

Improving Decision Making and Managing Knowledge

10

CHAPTER

STUDENT LEARNING OBJECTIVES

After completing this chapter, you will be able to answer the following questions:

1. What are the different types of decisions, and how does the decision-making process work?
2. How do information systems help people working individually and in groups make decisions more effectively?
3. What are the business benefits of using intelligent techniques in decision making and knowledge management?
4. What types of systems are used for enterprise-wide knowledge management, and how do they provide value for businesses?
5. What are the major types of knowledge work systems, and how do they provide value for firms?

CHAPTER OUTLINE

Chapter-Opening Case: *Eastern Mountain Sports Forges a Trail to Better Decisions*

- 10.1 Decision Making and Information Systems
- 10.2 Systems for Decision Support
- 10.3 Intelligent Systems for Decision Support
- 10.4 Systems for Managing Knowledge
- 10.5 Hands-On MIS

Business Problem-Solving Case: *HSBC's Mortgage Lending Decisions: What Went Wrong?*

EASTERN MOUNTAIN SPORTS FORGES A TRAIL TO BETTER DECISIONS

Founded in 1967 by two rock climbers, Eastern Mountain Sports (EMS) has grown into one of the leading outdoor specialty retailers in the United States, with more than 80 retail stores in 16 states, a seasonal catalogue, and a growing online presence. EMS designs and offers a wide variety of gear and clothing for outdoor enthusiasts.

Until recently, however, the company's information systems for management reporting were dated and clumsy. It was very difficult for senior management to have a picture of customer purchasing patterns and company operations because data were stored in disparate sources: legacy merchandising systems, financial systems, and point-of-sale devices. Employees crafted most of the reports by hand, wasting valuable people resources on producing information rather than analyzing it.

After evaluating several leading business intelligence products, EMS selected WebFOCUS and iWay middleware from Information Builders. EMS believed WebFOCUS was better than other tools in combining data from various sources and



presenting the results in a user-friendly view. It is Web-based and easy to implement, taking EMS only 90 days to be up and running.

iWay extracts point-of-sale data from EMS's legacy enterprise system running on an IBM AS/400 midrange computer and loads them into a data mart running Microsoft's SQL Server database management system. WebFOCUS then creates a series of executive dashboards accessible through Web browsers, which provide a common view of the data to more than 200 users at headquarters and retail stores.

The dashboards provide a high-level view of key performance indicators such as sales, inventory, and margin levels, but enable users to drill down for more detail on specific transactions. Merchandising managers monitor inventory levels and the rate that items turn over. E-commerce managers monitor hour-by-hour Web sales, visitors, and conversion rates. A color-coded system of red, yellow, and green alerts indicates metrics that are over, under, or at plan.

EMS is adding wikis and blogs to enable managers and employees to share tips and initiate dialogues about key pieces of data. For example, in identifying top-selling items and stores, EMS sales managers noticed that inner soles were moving very briskly in specialty stores. These stores had perfected a multi-step sales technique that included the recommendation of socks designed for specific uses, such as running or hiking, along with an inner sole that could be custom-fit to each customer. Wikis and blogs made it easier for managers to discuss this tactic and share it with the rest of the retail network.

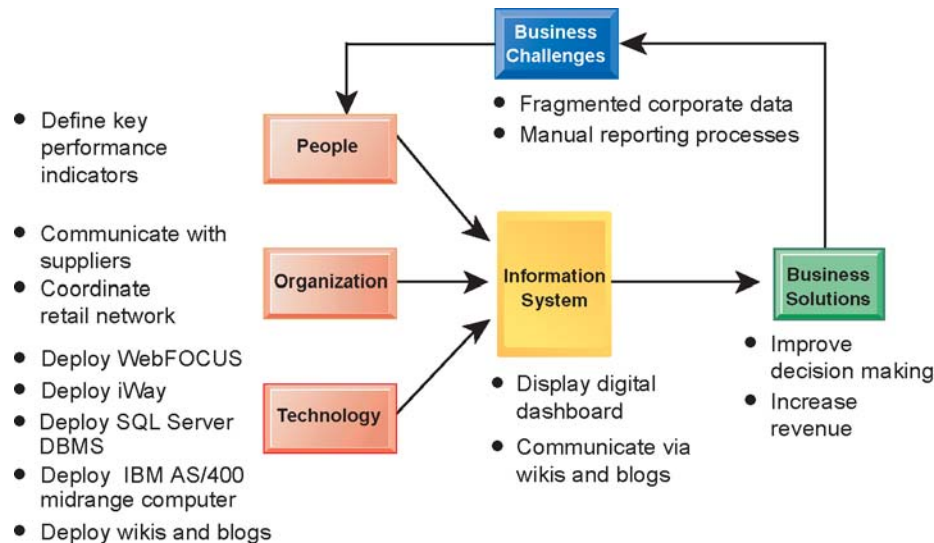
Longer term, EMS is planning for more detailed interactions with its suppliers. By sharing inventory and sales data with suppliers EMS will be able to quickly re-stock inventory to meet customer demand, while suppliers will know when to ramp up production.

Sources: Jeffrey Neville, "X-treme Web 2.0," *Optimize Magazine*, January 2007 and "Web 2.0's Wild Blue Yonder," *Information Week*, January 1/8, 2007; "Eastern Mountain Sports Forges a Trail to Merchandising Visibility," www.informationbuilders.com, accessed August 6, 2007.

Eastern Mountain Sports' executive dashboards are a powerful illustration of how information systems improve decision making. Management was unable to make good decisions about how and where to stock stores because the required data were scattered in many different systems and were difficult to access. Management reporting was excessively manual. Bad decisions about how to stock stores and warehouses increased operating costs and prevented EMS stores from responding quickly to customer needs.

EMS management could have continued to use its outdated management reporting system or implemented a large-scale enterprise-wide database and software, which would have been extremely expensive and time-consuming to complete. Instead, it opted for a business intelligence solution that could extract, consolidate, and analyze sales and merchandising data from its various legacy systems. It chose a platform from WebFOCUS because the tools were user-friendly and capable of pulling together data from many different sources.

The chosen solution populates a data mart with data from point-of-sale and legacy systems, and then pulls information from the data mart into a central series of executive dashboards visible to authorized users throughout the organization. Decision-makers can quickly access a unified high-level view of key performance indicators such as sales, inventory, and margin levels or drill down to obtain more detail about specific transactions. Increased availability of this information has helped EMS managers make better decisions about increasing sales, allocating resources, and propagating best practices.



HEADS UP

This chapter focuses on how business firms use information systems to improve decision making. Until the past decade, most businesses and their managers and employees operated in an information and knowledge fog, making decisions based on best guesses about the past and present, and making expensive errors in the process. Today, firms use a wide variety of information systems to directly improve decision making throughout the firm from the executive suite to the call center customer service representative, from the financial advisor's desk to the factory floor. Even customers are provided with systems to help them make better decisions. It would not be an overstatement to say that a primary contribution of information systems to business firms has been to improve decision making at all levels.

10.1 Decision Making and Information Systems

One of the main contributions of information systems has been to improve decision making, both for individuals and groups. Decision making in businesses used to be limited to management. Today, lower-level employees are responsible for some of these decisions, as information systems make information available to lower levels of the business. But what do we mean by better decision making? How does decision making take place in businesses and other organizations? Let's take a closer look.

BUSINESS VALUE OF IMPROVED DECISION MAKING

What does it mean to the business to be able to make a better decision? What is the monetary value to the business of better, improved decision making? Table 10.1 attempts to measure the monetary value of improved decision making for a small U.S. manufacturing firm with \$280 million in annual revenue and 140 employees. The firm has identified a number of key decisions where new system investments might improve the quality of decision making. The table provides selected estimates of annual value (in the form of cost savings or increased revenue) from improved decision making in selected areas of the business.

TABLE 10.1

Business Value of Enhanced Decision Making

Example Decision	Decision Maker	Number of Annual Decisions	Estimated Value to Firm of a Single Improved Decision	Annual Value
Allocate support to most valuable customers	Accounts manager	12	\$100,000	\$1,200,000
Predict call center daily demand	Call Center management	4	150,000	600,000
Decide parts inventory levels daily	Inventory manager	365	5,000	1,825,000
Identify competitive bids from major suppliers	Senior management	1	2,000,000	2,000,000
Schedule production to fill orders	Manufacturing manager	150	10,000	1,500,000
Allocate labor to complete a job	Production floor manager	100	4,000	400,000

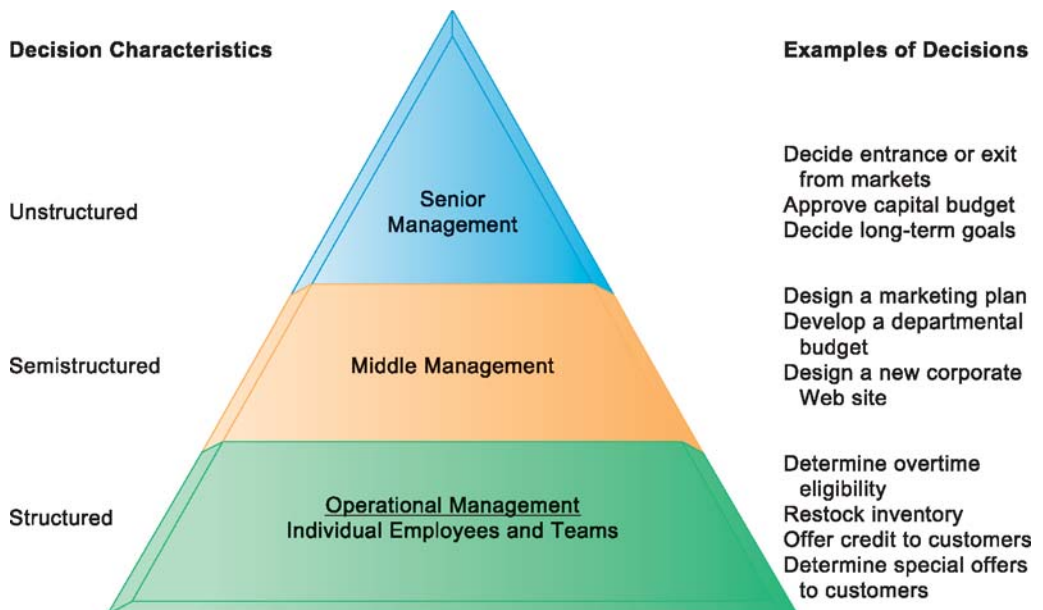
We can see from Table 10.1 that decisions are made at all levels of the firm, and that some of these decisions are common, routine, and numerous. Although the value of improving any single decision may be small, improving hundreds of thousands of “small” decisions adds up to a large annual value for the business.

TYPES OF DECISIONS

Chapter 2 showed that there are different levels in an organization. Each of these levels has different information requirements for decision support and responsibility for different types of decisions (see Figure 10-1). Decisions are classified as structured, semistructured, and unstructured.

Figure 10-1
Information Requirements of Key Decision-Making Groups in a Firm

Senior managers, middle managers, operational managers, and employees have different types of decisions and information requirements.



Unstructured decisions are those in which the decision maker must provide judgment, evaluation, and insight to solve the problem. Each of these decisions is novel, important, and nonroutine, and there is no well-understood or agreed-on procedure for making them.

Structured decisions, by contrast, are repetitive and routine, and they involve a definite procedure for handling them so that they do not have to be treated each time as if they were new. Many decisions have elements of both types of decisions and are **semistructured**, where only part of the problem has a clear-cut answer provided by an accepted procedure. In general, structured decisions are more prevalent at lower organizational levels, whereas unstructured problems are more common at higher levels of the firm.

Senior executives face many unstructured decision situations, such as establishing the firm's five- or ten-year goals or deciding new markets to enter. Answering the question "Should we enter a new market?" would require access to news, government reports, and industry views, as well as high-level summaries of firm performance. However, the answer would also require senior managers to use their own best judgment and poll other managers for their opinions.

Middle management faces more structured decision scenarios, but their decisions may include unstructured components. A typical middle-level management decision might be "Why is the reported order fulfillment showing a decline over the past six months at a distribution center in Minneapolis?" This middle manager could obtain a report from the firm's enterprise system or distribution management system on order activity and operational efficiency at the Minneapolis distribution center. This is the structured part of the decision. But before arriving at an answer, this middle manager will have to interview employees and gather more unstructured information from external sources about local economic conditions or sales trends.

Operational management and rank-and-file employees tend to make more structured decisions. For example, a supervisor on an assembly line has to decide whether an hourly paid worker is entitled to overtime pay. If the employee worked more than eight hours on a particular day, the supervisor would routinely grant overtime pay for any time beyond eight hours that was clocked on that day.

A sales account representative often has to make decisions about extending credit to customers by consulting the firm's customer database that contains credit information. If the customer met the firm's prespecified criteria for granting credit, the account representative would grant that customer credit to make a purchase. In both instances, the decisions are highly structured and are routinely made thousands of times each day in most large firms. The answer has been preprogrammed into the firm's payroll and accounts receivable systems.

THE DECISION-MAKING PROCESS

Making a decision is a multistep process. Simon (1960) described four different stages in decision making: intelligence, design, choice, and implementation (see Figure 10-2). These stages correspond to the four steps in problem-solving used throughout this book.

Intelligence consists of discovering, identifying, and understanding the problems occurring in the organization—why is there a problem, where, and what effects it is having on the firm.

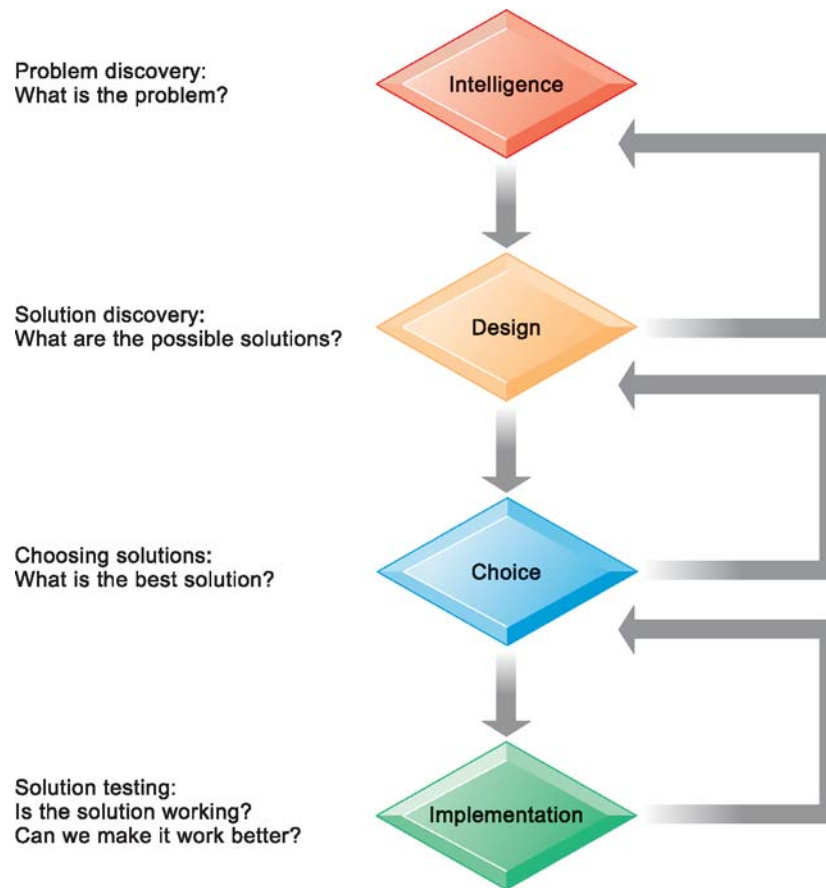
Design involves identifying and exploring various solutions to the problem.

