversion (11-29)
distributed database (11-12)
documentation (11-22)
economic feasibility (11-22)
e-form (11-15)
Extensible Markup Language (11-37)
feasibility study (11-25)
feature creep (11-22)
focus group (11-23)
forward recovery (11-18)
fourth-generation language (11-35)
front end (11-9)
function creep (11-6)
Gantt chart (11-21)
geolocation (11-39)
Hypertext Markup Language (11-37)
information system (11-19)
integrated development environment (IDE) (11-33)
integration test (11-29)
interpreter (11-32)
IT consultant (11-27)
JavaScript (11-39)
joint-application design (JAD) session (11-23)
logical design (11-25)
machine language (11-31)
metadata (11-14)
mock-up (11-27)
multidimensional database (11-12)
nonprocedural language (11-35)
numeric check (11-7)
object (11-12)
object code (11-32)
object program (11-32)
object-oriented database (OODB) (11-12)
operational feasibility (11-22)
parallel conversion (11-30)
PERT chart (11-21)
phased conversion (11-30)
phases (11-19)
pilot conversion (11-30)
post-implementation system review (11-30)
principle of least privilege policy (11-16)
program development life cycle (11-28)
program specification package (11-28)
project leader (11-20)
project manager (11-20)
project request (11-24)
project team (11-20)
proof of concept (11-28)
query by example (QBE) (11-15)
RAD (rapid application development) (11-33)
range check (11-7)
relational database (11-12)
report generator (11-16)
repository (11-14)
request for information (RFI) (11-26)
request for proposal (RFP) (11-26)
request for quotation (RFQ) (11-26)
request for system services (11-24)
rollback (11-18)
rollforward (11-18)
RSS 2.0 (11-38)
sandbox (11-29)
schedule feasibility (11-22)
scope (11-20)
scope creep (11-22)
scribe (11-24)
scripting language (11-38)
source program (11-31)
standards (11-20)
steering committee (11-20)
syntax (11-31)
systems test (11-29)
user buy-in (11-28)
technical feasibility (11-22)
unit test (11-29)
value-added reseller (VAR) (11-26)
visual programming environment (VPE) (11-35)
visual programming language (11-35)
web conference (11-23)
web developers (11-37)
WML (wireless markup language) (11-38)

The Checkpoint exercises test your knowledge of the module concepts.

Checkpoint

True/False

Mark T for True and F for False. If False, rewrite the statement so that it is True.

_____ 1. In a data hierarchy, each higher level of data contains one or more items from the lower level.
_____ 2. A check digit often confirms the accuracy of a primary key value.
_____ 3. In a typical database system, each department or area within an organization has its own set of files.
_____ 4. In a file processing system, duplicated data can increase the chance of errors.
_____ 5. Many programs today use forms on a webpage as their front end.
_____ 6. File processing systems require more memory, storage, and processing power than a database.
_____ 7. To retrieve or select data in a database, you query it.
_____ 8. Unlike a form, you use a report writer only to retrieve data.
_____ 9. One way to secure a database is to allow only administrators to have access to create and delete tables.
_____ 10. In a rollforward, the DBMS uses the log to undo any changes made to the database during a certain period.
_____ 11. Gantt charts are better suited than PERT charts for planning and scheduling large, complex projects.
_____ 12. The planning phase begins when the steering committee receives a project request.

Matching

Match the terms with their definitions.

_____ 1. check digit
_____ 2. data type
_____ 3. feature creep
_____ 4. file maintenance
_____ 5. object
_____ 6. object program
_____ 7. primary key
_____ 8. source program
_____ 9. standards
_____ 10. validation

a. procedures that keep data current
b. item that contains data, as well as the actions that read or process the data
c. field that uniquely identifies each record in a file
d. process of comparing data with a set of rules or values to determine if the data meets certain criteria
e. language instructions, or code, to be converted to machine language
f. machine language version of a program that results from compiling the procedural language
g. number(s) or character(s) that is appended to or inserted in a primary key value
h. specifies the kind of data a field can contain and how the field is used
i. problem that occurs when one activity has led to another that was not planned originally, causing the project to grow in scope
j. sets of rules and procedures an organization expects employees to accept and follow

STUDENT ASSIGNMENTS

Problem Solving

The Problem Solving exercises extend your knowledge of module concepts by seeking solutions to practical problems with technology that you may encounter at home, school, or work. The Collaboration exercise should be completed with a team.