Choice consists of choosing among solution alternatives.

Implementation involves making the chosen alternative work and continuing to monitor how well the solution is working.

What happens if the solution you have chosen does not work? Figure 10-2 shows that you can return to an earlier stage in the decision-making process and repeat it, if necessary. For instance, in the face of declining sales, a sales management team may decide to pay the sales force a higher commission for making more sales to spur on the sales effort. If this

Figure 10-2
Stages in Decision Making
 The decision-making process can be broken down into four stages.



does not produce sales increases, managers would need to investigate whether the problem stems from poor product design, inadequate customer support, or a host of other causes that call for a different solution.

QUALITY OF DECISIONS AND DECISION MAKING

How can you tell if a decision has become “better” or the decision-making process “improved?” Accuracy is one important dimension of quality: In general, we think decisions are “better” if they accurately reflect the real-world data. Speed is another dimension: We tend to think that the decision-making process should be efficient, even speedy. For instance, when you apply for car insurance, you want the decision making by the insurance firm to be fast and accurate. But there are many other dimensions of quality in decisions and the decision-making process to consider. Which is important for you will depend on the business firm where you work, the various parties involved in the decision, and your own personal values. Table 10.2 describes some quality dimensions for decision making. When we describe how systems “improve decisions and the decision-making process” in this chapter, we are referencing the dimensions in this table.

SYSTEMS AND TECHNOLOGIES FOR SUPPORTING DECISIONS

There are four kinds of systems for supporting the different levels and types of decisions we have just described. We introduced these systems in Chapter 2. *Management information systems (MIS)* deliver routine reports and summaries of transaction-level data to middle- and operational-level managers to provide answers to structured and

Quality Dimension	Description
Accuracy	Decision reflects reality
Comprehensiveness	Decision reflects a full consideration of the facts and circumstances
Fairness	Decision faithfully reflects the concerns and interests of affected parties
Speed (efficiency)	Decision making is efficient with respect to time and other resources, including the time and resources of affected parties, such as customers
Coherence	Decision reflects a rational process that can be explained to others and made understandable
Due process	Decision is the result of a known process and can be appealed to a higher authority

TABLE 10.2

Qualities of Decisions and the Decision-Making Process

semistructured decision problems. *Decision support systems (DSS)* provide analytical models or tools for analyzing large quantities of data and supportive interactive queries for middle managers who face semistructured decision situations. *Executive support systems (ESS)* are systems that provide senior management, making primarily unstructured decisions, with external information (news, stock analyses, and industry trends) and high-level summaries of firm performance. *Group decision-support systems (GDSS)* are specialized systems that provide a group electronic environment in which managers and teams can collectively make decisions and design solutions for unstructured and semistructured problems.

Decision making is also enhanced by intelligent techniques and knowledge management systems. **Intelligent techniques** consist of expert systems, case-based reasoning, genetic algorithms, neural networks, fuzzy logic, and intelligent agents. These technologies aid decision makers by capturing individual and collective knowledge, discovering patterns and behaviors in very large quantities of data, and generating solutions to problems that are too large and complex for human beings to solve on their own.

Knowledge management systems, which we introduced in Chapter 2, and knowledge work systems provide tools for knowledge discovery, communication, and collaboration that make knowledge more easily available to decision makers and integrate it into the business processes of the firm.

10.2 Systems for Decision Support

Exactly how do these different types of systems for supporting decisions affect a business? What can today's decision-support systems do for a business? Let's look more closely at how each major type of decision-support system works and provides value.

MANAGEMENT INFORMATION SYSTEMS (MIS)

Management information systems (MIS), which we introduced in Chapter 2, help managers monitor and control the business by providing information on the firm's performance. They typically produce fixed, regularly scheduled reports based on data extracted and summarized from the firm's underlying transaction processing systems (TPS). The formats for these reports are often specified in advance. A typical MIS report might show a summary of monthly or annual sales for each of the major sales territories of a company. Sometimes,

TABLE 10.3**Examples of MIS Applications**

Company	MIS Application
California Pizza Kitchen	Inventory Express application “remembers” each restaurant’s ordering patterns and compares the amount of ingredients used per menu item to predefined portion measurements established by management. The system identifies restaurants with out-of-line portions and notifies their managers so that corrective actions can be taken.
PharMark	Extranet MIS identifies patients with drug-use patterns that place them at risk for adverse outcomes.
Black & Veatch	Intranet MIS tracks construction costs for various projects across the United States.
Taco Bell	Total Automation of Company Operations (TACO) system provides information on food, labor, and period-to-date costs for each restaurant.

MIS reports are exception reports, highlighting only exceptional conditions, such as when the sales quotas for a specific territory fall below an anticipated level or employees have exceeded their spending limits in a dental care plan.

Traditional MIS produce primarily hard-copy reports. Today, many of these reports are available online through an intranet, and more MIS reports can be generated on demand. Table 10.3 provides some examples of MIS applications.

DECISION-SUPPORT SYSTEMS (DSS)

Whereas MIS primarily address structured problems, DSS support semistructured and unstructured problem analysis. The earliest DSS were heavily model driven, using some type of model to perform “what-if” and other kinds of analyses. In a “what if” analysis, a model is developed, various input factors are changed, and the output changes are measured (see the following section). DSS analysis capabilities were based on a strong theory or model combined with a good user interface that made the system easy to use.

The Interactive Session on People describes a model-driven DSS. In this particular case, the system did not perform as well as expected because of the assumptions driving the model and user efforts to circumvent the system. As you read this case, try to identify the problem these companies were facing, what alternative solutions were available to management, and how well the chosen solution worked.

Some contemporary DSS are data driven, using online analytical processing (OLAP) and data mining to analyze large pools of data in major corporate systems. The business intelligence applications described in Chapter 5 are examples of these data-driven DSS. They support decision making by enabling users to extract useful information that was previously buried in large quantities of data.

For example, Compass Bank, a leading financial holding company with 376 banking centers and more than \$28 billion in assets, uses a data-driven DSS to help it minimize default risk in its credit card business. The system analyzes the relationship between a customer’s checking and savings account activity and that person’s credit card default risk. The system is able to pull together and analyze 13 months of detailed data from multiple databases to flag customer accounts in danger of defaulting.

INTERACTIVE SESSION: PEOPLE**Too Many Bumped Fliers: Why?**

In a seemingly simpler and less hectic time, overbooked flights presented an opportunity. Frequent travelers regularly and eagerly chose to give up their seats and delay their departures by a few hours in exchange for rewards such as a voucher for a free ticket.

Today, fewer people are volunteering to give up their seats for a flight because there are fewer and fewer seats to be bumped to. Airlines are struggling to stay in business and look to save costs wherever possible. They are scheduling fewer flights and those flights are more crowded. Instead of delaying his or her trip by a few hours, a passenger that accepts a voucher for being bumped may have to wait several days before a seat becomes available on another flight. And passengers are being bumped from flights involuntarily more often.

Airlines routinely overbook flights to compensate for the millions of no-shows that cut into expected revenue. The purpose of overbooking is not to leave passengers without a seat but to come as close as possible to filling every seat on every flight. The revenue lost from an empty seat is much greater than the costs of compensating a bumped passenger. Airlines are much closer today to filling every seat on flights than at any point in their history. The problem is, the most popular routes often sell out, so bumped passengers may be stranded for days.

The airlines do not approach overbooking haphazardly. They employ young, sharp minds with backgrounds in math and economics as analysts. The analysts use computer modeling to predict how many passengers will fail to show up for a flight. They recommend overbooking based on the numbers generated by the software.

The software used by US Airways, for example, analyzes the historical record of no-shows on flights and looks at the rate at every fare level available. The lowest-priced fares are generally nonrefundable, and passengers at those fare levels tend to carry their reservations through. Business travelers with the high-priced fares no-show more often. The software examines the fares people are booking on each upcoming flight and takes other data into account, such as the rate of no-shows on flights originating from certain geographic regions. Analysts then predict the number of no-shows on a particular flight, based on which fares passengers have booked, and overbook the flight accordingly.

Of course, the analysts do not always guess correctly. And their efforts can be hampered by a number of factors. Ticket agents report that faulty

computer algorithms result in miscalculations. Changes in weather can introduce unanticipated weight restrictions. Sometimes a smaller plane is substituted for the scheduled plane. All of these circumstances result in fewer seats being available for the same number of passengers, which might have been set too high already.

Regardless of how much support the analysts have from airline management, gate attendants complain because they are the ones who receive the brunt of overbooked passengers' wrath. Attendants have been known to call in sick to avoid dealing with the havoc caused by overbooked flights.

Some gate attendants have gone as far as creating phony reservations, sometimes in the names of airline executives or cartoon characters, such as Mickey Mouse, in an effort to stop analysts from overbooking. This tactic may save the attendants some grief in the short term, but their actions often come back to haunt them. The modeling software counts the phony reservations as no-shows, which leads the analysts to overbook the flight even more the next time. Thomas Trenga, vice president for revenue management at US Airways, refers to this game of chicken as "the death spiral." US Airways discourages the practice of entering phony reservations.

With fewer passengers volunteering to accept vouchers, tensions can escalate. The number of passengers bumped involuntarily in 2006 rose 23 percent from the previous year and has continued to rise. The encouraging statistic is that only 676,408 of the 555 million people who flew in 2006 were bumped, voluntarily or involuntarily.

W. Douglas Parker, CEO of US Airways, says that airlines have to overbook their flights as long as they allow passengers to no-show without penalty. US Airways has a no-show rate of between 7 and 8 percent. The airline's revenue in 2006 was \$11.56 billion. US Airways claims that overbooking contributed to at least \$1 billion of that revenue. With a profit of only \$304 million, that extra revenue becomes critical to the survival of the business. Some airlines, such as JetBlue, have avoided the overbooking controversy by offering only nonrefundable tickets. No-shows cannot reclaim the price of their tickets. Business travelers often buy the most expensive seats, but also want the flexibility of refundable tickets, so JetBlue is considering a change in its policy.

The airlines are supposed to hold their analysts accountable for their work, but they are rarely subject to critical review. Some analysts make an effort to accommodate the wishes of the airport workers by

finding a compromise in the overbooking rate. Unfortunately, analysts often leave their jobs for new challenges once they become proficient at overbooking.

Sources: Jeff Bailey, “Bumped Fliers and Plan B,” *The New York Times*, May 30, 2007; Alice LaPlante, “Travel Problems? Blame Technology,” *InformationWeek.com*, June 11, 2007; Noelle Phillips, “More Fliers, Fewer Flights Mean More Bumping,” *TheState.com*, May 31, 2007; and “When Airlines Do the Bump, You Can Push Back,” *oregister.com*, June 10, 2007.

CASE STUDY QUESTIONS

1. Is the decision support system being used by airlines to overbook flights working well? Answer from the perspective of the airlines and from the perspective of customers.
2. What is the impact on the airlines if they are bumping too many passengers?
3. What are the inputs, processes, and outputs of this DSS?
4. What people, organization, and technology factors are responsible for excessive bumping problems?
5. How much of this is a “people” problem? Explain your answer.

MIS IN ACTION

Visit the Web sites for US Airways, JetBlue, and Continental. Search the sites to answer the following questions:

1. What is the policy of each of these airlines for dealing with involuntary refunds (overbookings)? (Hint: these matters are often covered in the Contract of Carriage.)
2. In your opinion, which airline has the best policy? What makes this policy better than the others?
3. How are each of these policies intended to benefit customers? How do they benefit the airlines?

Components of DSS

Figure 10-3 illustrates the components of a DSS. They include a database of data used for query and analysis; a software system with models, data mining, and other analytical tools; and a user interface.

The **DSS database** is a collection of current or historical data from a number of applications or groups. It may be a small database residing on a PC that contains a subset of corporate data that has been downloaded and possibly combined with external data. Alternatively, the DSS database may be a massive data warehouse that is continuously updated by major corporate TPS (including enterprise systems and data generated by Web site transactions). The data in DSS databases are generally extracts or copies of production databases so that using the DSS does not interfere with critical operational systems.

The **DSS software system** contains the software tools that are used for data analysis. It may contain various OLAP tools, data mining tools, or a collection of mathematical and analytical models that easily can be made accessible to the DSS user. A **model** is an abstract representation that illustrates the components or relationships of a phenomenon. A model can be a physical model (such as a model airplane), a mathematical model (such as an equation), or a verbal model (such as a description of a procedure for writing an order).

Statistical modeling helps establish relationships, such as relating product sales to differences in age, income, or other factors between communities. Optimization models determine optimal resource allocation to maximize or minimize specified variables, such as cost or time. A classic use of optimization models is to determine the proper mix of products within a given market to maximize profits. P&G uses optimization models to determine how to maximize its return on investment from the organization of its supply chain.

Forecasting models often are used to forecast sales. The user of this type of model might supply a range of historical data to project future conditions and the sales that might result

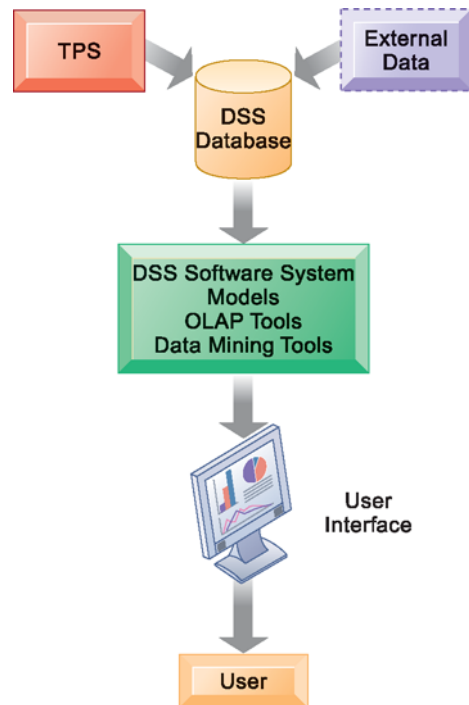


Figure 10-3
Overview of a Decision-Support System

The main components of the DSS are the DSS database, the DSS software system, and the user interface. The DSS database may be a small database residing on a PC or a large data warehouse.

from those conditions. The decision maker could vary those future conditions (entering, for example, a rise in raw materials costs or the entry of a new, low-priced competitor in the market) to determine how new conditions might affect sales.

Sensitivity analysis models ask “what-if” questions repeatedly to determine the impact on outcomes of changes in one or more factors. *What-if analysis*—working forward from known or assumed conditions—allows the user to vary certain values to test results to better predict outcomes if changes occur in those values. What happens if we raise product price by 5 percent or increase the advertising budget by \$100,000? What happens if we keep the price and advertising budgets the same? Spreadsheet software, such as Microsoft Excel, is often used for this purpose (see Figure 10-4). Backward sensitivity analysis software helps decision makers with goal seeking: If I want to sell one million product units next year, how much must I reduce the price of the product?

The DSS user interface permits easy interaction between users of the system and the DSS software tools. Many DSS today have Web interfaces to take advantage of graphic displays, interactivity, and ease of use.

Total fixed costs	19000				
Variable cost per unit	3				
Average sales price	17				
Contribution margin	14				
Break-even point	1357				
		Variable Cost per Unit			
Sales	1357	2	3	4	5
Price	14	1583	1727	1900	2111
	15	1462	1583	1727	1900
	16	1357	1462	1583	1727
	17	1267	1357	1462	1583
	18	1188	1267	1357	1462
					6
					2375
					2111
					1900
					1727
					1583
					1462
					1267
					1188

Figure 10-4
Sensitivity Analysis

This table displays the results of a sensitivity analysis of the effect of changing the sales price of a necktie and the cost per unit on the product’s break-even point. It answers the question, “What happens to the break-even point if the sales price and the cost to make each unit increase or decrease?”

Using Spreadsheet Pivot Tables to Support Decision Making

Managers also use spreadsheets to identify and understand patterns in business information. For instance, let's take a look at one day's worth of transactions at an online firm Online Management Training Inc. (OMT Inc.) that sells online management training videos and books to corporations and individuals who want to improve their management techniques. On a single day the firm experienced 517 order transactions. Figure 10-5 shows the first 25 records of transactions produced at the firm's Web site on that day. The names of customers and other identifiers have been removed from this list.

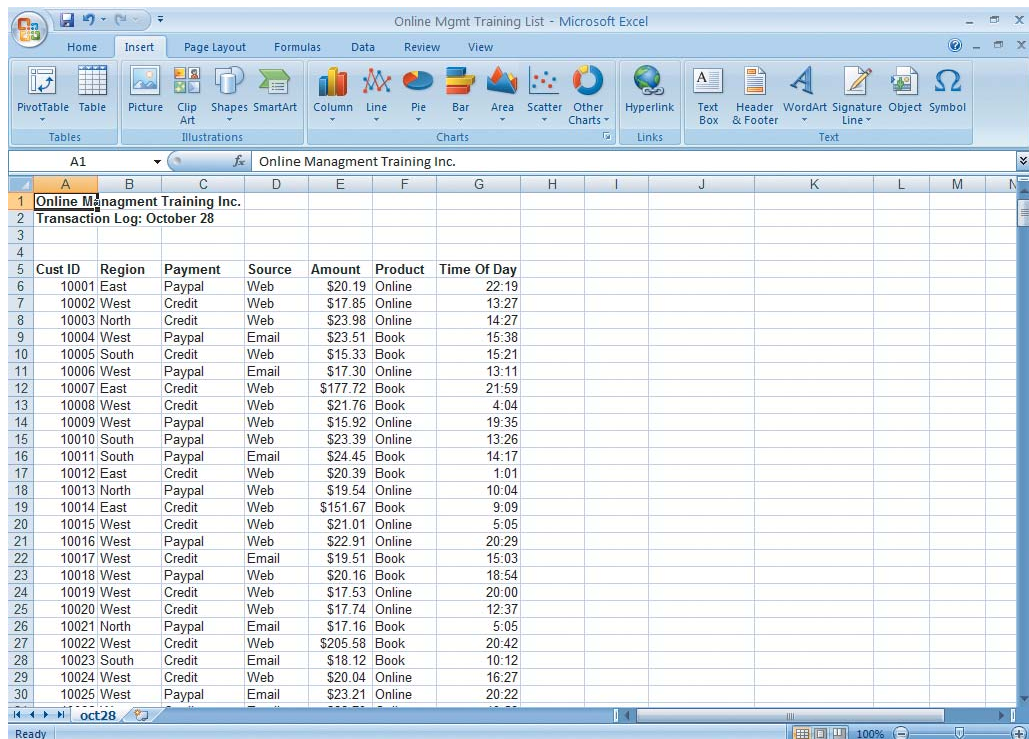
You can think of this list as a database composed of transaction records (the rows). The fields (column headings) for each customer record are: customer ID, region of purchase, payment method, source of contact (e-mail versus Web banner ad), amount of purchase, the product purchased (either online training or a book), and time of day (in 24 hour time).

There is a great deal of valuable information in this transaction list that could help managers answer important questions and make important decisions:

- Where do most of our customers come from? The answer might tell managers where to spend more marketing resources or to initiate new marketing efforts.
- Are there regional differences in the sources of our customers? Perhaps in some regions, e-mail is the most effective marketing tool, whereas in other regions, Web banner ads are more effective. The answer to this more complicated question could help managers develop a regional marketing strategy.
- Where are the average purchases higher? The answer might tell managers where to focus marketing and sales resources or to pitch different messages to different regions.
- What form of payment is the most common? The answer could be used to emphasize in advertising the most preferred means of payment.
- Are there any times of day when purchases are most common? Do people buy products while at work (likely during the day) or at home (likely in the evening)?
- Are there regional differences in the average purchase? If one region is much more lucrative, managers could focus their marketing and advertising resources on that region.

Figure 10-5
Sample List of
Transactions for
Online Management
Training Inc.

*This list shows a portion
of the order transactions
for Online Management
Training Inc. on
October 28, 2007.*



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Online Management Training Inc.													
2	Transaction Log: October 28													
3														
4														
5	Cust ID	Region	Payment	Source	Amount	Product	Time Of Day							
6	10001	East	Paypal	Web	\$20.19	Online	22:19							
7	10002	West	Credit	Web	\$17.85	Online	13:27							
8	10003	North	Credit	Web	\$23.98	Online	14:27							
9	10004	West	Paypal	Email	\$23.51	Book	15:38							
10	10005	South	Credit	Web	\$15.33	Book	15:21							
11	10006	West	Paypal	Email	\$17.30	Online	13:11							
12	10007	East	Credit	Web	\$177.72	Book	21:59							
13	10008	West	Credit	Web	\$21.76	Book	4:04							
14	10009	West	Paypal	Web	\$15.92	Online	19:35							
15	10010	South	Paypal	Web	\$23.39	Online	13:26							
16	10011	South	Paypal	Email	\$24.45	Book	14:17							
17	10012	East	Credit	Web	\$20.39	Book	1:01							
18	10013	North	Paypal	Web	\$19.54	Online	10:04							
19	10014	East	Credit	Web	\$151.67	Book	9:09							
20	10015	West	Credit	Web	\$21.01	Online	5:05							
21	10016	West	Paypal	Web	\$22.91	Online	20:29							
22	10017	West	Credit	Email	\$19.51	Book	15:03							
23	10018	West	Paypal	Web	\$20.16	Book	18:54							
24	10019	West	Credit	Web	\$17.53	Online	20:00							
25	10020	West	Credit	Web	\$17.74	Online	12:37							
26	10021	North	Paypal	Email	\$17.16	Book	5:05							
27	10022	West	Credit	Web	\$205.58	Book	20:42							
28	10023	South	Credit	Email	\$18.12	Book	10:12							
29	10024	West	Credit	Web	\$20.04	Online	16:27							
30	10025	West	Paypal	Email	\$23.21	Online	20:22							

Notice that these questions often involve multiple dimensions: region and average purchase; time of day and average purchase; payment type and average purchase; and region, source of customer, and purchase. Also, some of the dimensions are categorical, such as payment type, region, and source. If the list were small, you could simply inspect the list and find patterns in the data. But this is impossible when you have a list of over 500 transactions.

Fortunately, the spreadsheet pivot table provides a powerful tool for answering such questions using large data sets. A **pivot table** is a table that displays two or more dimensions of data in a convenient format. Microsoft Excel's PivotTable capability makes it easy to analyze lists and databases by automatically extracting, organizing, and summarizing the data.

For instance, let's take the first question, "Where do our customers come from?" We will start with region and ask the question "How many customers come from each region?" To find the answer using Excel 2007, you would create a pivot table by selecting the range of data, fields you want to analyze, and a location for the PivotTable report, as illustrated in Figure 10-6. The pivot table shows most customers come from the Western region.

Does the source of the customer make a difference in addition to region? We have two sources of customers: e-mail campaigns and online banner advertising. In a few seconds, you can find the answer shown in Figure 10-7. The pivot table shows that Web banner advertising produces most of the customers, and this is true of all the regions.

You can use pivot tables to answer all the questions we have posed about the Online Management Training data. The complete Excel file for these examples is available on our companion Web site. The Hands-On MIS section of this chapter asks you to find answers to a number of other questions regarding this data file.

Data Visualization and Geographic Information Systems

Data from information systems can be made easier for users to digest and act on by using graphics, charts, tables, maps, digital images, three-dimensional presentations, animations, and other data visualization technologies. By presenting data in graphical form, **data visualization** tools help users see patterns and relationships in large amounts of data that would be difficult to discern if the data were presented as traditional lists of text.

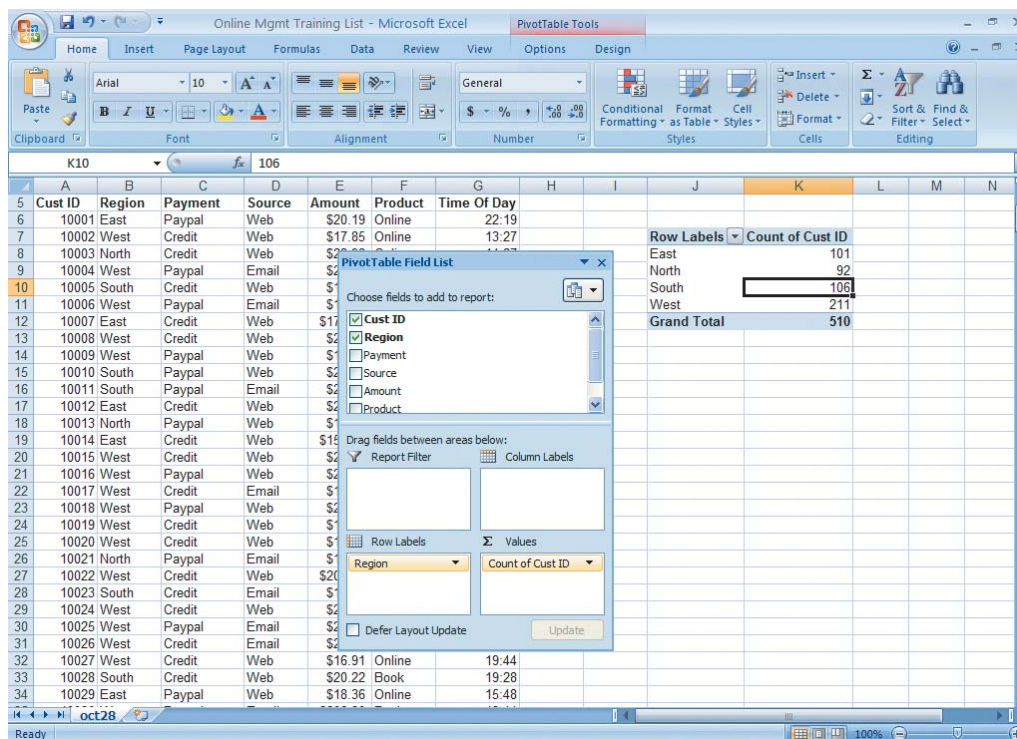
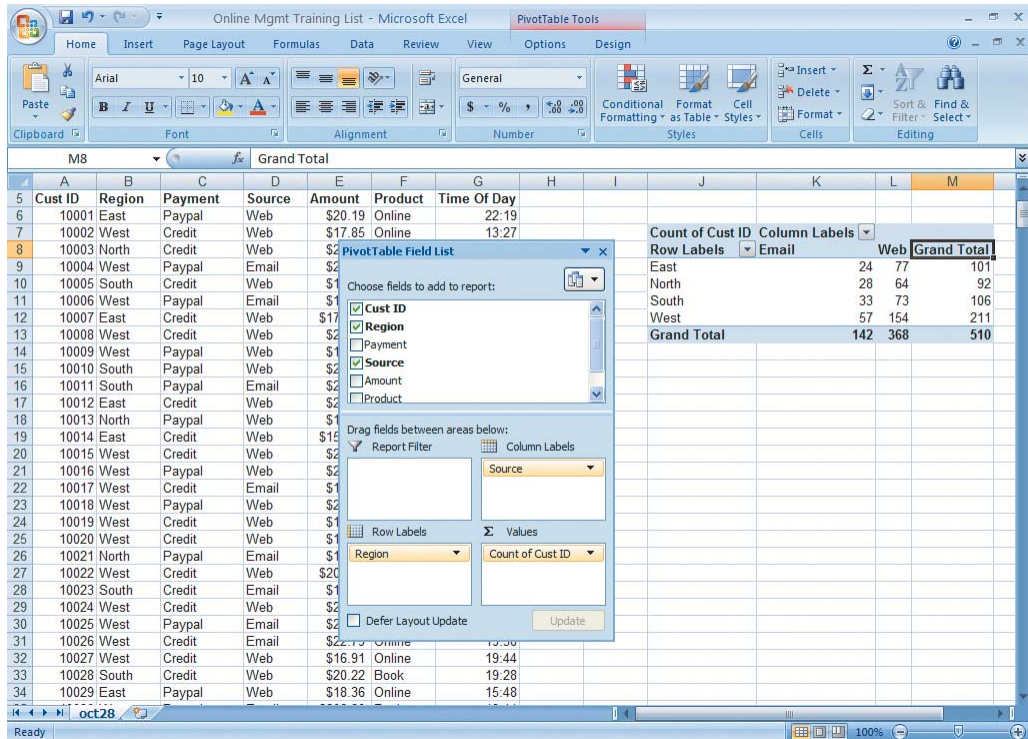


Figure 10-6
A Pivot Table That Determines the Regional Distribution of Customers
This pivot table was created using Excel 2007 to quickly produce a table showing the relationship between region and number of customers.