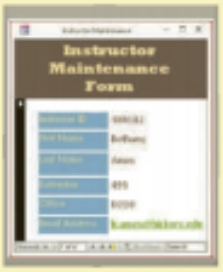
Instructions: You often can solve problems with technology in multiple ways. Determine a solution to the problems in these exercises by using one or more resources available to you (such as a computer or mobile device, articles on the web or in print, blogs, podcasts, videos, television, user guides, other individuals, electronics or computer stores, etc.). Describe your solution, along with the resource(s) used, in the format requested by your instructor (brief report, presentation, discussion, blog post, video, or other means).

Personal

1. **No Search Results** While searching a web database for a hotel room for an upcoming trip, a message is displayed stating that no search results match your criteria. What can you do to correct this problem?
2. **Incorrect Price** You are shopping for groceries and, after loading all items in your cart, it is time to check out. The cashier scans your items, but you realize that the register is not reflecting an advertised discount on one of the items. Why might this be happening?
3. **Webpage Not Readable** You are attempting to view a webpage on your smartphone, but the text is very small and you are having difficulty reading anything. It is extremely time consuming for you to zoom in and constantly scroll around the webpage to view the contents. What might be causing this?
4. **Inaccurate Credit Report** You have obtained a free copy of your credit report and notice that multiple companies are accessing your credit report without your knowledge or permission. Your financial records are very important, and it is troubling that other companies are accessing this information. Why might this be occurring?
5. **Webpage Script** You are viewing a webpage and have just submitted an online form. The browser does not appear to do anything for about one minute, and an error message finally appears stating that a script on the page is taking longer than expected to run. What might be wrong?

Professional

6. **Data Entry Issues** You are in charge of adding student information to your school's database using a front end. When you attempt to enter the street address for one of the students, the entire street name does not fit in the text box. What are your next steps?



Source: Microsoft

7. **Incorrect Postal Codes** Your company's database stores information about its customers, including their names, addresses, phone numbers, email addresses, and order history. While reviewing the database to ensure data integrity, you notice that some of the postal codes, which should be five digits, are only four digits. What might be wrong?
8. **Database Connection Error** While interacting with a web app, an error is displayed informing you that the web app is not able to connect to the database. What might be causing this?
9. **Database Recovery** Your boss has informed you that the main customer database for your company has become corrupt. Fortunately, you can attempt to use the recovery utility to salvage the data in the database. When you attempt to recover the database, you receive an error message that the recovery has failed. What are your next steps?
10. **Content Management System Updates** You are attempting to update your company's website using a content management system. When you make the requested changes in the content management system, they are not reflected on the company website. What might be the problem?

Collaboration

11. **Technology in Sports** You serve as an assistant coach for your former high school's baseball team. The head coach, whose computer is more than five years old, informs you that he would like to create an application that will allow him to keep track of his players' statistics. For instance, he would like to track each player's number of strikeouts, walks, hits, and home runs. Form a team of three people to determine the requirements for implementing his request. One team member will research the types of apps that can track this data, another team member will determine the specifications for a computer or mobile device capable of running the software and storing the data, and the other team member will determine the best way to collect the data during the game.

How To: Your Turn

The How To: Your Turn exercises present general guidelines for fundamental skills when using a computer or mobile device and then require that you determine how to apply these general guidelines to a specific program or situation.

Instructions: You often can complete tasks using technology in multiple ways. Figure out how to perform the tasks described in these exercises by using one or more resources available to you (such as a computer or mobile device, articles on the web or in print, online or program help, user guides, blogs, podcasts, videos, other individuals, trial and error, etc.). Summarize your 'how to' steps, along with the resource(s) used, in the format requested by your instructor (brief report, presentation, discussion, blog post, video, or other means).

1 Obtain and Verify the Accuracy of a Credit Report

It is important to obtain your credit report at least one time per year to verify its accuracy, as imperfections on a credit report can lead to problems such as financing being declined or higher interest rates on loans. The following steps guide you through the process of obtaining and verifying the accuracy of a credit report.

a. Run a browser and then navigate to annualcreditreport.com.
b. When you arrive at the website, verify that the browser is using the https protocol, indicating a secure connection.
c. Click the button to request the report.
d. Provide the necessary personal information.
e. Select the agency or agencies from which you want a copy of your credit report.
f. Click the button to continue to the credit reporting agency's website.
g. If necessary, enter the additional requested information to validate your request.
h. Follow the instructions on the website to finish obtaining a copy of your credit report.
i. Save and/or print a copy of the credit report.

After you have obtained a copy of your credit report, verify it for accuracy. The following points describe what to look for when reviewing the report:

- Verify the list of accounts is accurate.
- Verify your payment history.
- Verify current balances are accurate.
- Review your personal information, and report any inconsistencies to the credit reporting agency.
- Review your rights under the Fair Credit Reporting Act.

Exercises

1. In addition to the reasons mentioned in this exercise, why else might you want to obtain a copy of your credit report?
2. What is a credit score? How can you obtain your credit score? What are the highest and lowest possible credit scores?
3. If you find erroneous information on your credit report, how can you make the necessary corrections?

2 Use a Research Database

Students often use one or more research databases to locate information about a particular topic. Research databases often can be accessed in a public or school library, through a library's website, or through the research database's website. The following steps guide you through the process of using a research database:

a. Locate and then navigate to the research database that contains the information you are seeking. Consult a librarian if you need assistance in determining the exact database you should use.
b. Determine the location from which you can access the research database. For instance, you may need to access some research databases from a library computer. Other databases are accessible from anywhere if you can verify your identity as a library patron or a student. Some databases are available to the public at no charge or with no other restrictions.
c. Navigate to the research database you plan to use.
d. If the research database contains an option to perform an advanced search, click the option to perform the advanced search.
e. Specify the search criteria. Note that not all research databases will request the same search criteria. The following list contains some common criteria:
   1. Keywords
   2. Author
   3. Publication date

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4. Publication type
5. Education level

f. Run the search.
g. Browse the search results and then click the search result that interests you.

Exercises

1. Why might you want or need to use a research database?
2. What research databases are available through your school's library?
3. Evaluate three research databases that you may need to use throughout your academic career. Which one do you like the most? Why? Which one do you like the least? Why?

3 Protect Your Data If Your Device Is Lost or Stolen

If you misplace your device or it is stolen, you can use another device to help find yours. Certain apps will help you locate your device, cause your phone to ring, display an alert message, take a photo using the front or back camera, or remotely lock the device so that your data will be safe. Some apps require purchasing the full version to access advanced features, such as remotely locking or wiping your device. The following steps guide you through the process of protecting your data if your device is lost or stolen.

a. Determine whether your device has a built-in feature or app you can use to locate it in the event it is lost or stolen. If not, locate, install, and run an app that can perform this service. The app you locate and install should meet the following criteria:
   1. The app should be reputable and have good reviews.
   2. Reviews should contain no indication that the app is malicious.
   3. The app should be able to locate, lock, and erase data from your device if it is lost or stolen.
   4. You should be able to access or control your phone from a variety of devices (such as smartphones, tablets, and laptops) and operating systems (such as iOS, Android, macOS, and Windows).
   5. The app should be secure so that others cannot inadvertently or maliciously control your device.