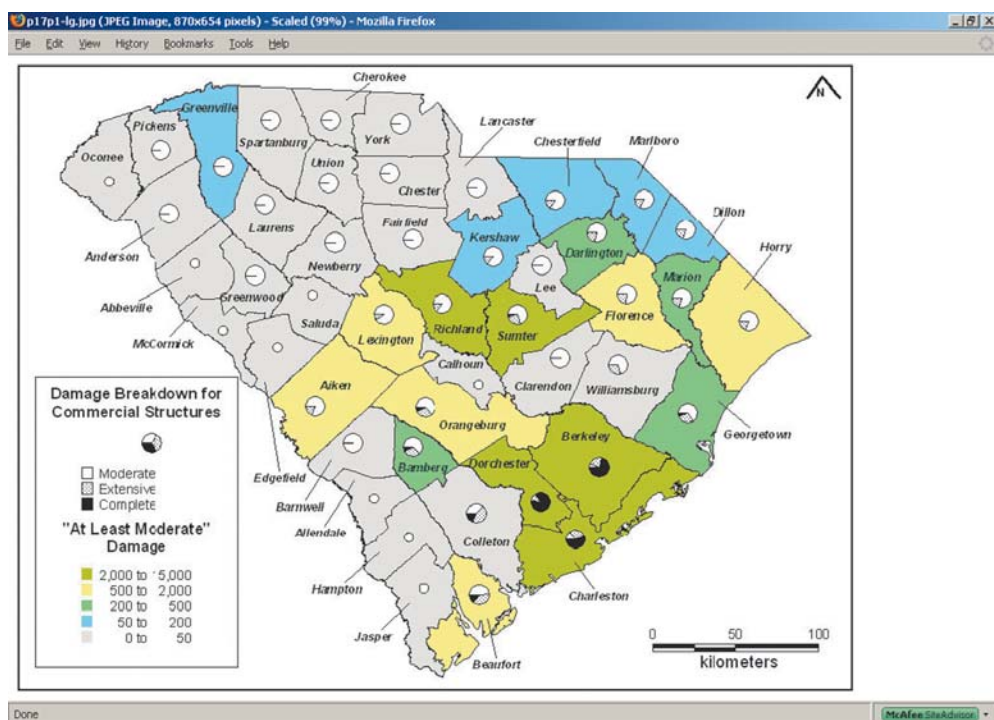
Figure 10-7
A Pivot Table that Examines Customer Regional Distribution and Advertising Source

In this pivot table, we can examine where customers come from in terms of region and advertising source. It appears nearly 30 percent of the customers respond to e-mail campaigns, and there are some regional variations.



Geographic information systems (GIS) are a special category of DSS that use data visualization technology to analyze and display data for planning and decision making in the form of digitized maps. The software assembles, stores, manipulates, and displays geographically referenced information, tying data to points, lines, and areas on a map. GIS have modeling capabilities, enabling managers to change data and automatically revise business scenarios.

South Carolina used a GIS-based program called HAZUS to estimate and map the regional damage and losses resulting from an earthquake of a given location and intensity. HAZUS estimates the degree and geographic extent of earthquake damage across the state based on inputs of building use, type, and construction materials. The GIS helps the state plan for natural hazards mitigation and response.



GIS support decisions that require knowledge about the geographic distribution of people or other resources. For example, GIS might be used to help state and local governments calculate emergency response times to natural disasters, to help retail chains identify profitable new store locations, or to help banks identify the best locations for installing new branches or automatic teller machine (ATM) terminals.

Web-Based Customer Decision-Support Systems

DSS based on the Web and the Internet support decision making by providing online access to various databases and information pools along with software for data analysis. **Customer decision-support systems (CDSS)** support the decision-making process of an existing or potential customer.

People interested in purchasing a product or service can use Internet search engines, intelligent agents, online catalogs, Web directories, newsgroup discussions, e-mail, and other tools to help them locate the information they need to help with their decision. Companies have developed specific customer Web sites where all the information, models, or other analytical tools for evaluating alternatives are concentrated in one location. Web-based DSS have become especially popular in the financial services area because so many people are trying to manage their own assets and retirement savings. For example, the T. Rowe Price Web site offers a series of online tools and planning guides for college planning, retirement planning, investment planning, tax planning, and estate planning.

EXECUTIVE SUPPORT SYSTEMS

If you were a senior executive and you wanted a picture of the overall performance of your firm, where would you find that information? You would turn to an executive support system. Executive support systems (ESS), which we introduced in Chapter 2, help solve unstructured and semistructured problems by focusing on the information needs of senior management. Contemporary ESS bring together data from many different internal and external sources, including data from the Web, often through a portal. These systems provide easy-to-use analytical tools and online displays to help users select, access, and tailor the data as needed.

You can think of ESS as generalized computing, communications, and graphic systems that, similar to a zoom lens, can focus quickly on detailed problems or retract back for a broad view of the company. ESS have a capability to **drill down**, moving from a piece of summary data to lower and lower levels of detail. Some display a high-level view of firm performance in the form of a digital dashboard. A **digital dashboard**, or “executive dashboard,” displays on a single screen all of the critical measurements for piloting a company, similar to the cockpit of an airplane or an automobile dashboard. The dashboard presents key performance indicators as graphs and charts, providing a one-page overview of all the critical measurements necessary to make key executive decisions. The EMS dashboards described in the chapter-opening case are an example.

ESS help senior executives monitor organizational performance, track activities of competitors, identify changing market conditions, spot problems, identify opportunities, and forecast trends. Employees lower down in the corporate hierarchy also use these systems to monitor and measure business performance in their areas of responsibility.

GROUP DECISION-SUPPORT SYSTEMS

The systems we have just described focus primarily on helping you make a decision acting alone. But what if you are part of a team and need to make a decision as a group? You would use a special category of systems called group decision-support systems (GDSS) for this purpose.

A **group decision-support system (GDSS)** is an interactive computer-based system for facilitating the solution of unstructured problems by a set of decision makers working together as a group in the same location or in different locations. Groupware and

Web-based tools for videoconferencing and electronic meetings described earlier in this text support some group decision processes, but their focus is primarily on communication. GDSS, however, provide tools and technologies geared explicitly toward group decision making.

GDSS-guided meetings take place in conference rooms with special hardware and software tools to facilitate group decision making. The hardware includes computer and networking equipment, overhead projectors, and display screens. Special electronic meeting software collects, documents, ranks, edits, and stores the ideas offered in a decision-making meeting. The more elaborate GDSS use a professional facilitator and support staff. The facilitator selects the software tools and helps organize and run the meeting.

A sophisticated GDSS provides each attendee with a dedicated desktop computer under that person's individual control. No one will be able to see what individuals do on their computers until those participants are ready to share information. Their input is transmitted over a network to a central server that stores information generated by the meeting and makes it available to all on the meeting network. Data can also be projected on a large screen in the meeting room.

GDSS make it possible to increase meeting size while at the same time increasing productivity because individuals contribute simultaneously rather than one at a time. A GDSS promotes a collaborative atmosphere by guaranteeing contributors' anonymity so that attendees can focus on evaluating the ideas themselves without fear of personally being criticized or of having their ideas rejected based on the contributor. GDSS software tools follow structured methods for organizing and evaluating ideas and for preserving the results of meetings, enabling nonattendees to locate needed information after the meeting. GDSS effectiveness depends on the nature of the problem and the group and on how well a meeting is planned and conducted.

10.3 Intelligent Systems for Decision Support

A number of intelligent techniques for enhancing decision making are based on **artificial intelligence (AI)** technology, which consists of computer-based systems (both hardware and software) that attempt to emulate human behavior and thought patterns. These techniques include expert systems, case-based reasoning, fuzzy logic, neural networks, genetic algorithms, and intelligent agents.

EXPERT SYSTEMS

What if employees in your firm had to make decisions that required some special knowledge, such as how to formulate a fast-drying sealing compound or how to diagnose and repair a malfunctioning diesel engine, but all the people with that expertise had left the firm? Expert systems are one type of decision-making aid that could help you out. An **expert system** captures human expertise in a limited domain of knowledge as a set of rules in a software system that can be used by others in the organization. These systems typically perform a limited number of tasks that can be performed by professionals in a few minutes or hours, such as diagnosing a malfunctioning machine or determining whether to grant credit for a loan. They are useful in decision-making situations where expertise is expensive or in short supply.

How Expert Systems Work

Human knowledge must be modeled or represented in a form that a computer can process. Expert systems model human knowledge as a set of rules that collectively are called the **knowledge base**. Expert systems can have from 200 to as many as 10,000 of these rules, depending on the complexity of the decision-making problem. These rules are much more interconnected and nested than in a traditional software program (see Figure 10-8).

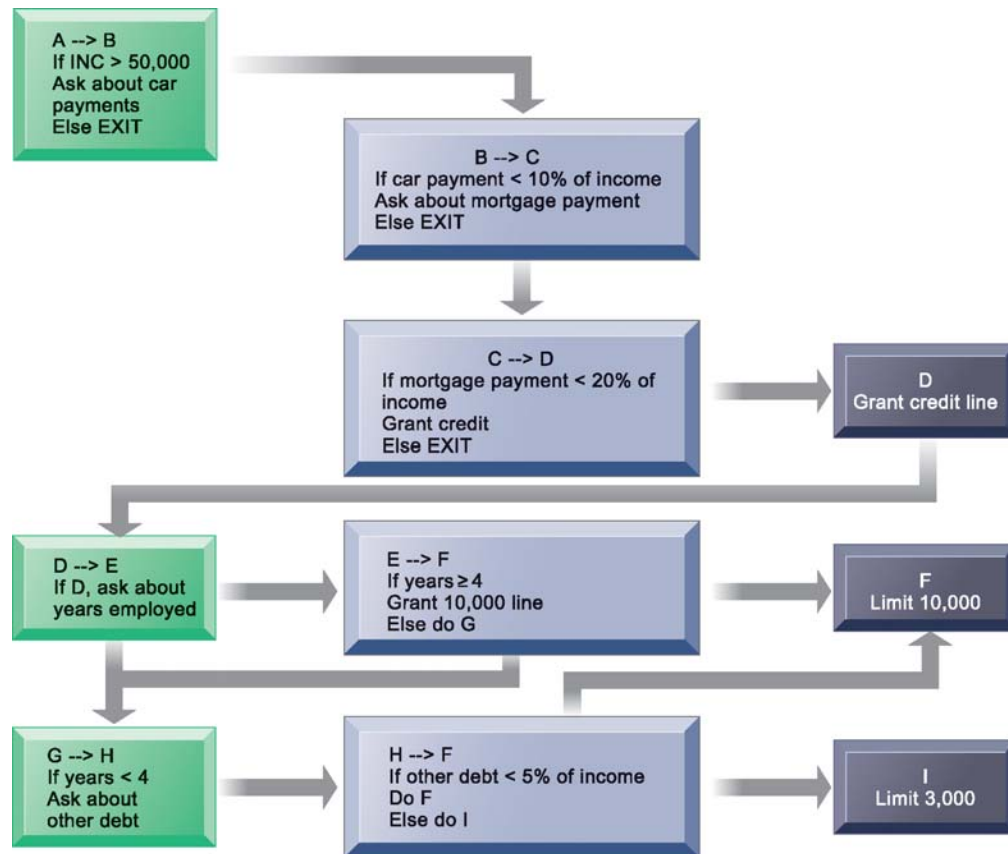


Figure 10-8
Rules in an Expert System

An expert system contains a set of rules to be followed when used. The rules are interconnected; the number of outcomes is known in advance and is limited; there are multiple paths to the same outcome; and the system can consider multiple rules at a single time. The rules illustrated are for a simple credit-granting expert system.

The strategy used to search through the collection of rules and formulate conclusions is called the **inference engine**. The inference engine works by searching through the rules and “firing” those rules that are triggered by facts gathered and entered by the user.

Expert systems provide businesses with an array of benefits, including improved decisions, reduced errors, reduced costs, reduced training time, and improved quality and service. For example, Con-Way Transportation built an expert system called Line-haul to automate and optimize planning of overnight shipment routes for its nationwide freight-trucking business. The expert system captures the business rules that dispatchers follow when assigning drivers, trucks, and trailers to transport 50,000 shipments of heavy freight each night across 25 U.S. states and Canada and when plotting their routes. Line-haul runs on a Sun platform and uses data on daily customer shipment requests, available drivers, trucks, trailer space, and weight stored in an Oracle database. The expert system uses thousands of rules and 100,000 lines of program code written in C++ to crunch the numbers and create optimum routing plans for 95 percent of daily freight shipments. Con-Way dispatchers tweak the routing plan provided by the expert system and relay final routing specifications to field personnel responsible for packing the trailers for their nighttime runs. Con-Way recouped its \$3 million investment in the system within two years by reducing the number of drivers, packing more freight per trailer, and reducing damage from rehandling. The system also reduces dispatchers’ arduous nightly tasks (Pastore, 2003).