b. From the app's home screen, configure the necessary settings so that you will be able to locate and control your device if it is lost or stolen. Consider configuring the following settings:
   1. Determine which ringer or sound you want to use if you are attempting to locate a lost device.
   2. Specify how to instruct the device to take an appropriate action. For example, you may be able to instruct a device to play a sound (such as a siren) by sending a text message to it with certain wording, or by tapping or clicking a button on a specific website.
   3. Enable the GPS feature on the device so that you will be able to see its location.

c. Make sure the data on your device is backed up regularly to a computer or to the cloud. Some devices have a feature (or apps available) to automatically back up your data in the event it is erased from your device.
d. Test the features of the app to make sure it works as intended.
e. In the event the device is lost or stolen, perform the following steps as soon as possible for the best chance at retrieving the device and its data:
   1. Issue a command to the device to lock it.
   2. If you are attempting to locate a phone, call it to see if someone answers. If so, try to retrieve the phone.
   3. If possible, send a text message to the device with your contact information to see if someone contacts you.
   4. Activate the ringer or sound on the device so that you can hear it if it is nearby.
   5. If possible, access a web app or an app on another device to track the device's location using GPS.
   6. If possible, take a photo with the device's front and back cameras to see if you can determine where it is located.
   7. If you are unsuccessful and you think the data on the device is at risk, issue a command to the device to erase all data. Consider contacting law enforcement if you think the device was stolen.

Exercises

1. Have you ever lost or misplaced a device? If so, did you locate it? How?
2. Evaluate at least three apps that can locate and remove data from a lost or stolen device. Which ones did you evaluate? Which is your favorite? Why?
3. Some devices offer a feature that allows you to encrypt the data. Would you encrypt the data on your device? Why or why not? What are the benefits of doing so? What drawbacks exist, if any?

Source: Google, Inc.

The Internet Research exercises broaden your understanding of module concepts by requiring that you search for information on the web.

Internet Research

Instructions: Use a search engine or another search tool to locate the information requested or answers to questions presented in the exercises. Describe your findings, along with the search term(s) you used and your web source(s), in the format requested by your instructor (brief report, presentation, discussion, blog post, video, or other means).

1 Making Use of the Web

Entertainment

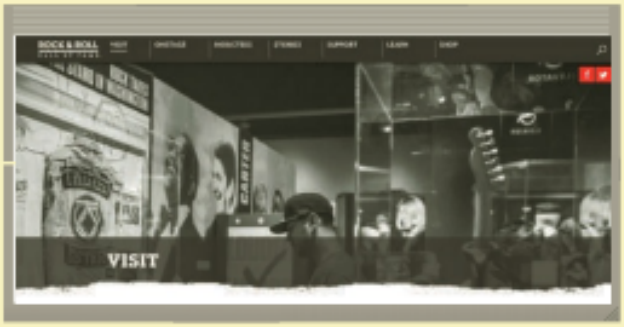
Americans, on average, spend nearly six percent of their income on entertainment, which includes tickets for concerts and movies, electronic equipment, hobbies, and services. They have scaled back their away-from-home activities in favor of in-home entertainment as they have invested in home theaters, high-speed Internet, and game consoles.

Many websites satisfy our cravings for amusement. For example, the Rock and Roll Hall of Fame and Museum has videos, stories, and a comprehensive "The Story of Rock" to enjoy. The Internet Movie Database (IMDb) has facts about more than 2.7 million movies, television shows, and entertainment programs. It also has video highlights, quotes, quizzes, and movie showtimes. Other entertainment websites have a variety of content aimed at amusing visitors and relieving boredom.

Research This: (a) Locate the Rock and Roll Hall of Fame and Museum website and view the information about the latest inductees. What is the total number of inductees? Which artists have been inducted more than once? Describe two upcoming events. Which classes are being offered in the Rock and Roll Night School?

(b) Locate the Internet Movie Database website. Take the IMDb Internet Icon Quiz. What score did you earn? What are three movies opening this week? What is the top news story of the day?