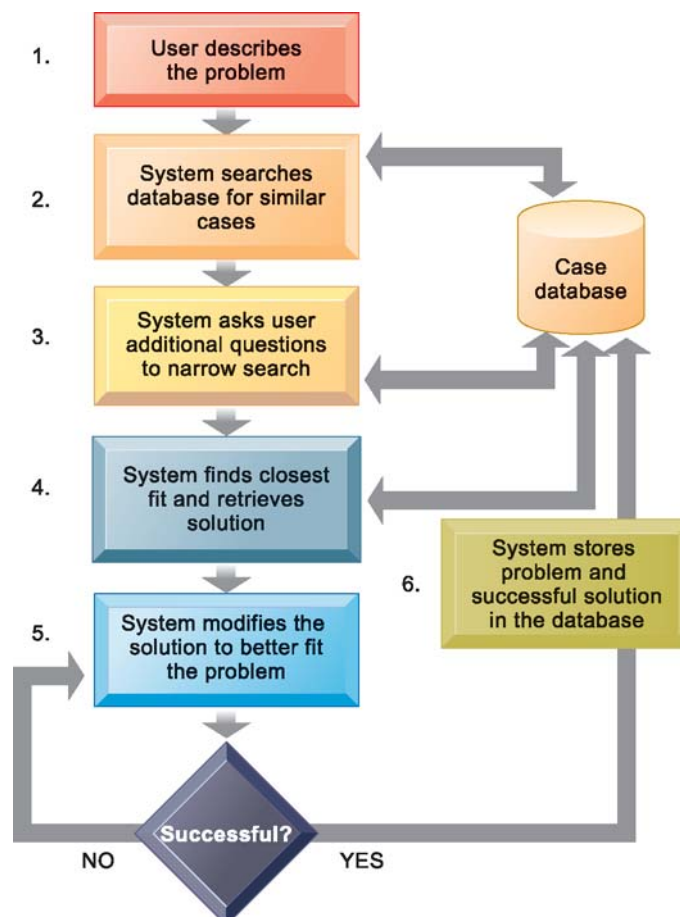
Although expert systems lack the robust and general intelligence of human beings, they can provide benefits to organizations if their limitations are well understood. Only certain classes of problems can be solved using expert systems. Virtually all successful expert systems deal with problems of classification in which there are relatively few alternative outcomes and in which these possible outcomes are all known in advance. Expert systems are much less useful for dealing with unstructured problems typically encountered by managers.

CASE-BASED REASONING

Expert systems primarily capture the knowledge of individual experts, but organizations also have collective knowledge and expertise that they have built up over the years. This organizational knowledge can be captured and stored using case-based reasoning. In **case-based reasoning (CBR)**, knowledge and past experiences of human specialists are represented as cases and stored in a database for later retrieval when the user encounters a new case with similar parameters. The system searches for stored cases with problem characteristics similar to the new one, finds the closest fit, and applies the solutions of the old case to the new case. Successful solutions are tagged to the new case and both are stored together with the other cases in the knowledge base. Unsuccessful solutions also are appended to the case database along with explanations as to why the solutions did not work (see Figure 10-9).

You'll find case-based reasoning in diagnostic systems in medicine or customer support where users can retrieve past cases whose characteristics are similar to the new case. The system suggests a solution or diagnosis based on the best-matching retrieved case.

Figure 10-9
How Case-Based Reasoning Works
Case-based reasoning represents knowledge as a database of past cases and their solutions. The system uses a six-step process to generate solutions to new problems encountered by the user.



FUZZY LOGIC SYSTEMS

Most people do not think in terms of traditional IF-THEN rules or precise numbers. Humans tend to categorize things imprecisely, using rules for making decisions that may have many shades of meaning. For example, a man or a woman may be *strong* or *intelligent*. A company may be *large*, *medium*, or *small* in size. Temperature may be *hot*, *cold*, *cool*, or *warm*. These categories represent a range of values.

Fuzzy logic is a rule-based technology that represents such imprecision by creating rules that use approximate or subjective values. It describes a particular phenomenon or process linguistically and then represents that description in a small number of flexible rules.

Let's look at the way fuzzy logic would represent various temperatures in a computer application to control room temperature automatically. The terms (known as *membership functions*) are imprecisely defined so that, for example, in Figure 10-10, cool is between 45 degrees and 70 degrees, although the temperature is most clearly cool between about 60 degrees and 67 degrees. Note that *cool* is overlapped by *cold* or *norm*. To control the room environment using this logic, the programmer would develop similarly imprecise definitions for humidity and other factors, such as outdoor wind and temperature. The rules might include one that says, "If the temperature is *cool* or *cold* and the humidity is low while the outdoor wind is high and the outdoor temperature is low, raise the heat and humidity in the room." The computer would combine the membership function readings in a weighted manner and, using all the rules, raise and lower the temperature and humidity.

Fuzzy logic provides solutions to problems requiring expertise that is difficult to represent in the form of crisp IF-THEN rules. In Japan, Sendai's subway system uses fuzzy logic controls to accelerate so smoothly that standing passengers need not hold on. Fuzzy logic allows incremental changes in inputs to produce smooth changes in outputs instead of discontinuous ones, making it useful for consumer electronics and engineering applications.

NEURAL NETWORKS

Neural networks are used for solving complex, poorly understood problems for which large amounts of data have been collected. They find patterns and relationships in massive amounts of data that would be too complicated and difficult for a human being

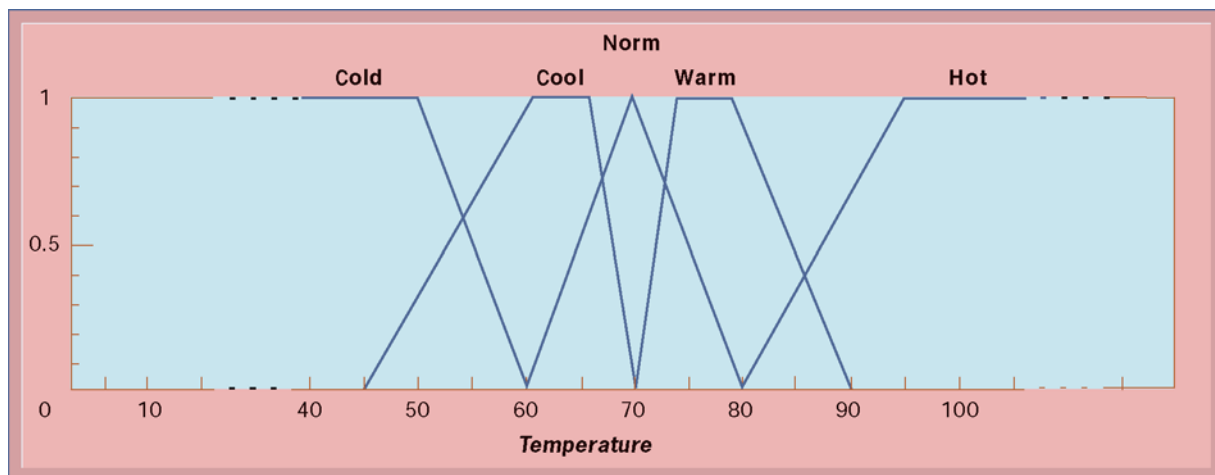


Figure 10-10
Fuzzy Logic for Temperature Control

The membership functions for the input called temperature are in the logic of the thermostat to control the room temperature. Membership functions help translate linguistic expressions, such as warm, into numbers that the computer can manipulate

to analyze. Neural networks discover this knowledge by using hardware and software that parallel the processing patterns of the biological or human brain. Neural networks “learn” patterns from large quantities of data by sifting through data, searching for relationships, building models, and correcting over and over again the model’s own mistakes.

A neural network has a large number of sensing and processing nodes that continuously interact with each other. Figure 10-11 represents one type of neural network comprising an input layer, an output layer, and a hidden processing layer. Humans “train” the network by feeding it a set of training data for which the inputs produce a known set of outputs or conclusions. This helps the computer learn the correct solution by example. As the computer is fed more data, each case is compared with the known outcome. If it differs, a correction is calculated and applied to the nodes in the hidden processing layer. These steps are repeated until a condition, such as corrections being less than a certain amount, is reached. The neural network in Figure 10-11 has learned how to identify a fraudulent credit card purchase. Also, self-organizing neural networks can be trained by exposing them to large amounts of data and allowing them to discover the patterns and relationships in the data.

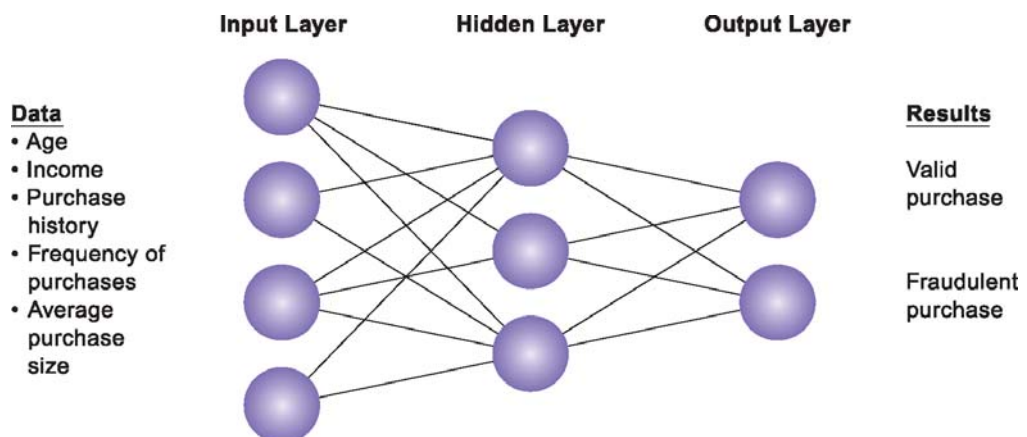
Whereas expert systems seek to emulate or model a human expert’s way of solving problems, neural network builders claim that they do not program solutions and do not aim to solve specific problems. Instead, neural network designers seek to put intelligence into the hardware in the form of a generalized capability to learn. In contrast, the expert system is highly specific to a given problem and cannot be retrained easily.

Neural network applications in medicine, science, and business address problems in pattern classification, prediction, financial analysis, and control and optimization. In medicine, neural network applications are used for screening patients for coronary artery disease, for diagnosing patients with epilepsy and Alzheimer’s disease, and for performing pattern recognition of pathology images. The financial industry uses neural networks to discern patterns in vast pools of data that might help investment firms predict the performance of equities, corporate bond ratings, or corporate bankruptcies. Visa International uses a neural network to help detect credit card fraud by monitoring all Visa transactions for sudden changes in the buying patterns of cardholders.

There are many puzzling aspects of neural networks. Unlike expert systems, which typically provide explanations for their solutions, neural networks cannot always explain why they arrived at a particular solution. They may not perform well if their training covers too little or too much data. In most current applications, neural networks are best used as aids to human decision makers instead of substitutes for them.

Figure 10-11 How a Neural Network Works

A neural network uses rules it “learns” from patterns in data to construct a hidden layer of logic. The hidden layer then processes inputs, classifying them based on the experience of the model. In this example, the neural network has been trained to distinguish between valid and fraudulent credit card purchases.



GENETIC ALGORITHMS

Genetic algorithms are useful for finding the optimal solution for a specific problem by examining a very large number of alternative solutions for that problem. They are based on techniques inspired by evolutionary biology, such as inheritance, mutation, selection, and crossover (recombination).

A genetic algorithm works by representing a solution as a string of 0s and 1s. The genetic algorithm searches a population of randomly generated strings of binary digits to identify the right string representing the best possible solution for the problem. As solutions alter and combine, the worst ones are discarded and the better ones survive to go on to produce even better solutions.

In Figure 10-12, each string corresponds to one of the variables in the problem. One applies a test for fitness, ranking the strings in the population according to their level of desirability as possible solutions. After the initial population is evaluated for fitness, the algorithm then produces the next generation of strings, consisting of strings that survived the fitness test plus offspring strings produced from mating pairs of strings, and tests their fitness. The process continues until a solution is reached.

Genetic algorithms are used to solve complex problems that are very dynamic and complex, involving hundreds or thousands of variables or formulas. The problem must be one where the range of possible solutions can be represented genetically and criteria can be established for evaluating fitness. Genetic algorithms expedite the solution because they can evaluate many solution alternatives quickly to find the best one. For example, General Electric engineers used genetic algorithms to help optimize the design for jet turbine aircraft engines, where each design change required changes in up to 100 variables. The supply-chain management software from i2 Technologies uses genetic algorithms to optimize production-scheduling models, incorporating hundreds of thousands of details about customer orders, material and resource availability, manufacturing and distribution capability, and delivery dates.

INTELLIGENT AGENTS

Intelligent agent technology helps businesses and decision makers navigate through large amounts of data to locate and act on information that is considered important.

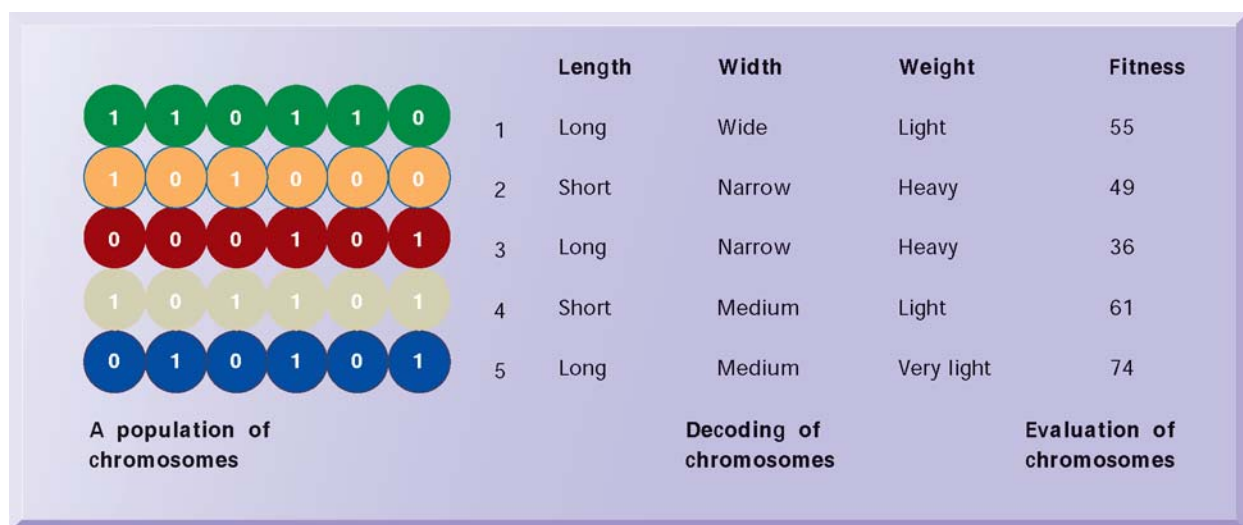


Figure 10-12
The Components of a Genetic Algorithm

This example illustrates an initial population of “chromosomes,” each representing a different solution. The genetic algorithm uses an iterative process to refine the initial solutions so that the better ones, those with the higher fitness, are more likely to emerge as the best solution.

Intelligent agents are software programs that work in the background without direct human intervention to carry out specific, repetitive, and predictable tasks for an individual user, business process, or software application. The agent uses a limited built-in or learned knowledge base to accomplish tasks or make decisions on the user's behalf, such as deleting junk e-mail, scheduling appointments, or finding the cheapest airfare to California.

There are many intelligent agent applications today in operating systems, application software, e-mail systems, mobile computing software, and network tools. Of special interest to business are intelligent agents that search for information on the Internet. Chapter 6 describes how shopping bots help consumers find products they want and assists them in comparing prices and other features.