(c) Visit an entertainment website. What content is featured, such as humorous and sports video clips, photos, animations, and audio clips? What categories are available? Are advertisements included in the content? Which content is available at no cost, and which requires a fee to access?



Source: The Rock and Roll Hall of Fame and Museum, Inc.

2 Social Media

Targeted Ads

Companies collect data as people browse websites. Just seconds after individuals visit a specific webpage, advertisements are displayed matching their shopping patterns and favorite products. This tracking is prevalent in online social networks, too, as marketers match users' profiles and other posted information, such as status updates, with specific businesses. Facebook, for example, allows retailers to upload their databases containing email addresses, phone numbers, and other personal facts. This data then is compared with the Facebook users' data. When a match is found, specific advertisements are displayed. Social media may charge the advertisers each time a user clicks an ad, called CPC (cost per click) or PPC (pay per click), which could range from a few cents to several dollars. Another option is to charge for a specific number of times an ad is displayed, called CPI (cost per impression).

Research This: Locate at least two articles discussing targeting ads on online social networks. How do the businesses place their ads based on the users' online identities and profiles? What steps are taken to ensure the users' privacy? Should users expect companies to collect data about some of their online behaviors in return for using the websites at no charge?

3 Search Skills

Verifying Your Search Results

Even though a link to a website or other online resource may appear first in your list of search results, the information it presents may not be accurate. Several strategies exist to help you determine the credibility of search results. Verify the information you read by finding supporting information on other websites or by comparing search results from different search engines. Often authors will provide links to sources within or at the end of an article. Search for information about the author to help determine his or her credibility, authenticity, or objectivity. Some articles may present opinions, not facts.

If you do not recognize or have doubts about the domain name of a website you are reading, type the search text, whois, in a search engine to locate the WhoIs database. Then type the domain name of the website in question (such as cengagebrain.com) in

Internet Research

the WhoIs search box to find its owner. You then can search for more information about the website's owner. If you are looking for time-sensitive information, check the date when the links or pages were updated. If a webpage is filled with ads or pop-ups, it may be a scam.

Source: Whois

Research This: Use a search engine to answer these questions and report your findings. (1) Find an article on Wikipedia about relational databases. What references reinforce the statements in the article? (2) Find a popular blog about CRM systems and use WhoIs to determine the blog's owner. (3) Search for a news article about web databases and then find two additional articles by the same author on a similar topic. (4) Search for information about the five most popular content management systems in use today. Do different websites give you different results? How was popularity determined?

4 Security

Selling Data

When you use supermarket loyalty cards, enter contests, complete warranty registrations, apply for credit cards, and subscribe to newsletters, businesses automatically store personal data about you, your transactions, and your preferences in their marketing databases. They often use this data to analyze sales, develop advertising campaigns, and solicit more business from you. Unbeknownst to many consumers, some companies also sell or rent this data to other businesses for the purpose of developing interest-based or online behavioral advertising. Consumers can refuse to receive targeted email messages and marketing materials, but they often must search the websites or paper forms for check boxes to indicate these opt-out preferences. Some consumer advocates view this practice as an invasion of privacy and urge businesses to default to not adding consumers' information to databases unless the consumer opts in to receive additional materials.

Research This: Visit at least two websites that include opt-in or opt-out provisions and read the disclosure notices. What steps can you take to remove yourself from databases? Which organizations help protect consumers and offer information on maintaining online privacy? Then, search for at least two marketing companies that provide online direct advertising campaigns. How do these companies use databases to match consumers' buying preferences with targeted offers?

5 Cloud Services

Online Databases (DaaS)

Accessing information from online databases is an example of data as a service (DaaS), a service of cloud computing that provides data on demand for use in applications or visualizations. Federal, state, and local governments provide data online to promote transparency and enable users to perform research online. Independent data markets are websites that aggregate and offer data from leading providers, along with web-based tools for exploring, analyzing, and visualizing online data. Data providers make the data available to developers through an API (application programming interface), who incorporate the data in new products, such as web or mobile apps. Users often can explore the data through a web interface.

Research This: (1) Use a search engine to find and visit the open data site for your city, state, or country's government. Select a topic for which data is available, and use the online tools provided to explore a data set and create a visualization in the form of a map or graph. (2) Use a search engine to find and visit an independent data market website, and browse the data sets listed. Select one of the data sets and read about the data it contains. How might an app make use of this data? What pricing models are available for developers who wish to incorporate this data into their apps?

Critical Thinking

The Critical Thinking exercises challenge your assessment and decision-making skills by presenting real-world situations associated with module concepts. The Collaboration exercise should be completed with a team.

Instructions: Evaluate the situations below, using personal experiences and one or more resources available to you (such as articles on the web or in print, blogs, podcasts, videos, television, user guides, other individuals, electronics or computer stores, etc.). Perform the tasks requested in each exercise and share your deliverables in the format requested by your instructor (brief report, presentation, discussion, blog post, video, or other means).

1. Online Movie Reviews

Information about movie titles and television shows is available from the web database IMDb (Internet Movie Database). Visitors can search IMDb using by title, cast member, year produced, characters, genre, awards, or other criteria. Each movie or show's listing offers a brief description and rating and includes links to such items as summary, trivia, reviews, quotes, and even streaming video options.

Do This: Visit imdb.com and search for both recently released and classic movies. Explain the steps you used to query the movie database. Assess how complete the information provided was. Who would benefit most from using the movie database? Why? Answer the following questions about your experiences. Did the information provided differ when viewing recently released titles versus classic movies? What did you learn from your queries? Can you identify a few fields that are included in the records for each movie? What interactive features can you identify? Can you find any HTML5 features that have been incorporated?

2. Spreadsheets versus Databases

Some individuals and small organizations prefer using spreadsheets instead of databases. People who use spreadsheets might argue that similar to databases, spreadsheets have columns and rows, and you can keep track of different sets of data in individual worksheets. This is similar to how you would use tables in a database to store different data sets. In addition, some find it easier to install, use, and maintain spreadsheet software than database software. After reading this module, you are convinced that databases have additional advantages, such as the capability of storing more data and more quickly searching for data, as well as generating reports.

Do This: Prepare information aimed toward individuals who prefer spreadsheets to databases. Include reasons why it is not advisable to store large amounts of data in spreadsheets, as well as the reporting and querying capabilities of databases. Explain benefits for using a database for collaborating and sharing information among departments in a business.

Source: Microsoft

3. Case Study

Family-Owned Coffee Shop You are the new manager for a family-owned coffee shop. The coffee shop uses a database to store information about its inventory, prices, employees, customers, and special offers. The coffee shop's website uses information stored in the database to display products, pricing, and sales. The owners have asked you to investigate how the coffee shop should secure its database.

Do This: Using information learned in the module as well as performing additional research, prepare information about securing a database. What risks exist for databases? Who should determine the security measures to take? What should you include in the database security policy? Include recommendations for backing up data, validation, maintenance, and assigning different access levels to employees and managers. Is the coffee shop bound to uphold pricing mistakes that appear on its website? Why or why not? Compile your findings.

Collaboration

4. System Development Life Cycle A major retail company has hired your team to create and implement the steps in the system development life cycle (SDLC) to create custom inventory software.

Do This: Assign SDLC steps to different teammates and compile a plan for each step. Share your findings. Does the plan contain gaps? Do any steps or tasks overlap? What guidelines should you follow during system development? What roles are needed? How might you use project management software? As a team, answer the following questions to share with the retail company: Would you use a compiler or an interpreter? Why? Would you use an object-oriented programming language? Why or why not? What types of information gathering techniques would be most effective? Why? Would you recommend outsourcing parts of the process? Why or why not? What is necessary to create a prototype of the project? Search for popular programming languages. Find industry experts' reviews of each language. Can you find an example of a program that uses each language? Which language might be best suited to this project? Why? As a team, compile your findings and share your recommendation with the class.