Procter & Gamble (P&G) used intelligent agent technology to make its supply chain more efficient (see Figure 10-13). It modeled a complex supply chain as a group of semiautonomous "agents" representing individual supply-chain components, such as trucks, production facilities, distributors, and retail stores. The behavior of each agent is programmed to follow rules that mimic actual behavior, such as "order an item when it is out of stock." Simulations using the agents enable the company to perform what-if analyses on inventory levels, in-store stockouts, and transportation costs.

Using intelligent agent models, P&G discovered that trucks should often be dispatched before being fully loaded. Although transportation costs would be higher using partially loaded trucks, the simulation showed that retail store stockouts would occur less often, thus reducing the amount of lost sales, which would more than make up for the higher distribution costs. Agent-based modeling has saved P&G \$300 million annually on an investment of less than 1 percent of that amount (Anthes, 2003).

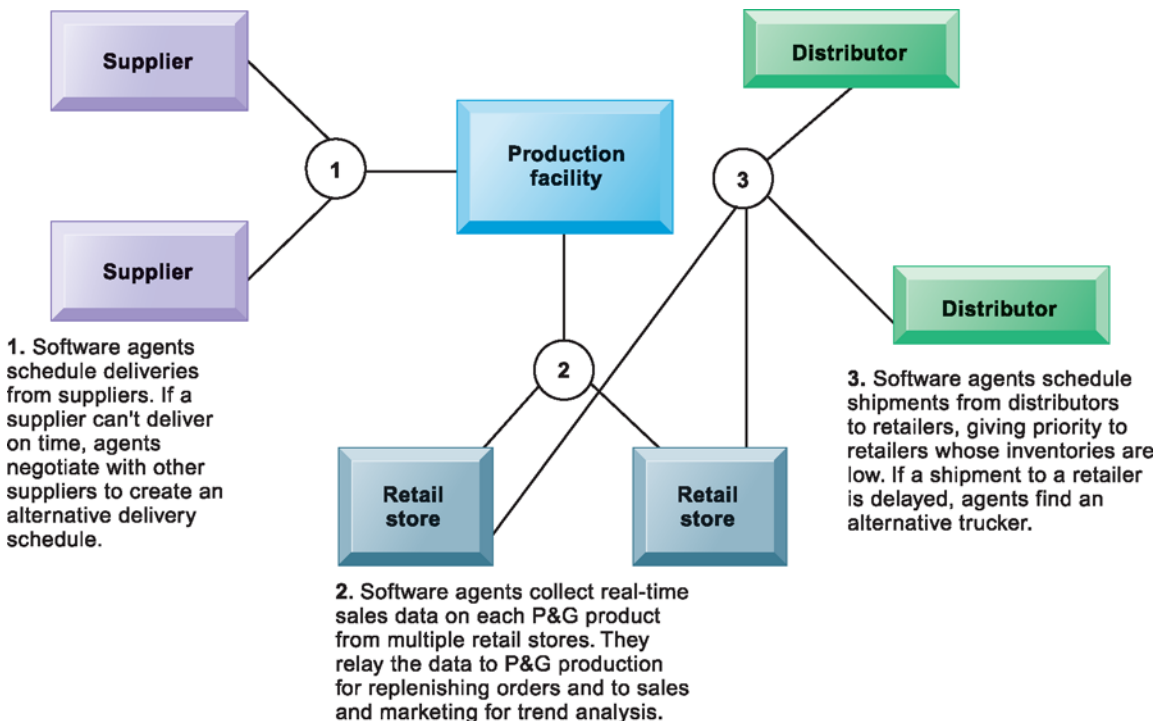


Figure 10-13

Intelligent Agents in P&G's Supply-Chain Network

Intelligent agents are helping Procter & Gamble shorten the replenishment cycles for products, such as a box of Tide.

10.4 Systems for Managing Knowledge

Systems for knowledge management improve the quality and utilization of knowledge used in the decision-making process. **Knowledge management** refers to the set of business processes developed in an organization to create, store, transfer, and apply knowledge. Knowledge management increases the ability of the organization to learn from its environment and to incorporate knowledge into its business processes and decision making.

Knowledge that is not shared and applied to the problems facing firms and managers does not add any value to the business. Knowing how to do things effectively and efficiently in ways that other organizations cannot duplicate is a major source of profit and competitive advantage. Why? Because the knowledge you generate about your own production processes, and about your customers, usually stays within your firm and cannot be sold or purchased on the open market. In this sense, self-generated business knowledge is a strategic resource and can provide strategic advantage. Businesses will operate less effectively and efficiently if this unique knowledge is not available for decision making and ongoing operations. There are two major types of knowledge management systems: enterprise-wide knowledge management systems and knowledge work systems.

ENTERPRISE-WIDE KNOWLEDGE MANAGEMENT SYSTEMS

Firms must deal with at least three kinds of knowledge. Some knowledge exists within the firm in the form of structured text documents (reports and presentations). Decision makers also need knowledge that is semistructured, such as e-mail, voice mail, chat room exchanges, videos, digital pictures, brochures, or bulletin board postings. In still other cases, there is no formal or digital information of any kind, and the knowledge resides in the heads of employees. Much of this knowledge is **tacit knowledge** and is rarely written down.

Enterprise-wide knowledge management systems deal with all three types of knowledge. Enterprise-wide knowledge management systems are general-purpose, firmwide systems that collect, store, distribute, and apply digital content and knowledge. These systems include capabilities for searching for information, storing both structured and unstructured data, and locating employee expertise within the firm. They also include supporting technologies such as portals, search engines, collaboration tools (e-mail, instant messaging, wikis, blogs, social bookmarking, and groupware) and learning management systems.

Enterprise Content Management Systems

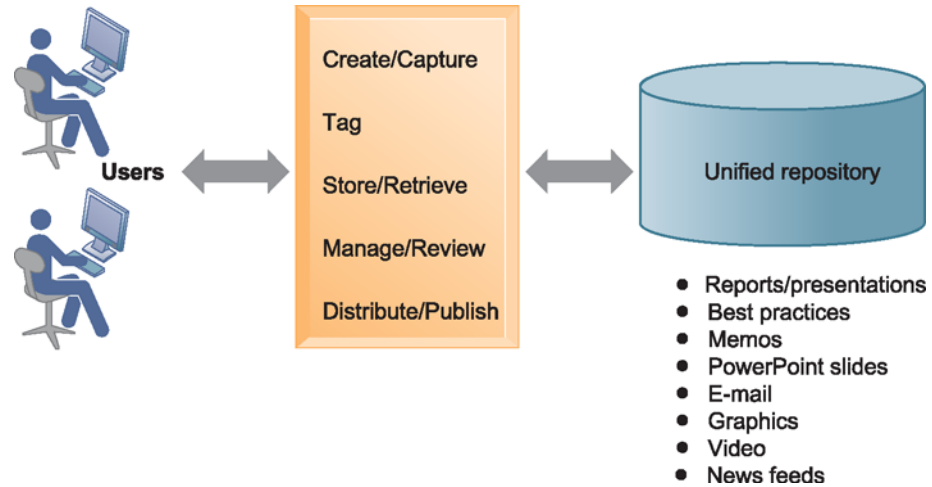
Businesses today need to organize and manage both structured and semistructured knowledge assets. **Structured knowledge** is explicit knowledge that exists in formal documents, as well as in formal rules that organizations derive by observing experts and their decision-making behaviors. But, according to experts, at least 80 percent of an organization's business content is semistructured or unstructured—information in folders, messages, memos, proposals, e-mails, graphics, electronic slide presentations, and even videos created in different formats and stored in many locations.

Enterprise content management systems help organizations manage both types of information. They have capabilities for knowledge capture, storage, retrieval, distribution, and preservation to help firms improve their business processes and decisions. Such systems include corporate repositories of documents, reports, presentations, and best practices, as well as capabilities for collecting and organizing semistructured knowledge such as e-mail (see Figure 10-14). Major enterprise content management systems also enable users to access external sources of information, such as news feeds and research, and to communicate via e-mail, chat/instant messaging, discussion groups, and videoconferencing.

A key problem in managing knowledge is the creation of an appropriate classification scheme to organize information into meaningful categories. Once the categories for classifying knowledge have been created, each knowledge object needs to be “tagged,” or classified, so that it can be easily retrieved. Enterprise content management systems have

Figure 10-14 An Enterprise Content Management System

An enterprise content management system has capabilities for classifying, organizing, and managing structured and semistructured knowledge and making it available throughout the enterprise.



capabilities for tagging, interfacing with corporate databases where the documents are stored, and creating an enterprise portal environment for employees to use when searching for corporate knowledge.

BAE Systems, the largest aerospace and defense company in Europe, used Autonomy enterprise content management software to aggregate structured and unstructured content from many different sources, including reports, e-mail, resumes, profiles, intranet content, and 10,000 news feeds per day. The system automatically categorizes and tags the content and alerts its 130,000 employees to documents in the system that relate to their jobs. It has reduced the amount of time spent retrieving information by over 90 percent (Lamont, 2006).

Firms in publishing, advertising, broadcasting, and entertainment have special needs for storing and managing unstructured digital data such as photographs, graphic images, video, and audio content. **Digital asset management systems** help them classify, store, and distribute these digital objects.

Knowledge Network Systems

Knowledge network systems, also known as *expertise location and management systems*, address the problem that arises when the appropriate knowledge is not in the form of a digital document but instead resides in the memory of expert individuals in the firm. Knowledge network systems provide an online directory of corporate experts in well-defined knowledge domains and use communication technologies to make it easy for employees to find the appropriate expert in a company. Some knowledge network systems go further by systematizing the solutions developed by experts and then storing the solutions in a knowledge database as a best-practices or frequently asked questions (FAQs) repository (see Figure 10-15). AskMe, Tacit ActiveNet, and Xpert SHARE provide tools for internal corporate use. Tacit offers another service called Illumio, which allows users to solicit expertise from friends, colleagues, and business experts over the open Internet.

Collaboration Tools and Learning Management Systems

Companies are starting to use consumer Web technologies such as blogs, wikis, and social bookmarking for internal use to foster collaboration and information exchange between individuals and teams. Blogs and wikis help capture, consolidate, and centralize this knowledge for the firm.

Wikis, which we introduced in Chapter 6, are inexpensive and easy to implement. Wikis provide a central repository for all types of corporate data that can be displayed in a Web browser, including electronic pages of documents, spreadsheets, and electronic slides, and can embed e-mail and instant messages. Although users are able to modify wiki content

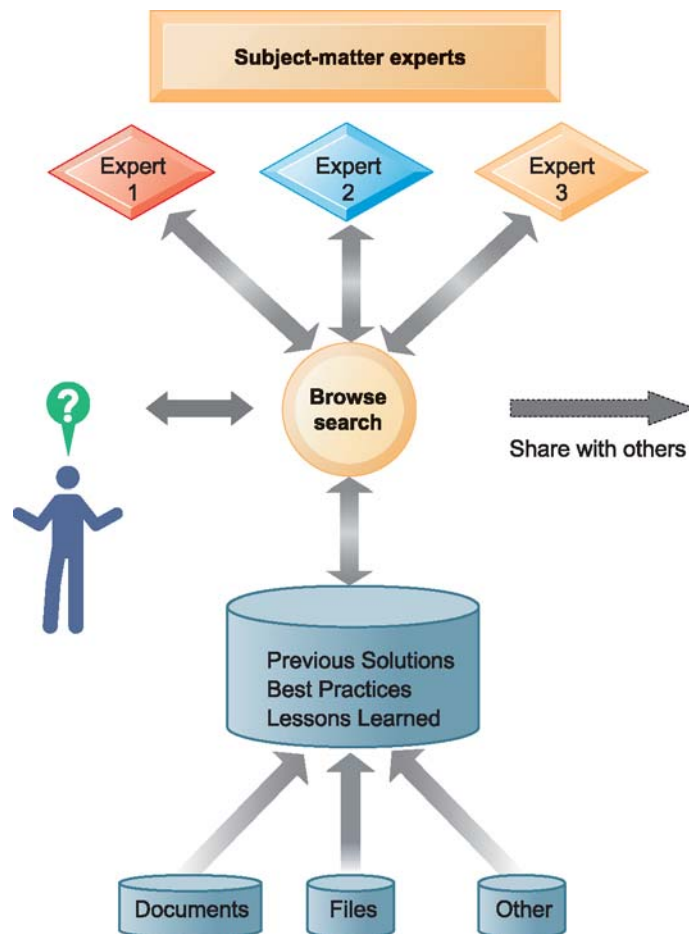


Figure 10-15
An Enterprise Knowledge Network System

A knowledge network maintains a database of firm experts, as well as accepted solutions to known problems, and then facilitates the communication between employees looking for knowledge and experts who have that knowledge. Solutions created in this communication are then added to a database of solutions in the form of frequently asked questions (FAQs), best practices, or other documents.

contributed by others, wikis have capabilities for tracking these changes and tools for reverting to earlier versions. A wiki is most appropriate for information that is revised frequently but must remain available perpetually as it changes.

The Interactive Session on Organizations describes some of these corporate uses of Web 2.0 tools. As you read this case, try to identify the problem these companies were facing, what alternative solutions were available to management, and how well the chosen solution worked.

Social bookmarking makes it easier to search for and share information by allowing users to save their bookmarks to Web pages on a public Web site and tag these bookmarks with keywords. These tags can be used to organize and search for the documents. Lists of tags can be shared with other people to help them find information of interest. The user-created taxonomies created for shared bookmarks are called “folksonomies.” Del.icio.us and Digg are two popular social bookmarking sites.

Suppose, for example, that you are on a corporate team researching wind power. If you did a Web search and found relevant Web pages on wind power, you would click on a bookmarking button on a social bookmarking site and create a tag identifying each Web document you found to link it to wind power. By clicking on the “tags” button at the social networking site, you would be able to see a list of all the tags you created and select the documents you need.

Companies need ways to keep track of and manage employee learning and to integrate it more fully into their knowledge management and other corporate systems. A **learning management system (LMS)** provides tools for the management, delivery, tracking, and assessment of various types of employee learning and training.

INTERACTIVE SESSION: ORGANIZATIONS Managing with Web 2.0

Who's blogging? It is not just twenty-somethings who want to chronicle their experiences, vent about consumer products, or put out a political message. Today's blogger might very well be an employee at IBM, Intel, Procter & Gamble, or any number of companies that have embraced Web 2.0 tools. Blogs, wikis, and social networking are emerging as powerful tools to boost communication and productivity in the corporate workforce. McKinsey & Co. reported that approximately one-third of the top executives it polled have Web 2.0 tools in use or plan to deploy them.

Web 2.0 tools have made inroads into the business world because the software that supports them is generally inexpensive and user-friendly. A manager who wants to communicate with his or her team via a blog or have the progress of a project documented on a wiki can institute the technology without help from the IT department and without superiors worrying about high costs.

At Sun Microsystems, management compelled its engineers to create wiki pages that described their projects. Once the engineers were comfortable with the technology, it was easier for them to transition to using wikis for the company's formal software documentation. The use of wikis also spread to meeting notes, project plans, and software reports, resulting in a total four-fold increase in the amount of documented information at Sun.

At IBM, over 26,000 employees have created blogs on the company's network to post about technology and the work they are doing. Project team members use wikis to store information and share memos. IBM's Wiki Central manages over 20,000 company wikis with over 125,000 participants. The company created a wiki to help 50 of its experts on law, economics, government, and technology to collaborate on an intellectual property manifesto that serves as the foundation of its new patent policy.

Web 2.0 tools are particularly valuable at IBM, where 42 percent of the workforce operates remotely, either from home or from client offices. Brian Goodman, who is the Connecticut-based manager of a software development team with members in New York and Massachusetts, says that the wikis give him "a single view of the projects and their status without pinging each" worker every day with an instant message.

The use of social networking in business is so far limited mostly to recruiting and making sales contacts. Recruiters at Microsoft and Starbucks have used

LinkedIn to search for potential job candidates. At IBM, however, employees engage in social networking internally through its corporate directory, BluePages, which is edited by employees and serves as a sort of internal corporate MySpace. The directory contains basic information on 400,000 employees and is accessed six million times daily. Employees have control of most of the content on their individual entries, and can post their own photos and resumes to their corporate "profiles."

Two of the biggest challenges for companies using Web 2.0 technologies are convincing workers to embrace these tools and regulating their use. IBM reminds employees to remember the rules of privacy, respect, and confidentiality in its corporate code of conduct and does not allow any anonymous online communication.

Some companies, such as Nokia and Frankfurt-based investment bank Dresdner Kleinwort, started wiki or blog implementations with a small group of employees. Once other managers and employees saw the business benefits, ease of use, and versatility of the tools, their departments were quick to adopt the technology.

A few pioneers in the London office IT department of Dresdner Kleinwort sent the Socialtext wiki software program to several IT groups to see how it might be used to facilitate some of their tasks. The program spread so rapidly that Dresdner launched a corporate wiki for collaborating on materials related to meetings, supporting brainstorming sessions, and developing presentations. Some employees were initially uncertain about how to use the wiki. They were ordered to use the wiki instead of sending e-mail. By 2006, the wiki had nearly 8,000 users.

Alex Thill, who leads a team of 52 that designs and maintains Web sites for many Dresdner divisions, reports that using the wiki along with blogs and instant messaging has cut down his group's e-mail use by at least 75 percent. He and his team also save time because the key metrics on the 80 Web sites they monitor are on a single wiki page. Each user only needs about 30 seconds to enter his or her data and make it available to the whole team. In the past, Till had to sift and sort these data from 80 sources, a process that might take weeks.

Sources: Michael Totty, "Social Studies," *The Wall Street Journal*, June 18, 2007; William M. Bulkeley, "Playing Well with Others," *The Wall Street Journal*, June 18, 2007; Vauhini Vara, "Wikis at Work," *The Wall Street Journal*, June 18, 2007; Dan Carlin, "Corporate Wikis Go Viral," *BusinessWeek*, March 12, 2007; and Rachael King, "No Rest for the Wiki," *BusinessWeek*, March 12, 2007.

CASE STUDY QUESTIONS

1. How do Web 2.0 tools help companies manage knowledge, coordinate work, and enhance decision making?
2. What business problems do blogs, wikis, and other social networking tools help solve?
3. Describe how a company such as Wal-Mart or Procter & Gamble would benefit from using Web 2.0 tools internally.
4. What challenges do companies face in spreading the use of Web 2.0? What issues should managers be concerned with?

MIS IN ACTION

Go to Sun Microsystems' Blogs home page at <http://blogs.sun.com> and click the Blog Directory tab. Select a blog from the directory and then answer the following questions:

1. What is the name of the blog you selected?
2. Who is the intended audience of this blog?
3. What subjects does the blog address?
4. Visit several more blogs in Sun's directory. If you were a Sun employee, do you think you would find these blogs helpful? Why or why not? Do you think there is value in blog entries that discuss the author's personal life instead of work-related matters?

For example, the Whirlpool Corporation uses CERTPOINT's learning management system to manage the registration, scheduling, reporting, and content for its training programs for 3,500 salespeople. The system helps Whirlpool tailor course content to the right audience, track the people who took courses and their scores, and compile metrics on employee performance (Summerfield, 2007).

KNOWLEDGE WORK SYSTEMS

The enterprise-wide knowledge systems we have just described provide a wide range of capabilities used by many, if not all, the workers and groups in an organization. Firms also have specialized systems for knowledge workers to help them create new knowledge for improving the firm's business processes and decision making. **Knowledge work systems (KWS)** are specialized systems for engineers, scientists, and other knowledge workers that are designed to promote the creation of knowledge and to ensure that new knowledge and technical expertise are properly integrated into the business.

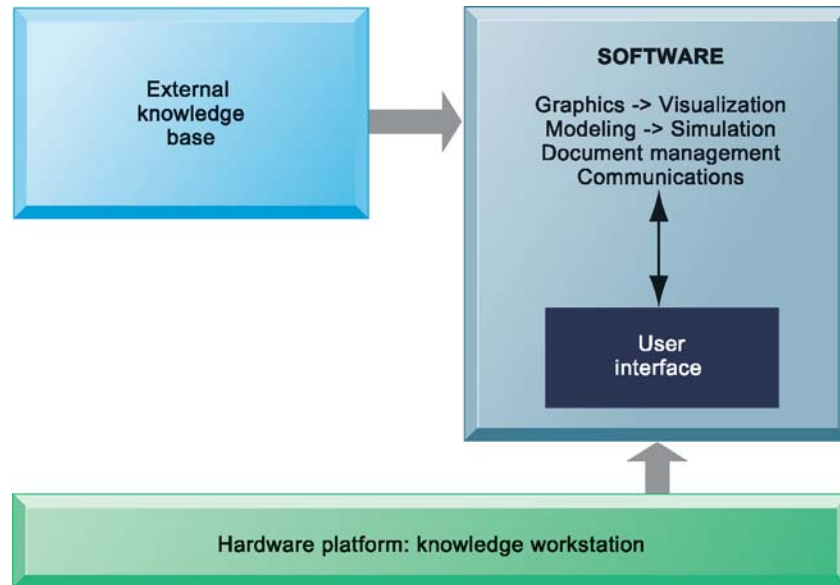
Requirements of Knowledge Work Systems

Knowledge work systems give knowledge workers the specialized tools they need, such as powerful graphics, analytical tools, and communications and document management. These systems require great computing power to handle the sophisticated graphics or complex calculations necessary for such knowledge workers as scientific researchers, product designers, and financial analysts. Because knowledge workers are so focused on knowledge in the external world, these systems also must give the worker quick and easy access to external databases. They typically feature user-friendly interfaces that enable users to perform needed tasks without having to spend a lot of time learning how to use the computer. Figure 10-16 summarizes the requirements of knowledge work systems.

Knowledge workstations often are designed and optimized for the specific tasks to be performed. Design engineers need graphics with enough power to handle three-dimensional, computer-aided design (CAD) systems. However, financial analysts are more interested in access to a myriad of external databases and technology for efficiently storing and accessing massive amounts of financial data.

Figure 10-16 Requirements of Knowledge Work Systems

Knowledge work systems require strong links to external knowledge bases in addition to specialized hardware and software.



Examples of Knowledge Work Systems

Major knowledge work applications include computer-aided design (CAD) systems (which we introduced in Chapter 3), virtual reality systems for simulation and modeling, and financial workstations.

Contemporary CAD systems are capable of generating realistic-looking three-dimensional graphic designs that can be rotated and viewed from all sides. Architects from Skidmore, Owings, & Merrill LLP used a three-dimensional CAD program called Revit to work out the creative and technical details of the design for the Freedom Tower at the site of the former World Trade Center. The software enabled the architects to strip away the outer layer to manipulate the shape of the floors. Changes appeared immediately in the entire model, and the software automatically recalculated the technical details in the blueprints.

Virtual reality systems use interactive graphics software to create computer-generated simulations that are so close to reality that users almost believe they are participating in a real-world situation. In many virtual reality systems, the user dons special clothing, headgear, and equipment, depending on the application. The clothing contains sensors that record the user's movements and immediately transmit that information back to the computer. For instance, to walk through a virtual reality simulation of a house, you would need garb that monitors the movement of your feet, hands, and head. You also would need goggles containing video screens and sometimes audio attachments and feeling gloves so that you are immersed in the computer feedback.

Virtual reality is just starting to provide benefits in educational, scientific, and business work. For example, neuroradiologists at New York's Beth Israel Medical Center use the Siemens Medical Systems 3D Virtuoso System to peek at the interplay of tiny blood vessels or take a fly-through of the aorta. Surgeons at New York University School of Medicine use three-dimensional modeling to target brain tumors more precisely, thereby reducing bleeding and trauma during surgery.

Virtual reality applications developed for the Web use a standard called **Virtual Reality Modeling Language (VRML)**. VRML is a set of specifications for interactive, three-dimensional modeling on the World Wide Web that organize multiple media types, including animation, images, and audio to put users in a simulated real-world environment. VRML is platform independent, operates over a desktop computer, and requires little bandwidth.

DuPont, the Wilmington, Delaware, chemical company, created a VRML application called HyperPlant, which enables users to access three-dimensional data over the Internet using Web browser software. Engineers can go through three-dimensional models as if they were physically walking through a plant, viewing objects at eye level. This level of detail reduces the number of mistakes they make during construction of oil rigs, oil plants, and other structures.

The financial industry is using specialized **investment workstations** to leverage the knowledge and time of its brokers, traders, and portfolio managers. Firms such as Merrill Lynch and UBS Financial Services have installed investment workstations that integrate a wide range of data from both internal and external sources, including contact management data, real-time and historical market data, and research reports. Previously, financial professionals had to spend considerable time accessing data from separate systems and piecing together the information they needed. By providing one-stop information faster and with fewer errors, the workstations streamline the entire investment process from stock selection to updating client records.

10.5 Hands-On MIS

The projects in this section give you hands-on experience using spreadsheet software to analyze the impact of changes in prices of component parts on production costs for a real-world company, using a spreadsheet pivot table to analyze sales data, and using intelligent agents to research products for sale on the Web.

IMPROVING DECISION MAKING: ANALYZING THE IMPACT OF COMPONENT PRICE CHANGES

Software skills: Spreadsheet formulas, two-variable data table

Business skills: Manufacturing bill of materials sensitivity analysis

A bill of materials is used in manufacturing and production to show all of the parts and materials required to manufacture a specific item or for the subassembly of a finished product, such as a motorcycle. The information in the bill of materials is useful for determining product costs, coordinating orders, and managing inventory. It can also show how product costs will be affected by price changes in components or raw materials. This project provides you with an opportunity to use spreadsheet software to perform a sensitivity analysis showing the impact of various prices for component parts on the total costs of a dirt bike. The bill of materials for this project has been simplified for instructional purposes.

Dirt Bikes's management has asked you to explore the impact of changes in some of its parts components on production costs. Review the following bill of materials information for the brake system for Dirt Bikes's Moto 300 model.

The completed bill of materials contains the description of the component, the identification number of each component, the supplier (source) of the component, the unit cost of each component, the quantity of each component needed to make each finished brake system, the extended cost of each component, and the total materials cost. The extended cost is calculated by multiplying the quantity of each component needed to produce the finished brake system by the unit cost. The prices of components are constantly changing, and you will need to develop a spreadsheet application that can show management the impact of such price changes on the cost to produce each brake system and on total production costs for the Moto 300 model.

- Complete the bill of materials by calculating the extended cost of each component and the total materials cost for each brake system.
- Develop a sensitivity analysis to show the impact on total brake system materials costs if the front brake calipers unit cost ranges from \$103 to \$107 and if the brake pipe unit cost ranges from \$27 to \$30.



**Bill of Materials: Moto
300 Brake System**

Component	Component No.	Source	Unit Cost	Quantity	Extended Cost
Brake cable	M0593	Nissin	\$27.81	1	
Brake pedal	M0546	Harrison Billet	\$6.03	2	
Brake pad	M3203	Russell	\$27.05	2	
Front brake pump	M0959	Brembo	\$66.05	1	
Rear brake pump	M4739	Brembo	\$54.00	1	
Front brake caliper	M5930	Nissin	\$105.20	1	
Rear brake caliper	M7942	Nissin	\$106.78	1	
Front brake disc	M3920	Russell	\$143.80	1	
Rear brake disc	M0588	Russell	\$56.42	1	
Brake pipe	M0943	Harrison Billet	\$28.52	1	
Brake lever cover	M1059	Brembo	\$2.62	1	

- The brake system represents 30 percent of the total materials cost for one Moto 300 motorcycle. Use sensitivity analysis again to show the impact of the changes in front brake caliper unit costs and brake pipe unit costs described previously on total materials costs for this motorcycle model.

IMPROVING DECISION MAKING: USING PIVOT TABLES TO ANALYZE SALES DATA

Software skills: Pivot tables

Business skills: Analyzing sales data

This project gives you an opportunity to learn how to use Excel's PivotTable functionality to analyze a database or data list.

Use the data file for Online Management Training Inc. described earlier in the chapter. This is a list of the sales transactions at OMT for one day. You can find this spreadsheet file at the Laudon Web site for this chapter.

Use Excel's PivotTable to help you answer the following questions:

- Where are the average purchases higher? The answer might tell managers where to focus marketing and sales resources, or pitch different messages to different regions.
- What form of payment is the most common? The answer could be used to emphasize in advertising the most preferred means of payment.
- Are there any times of day when purchases are most common? Do people buy are products while at work (likely during the day) or at home (likely in the evening)?
- What's the relationship between region, type of product purchased, and average sales price?

We provide instructions on how to use Excel PivotTables in our Learning Tracks.

IMPROVING DECISION MAKING: USING INTELLIGENT AGENTS FOR COMPARISON SHOPPING

Software skills: Web browser and shopping bot software

Business skills: Product evaluation and selection

This project will give you experience using shopping bots to search online for products, find product information, and find the best prices and vendors.

You have decided to purchase a new digital camera. Select a digital camera you might want to purchase, such as the Canon PowerShot SD 1000 or the Fuji FinePix A900. To purchase the camera as inexpensively as possible, try several of the shopping bot sites, which do the price comparisons for you. Visit MySimon (www.mysimon.com), BizRate.com (www.bizrate.com), and Google Product Search. Compare these shopping sites in terms of their ease of use, number of offerings, speed in obtaining information, thoroughness of information offered about the product and seller, and price selection. Which site or sites would you use and why? Which camera would you select and why? How helpful were these sites for making your decision?

LEARNING TRACKS

The following Learning Tracks provide content relevant to topics covered in this chapter:

1. Building and Using Pivot Tables
2. How an Expert System Inference Engine Works
3. Challenges of Implementing and Using Knowledge Management Systems

Review Summary

1 What are the different types of decisions, and how does the decision-making process work? Decisions may be structured, semistructured, or unstructured, with structured decisions clustering at the operational level of the organization and unstructured decisions at the strategic level. Decision making can be performed by individuals or groups and includes employees as well as operational, middle, and senior managers. There are four stages in decision making: intelligence, design, choice, and implementation.

2 How do information systems help people working individually and in groups make decisions more effectively? Systems specifically designed to help managers and employees make better decisions include management information systems (MIS), decision-support systems (DSS), group decision-support systems (GDSS), and executive support systems (ESS).

MIS provide information on firm performance to help managers monitor and control the business, often in the form of fixed regularly scheduled reports based on data summarized from the firm's transaction processing systems. MIS support structured decisions and some semistructured decisions.

Decision-support systems combine data, sophisticated analytical models and tools, and user-friendly software into a single powerful system that can support semistructured or unstructured decision making. Geographic information systems (GIS) uses data visualization technology to analyze and display data for planning and decision making with digitized maps.

Group decision-support systems (GDSS) help people meeting together in a group arrive at decisions more efficiently. GDSS feature special conference room facilities where participants contribute their ideas using networked computers and software tools for organizing ideas, gathering information, ranking and setting priorities, and documenting meeting sessions.

Executive support systems (ESS) help senior managers with unstructured problems by combining data from internal and external sources for high-level overviews or drilling down to detailed transaction data.

3 What are the business benefits of using intelligent techniques in decision making and knowledge management? Expert systems capture tacit knowledge from a limited domain of human expertise and express that knowledge in the form of rules. The strategy used to search through the knowledge base is called the *inference engine*. Case-based reasoning represents organizational knowledge as a database of cases that can be continually expanded and refined.

Fuzzy logic is a software technology for expressing knowledge in the form of rules that use approximate or subjective values. Neural networks consist of hardware and software that attempt to mimic the thought processes of the human brain. Neural networks are notable for their ability to learn without programming and to recognize patterns in massive amounts of data.

Genetic algorithms develop solutions to particular problems using genetically based processes, such as fitness, crossover, and mutation. Intelligent agents are software programs with built-in or learned knowledge bases that carry out specific, repetitive, and predictable tasks for an individual user, business process, or software application.

4 What types of systems are used for enterprise-wide knowledge management, and how do they provide value for businesses? Enterprise content management systems feature databases and tools for organizing and storing structured documents and semistructured knowledge, such as e-mail or rich media. Knowledge network systems provide directories and tools for locating firm employees with special expertise who are important sources of tacit knowledge. Often these systems include group collaboration tools, portals to simplify information access, search tools, and tools for classifying information based on a taxonomy that is appropriate for the organization. Learning management systems provide tools for the management, delivery, tracking, and assessment of various types of employee learning and training.

5 What are the major types of knowledge work systems, and how do they provide value for firms? Knowledge work systems (KWS) support the creation of new knowledge and its integration into the organization. KWS require easy access to an external knowledge base; powerful computer hardware that can support software with intensive graphics, analysis, document management, and communications capabilities; and a user-friendly interface.

Key Terms

Artificial intelligence (AI), 346
Case-based reasoning (CBR), 348

Choice, 335
Customer decision-support systems (CDSS), 345
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	Learning management system (LMS), 355	Virtual reality systems, 358
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Review Questions

- What are the different types of decisions, and how does the decision-making process work?
 - List and describe the different decision-making levels and decision-making groups in organizations and their decision-making requirements.
 - Distinguish between an unstructured, semistructured, and structured decision.
 - List and describe the stages in decision making.
- How do information systems help people working individually and in groups make decisions more effectively?
 - Distinguish between a decision-support system (DSS) and a management information system (MIS).
 - List and describe the three basic components of a DSS.
 - Define a geographic information system (GIS), and explain how it supports decision making.
 - Define a customer decision-support system (CDSS), and explain how the Internet is used for this purpose.
 - Define an executive support system (ESS), and explain how its capabilities enhance managerial decision making and provide value for a business.
 - Define a group decision-support system (GDSS), explaining how it works and the problems it solves.
- What are the business benefits of using intelligent techniques in decision making and knowledge management?
 - Define an expert system, describe how it works, and explain its value to business.
 - Define case-based reasoning, and explain how it differs from an expert system.
 - Define a neural network, and describe how it works and how it benefits businesses.
 - Define and describe fuzzy logic, genetic algorithms, and intelligent agents. Explain how each works and the kinds of problems for which each is suited.
- What types of systems are used for enterprise-wide knowledge management, and how do they provide value for businesses?
 - Define knowledge management, and explain its value to businesses.
 - Define and describe the various types of enterprise-wide knowledge systems, and explain how they provide value for businesses.
 - Describe how the various types of collaboration tools and learning management systems facilitate knowledge management.

5. What are the major types of knowledge work systems, and how do they provide value for firms?

- Define knowledge work systems, and describe the generic requirements of knowledge work systems.
- Describe how the following systems support knowledge work: computer-aided design (CAD), virtual reality, and investment workstations.

Discussion Questions

1. If businesses used DSS, GDSS, and ESS more widely, would they make better decisions? Do you agree? Why or why not?

2. Describe various ways that knowledge management systems could help firms with sales and marketing or with manufacturing and production.

Video Case

You will find a video case illustrating some of the concepts in this chapter on the Laudon Web site along with questions to help you analyze the case.

Teamwork

Designing a University GDSS

With three or four of your classmates, identify several groups in your university that could benefit from a GDSS. Design a GDSS for one of those groups, describing its hardware, software and people elements. If possible, use electronic presentation software to present your findings to the class.

BUSINESS PROBLEM-SOLVING CASE

HSBC's Mortgage Lending Decisions: What Went Wrong?

One of the biggest news stories of late summer and fall of 2007 was about the U.S. subprime mortgage loan crisis and its effect on worldwide financial markets. A major player in this crisis was HSBC Holdings PLC, the third largest bank in the world based on market value. With headquarters in London, HSBC operates in 76 countries and territories. In 2006, it had become one of the largest lenders of subprime mortgages in the United States.

Subprime mortgages are targeted toward low-end borrowers who represent a risk of default, but, at times, a

good business opportunity to the lender. Subprime customers often have blemished credit histories, low incomes, or other traits that suggest a greater likelihood of defaulting on a loan. Generally speaking, lenders try to avoid making such loans. However, during a housing boom, competition for customers motivates lenders to relax their lending standards. During such a time, subprime mortgages, including those that do not require a down payment and have very low introductory rates, become far more prevalent, as they did between 2001 and 2006 in the United States.

By 2007, 12 percent of the total \$8.4 trillion U.S. mortgage market consisted of subprime mortgages, up from just 7.5 percent near the end of 2001. In early February 2007, HSBC revealed that this risky lending technique had become a major problem.

As the U.S. real estate market slowed in 2006, the growth rate of home values also slowed. With the coinciding rise in interest rates, many borrowers with adjustable-rate mortgages were unable to make their mortgage payments and defaulted on their loans. HSBC anticipated seeing the number of delinquent and defaulted accounts grow, but not to the level it actually discovered.

Mortgage lenders in the United States participate in a complicated business that involves more than a simple lender-borrower relationship. A bank or mortgage broker that originates a mortgage may not keep it. Mortgage wholesalers often buy loans and then turn right around and resell them to large financial institutions. The default risk passes along to whomever winds up with the account last. HSBC participated in several zones of the mortgage market. One unit of HSBC Mortgage Services originated mortgages, often of the subprime variety. HSBC flipped some of these loans to other companies, but kept others as investments. The ones HSBC kept provided revenue from the interest they generated, assuming the borrowers kept current with their payments. If the borrowers fell behind or defaulted, HSBC suffered the losses.

In its quest for higher revenue, HSBC began buying up subprime loans from other sources. In 2005 and 2006, with the housing boom in its final stages, HSBC bought billions of dollars of subprime loans from as many as 250 wholesale mortgage companies, which had acquired the loans from independent brokers and banks. HSBC found the high interest rates of these loans to be very alluring. Many of these loans were second-lien, or piggyback loans, which allow home owners who are unable to come up with a downpayment for a house to qualify for a mortgage by borrowing the downpayment amount, so they actually borrow the entire purchase price of a home.

HSBC stated it had a process for forecasting how many of the loans it purchased from wholesalers were likely to default. First, the bank would tell the wholesaler what types of loans it was interested in, based on the income and credit scores of the borrowers. Once the wholesaler offered a pool of mortgages, HSBC analysts evaluated the lot to determine whether it met HSBC standards.

Perhaps due to the intense competition for mortgages, HSBC accepted pools that included stated-income loans. These are loans for which the borrower simply states his or her income with providing any documentation to verify it. According to Martin Eakes, CEO of the Center for Responsible Lending, 90 percent of stated-income

loan applicants declare their incomes to be higher than they are in IRS records. Sixty percent of these people inflate their incomes by 50 percent or more. Many also exaggerate their employment positions to coincide with the inflated income. As a result, they receive approval for loans that are much larger than they can actually afford.

Between September 2005 and March 2006, HSBC bought nearly \$4 billion in second-lien loans. The surge increased the bank's second-lien to a total of \$10.24 billion. Earlier in 2005, Bobby Mehta, the top HSBC executive in the United States, described the development of the bank's mortgage portfolio as disciplined. He reported to investors, "We've done them conservatively based on analytics and based on our ability to earn a good return for the risks that we undertake."

In early February 2007, HSBC shook up Wall Street when it announced a much higher percentage of its subprime loans defaulted than it had anticipated. It would have to make provisions for \$10.6 billion in bad debt stemming from loan delinquencies in 2006. In the third quarter of 2006, the percentage of all HSBC Mortgage Services loans that were overdue by 60 days or more jumped from 2.95 to 3.74. The bank announced that a similar increase was expected for the fourth quarter. In short, the subprime mortgage market was in distress, and profits from the high-risk loans were disappearing.

HSBC had begun lending to American consumers in 2003, when it purchased Household International Inc., a major subprime lender based in Prospect Heights, Illinois. Household's CEO William Aldinger touted his company's ability to assess credit risk using modeling techniques designed by 150 Ph.Ds. The system, called the Worldwide Household International Revolving Lending System, or Whirl, helped Household underwrite credit card debt and support collection services in the United States, Mexico, the United Kingdom, and the Middle East.

Lenders such as HSBC who are analyzing applicants for credit cards, car loans, and fixed-rate mortgages use a credit rating from Fair Isaac Corp. of Minneapolis called a FICO score. However, FICO scores had not yet been proven reliable tools for predicting the performance, during a weakening housing market, of second-lien loans or of adjustable-rate mortgages taken out by subprime borrowers. Data on subprime borrowers who made small or no down payments were scarce, and the FICO scores did not adequately distinguish between loans where borrowers had put their own money down and loans with no downpayment. Nor did the models take into account what would happen if housing prices fell to the point where the amount owed on some mortgages exceeded the value of the homes they covered.

Nevertheless, HSBC used FICO scores to screen subprime applicants for both second-lien loans and adjustable-rate mortgages.

In response to its subprime loan crisis, HSBC made changes in both personnel and policy. The company ceased originating and purchasing stated-income loans and boosted the required FICO score for some loans. Tom Detelich, who had led the transition from Household to HSBC's consumer lending business, was appointed head of HSBC Mortgage Services.

HSBC doubled the number of customer representatives who call on borrowers who have missed payments and discuss payment plans that are more manageable. Those operations now run seven days a week. HSBC is also utilizing information technology to pinpoint ahead of time which customers are most in danger of failing to meet their monthly payments once their adjustable-rate mortgages (ARMs) jump from their initial teaser interest rates to higher rates. In some cases, the adjustment can increase a monthly payment by \$500. With so many mortgages originated in 2005 and 2006, HSBC could be facing another onslaught of delinquencies and defaults over the next two years. The Center for Responsible Lending predicted that 20 percent of subprime mortgages sold during those two years would result in foreclosure.

HSBC adopted business analytics software from Experian-Scorex to help support the decision making of its credit application processing staff. The software provides users with the ability to consistently deploy scoring models and portfolio segmentation. It also includes tools for managing customer relationships and improving risk management decisions. By using these tools, HSBC should be able to create strategies for individual applicants, assess the value of each applicant, and then customize a loan offer that suits the customer's needs as well as the bank's business.

Sources: Carrick Mollenkamp, "In Home-Lending Push, Banks Misjudged Risk," *The Wall Street Journal*, February 8, 2007; Joe Niedzielski, "A Sinking Sensation for Subprime Loans," *BusinessWeek*, February 14, 2007; Carrick Mollenkamp, "HSBC Taps 2 to Help Fix U.S. Mortgage Unit Woes," *The Wall Street Journal*, February 9, 2007; Edward Chancellor and Mike Verdin, "Subprime Lenders' Miscue," *The Wall Street Journal*, February 9, 2007; "Rising Subprime Defaults Hit Local HSBC Unit," Reuters, accessed via www.chicagobusiness.com, February 8, 2007; and "HSBC Implements Experian-Scorex Decision Support Software," www.finextra.com, February 23, 2007.

Case Study Questions

1. What problem did HSBC face in this case? What people, technology, and organization factors were responsible for the problem? Did HSBC management correctly identify the problem?
2. HSBC had sophisticated information systems and analytical tools for predicting the risk presented by subprime mortgage applicants. Why did HSBC still run into trouble? If HSBC had a solution to the problem all along, why was the right solution not used?
3. What solutions is HSBC relying on to deal with its problem going forward? Will these solutions be sufficient to turn the subprime mortgage business around? Are there additional factors for which HSBC has not accounted? What are they?
4. What are the possible consequences of HSBC changing its approach to subprime lending? How might these changes affect the business? How might they affect the customer? How might they affect the U.S. economy?
5. HSBC made a decision to pursue subprime mortgages as a segment of its business. Explain how this was a structured, unstructured, or semistructured decision. Then, present your opinion about where in the decision-making process HSBC went wrong. Finally, apply the decision quality concepts of accuracy and comprehensiveness to this case.