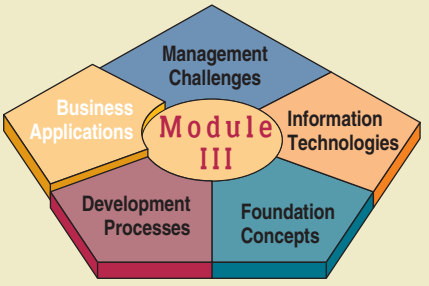
CHAPTER 10



SUPPORTING DECISION MAKING

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Learning Objectives

1. Identify the changes taking place in the form and use of decision support in business.
2. Identify the role and reporting alternatives of management information systems.
3. Describe how online analytical processing can meet key information needs of managers.
4. Explain the decision support system concept and how it differs from traditional management information systems.
5. Explain how the following information systems can support the information needs of executives, managers, and business professionals:
   a. Executive information systems
   b. Enterprise information portals
   c. Knowledge management systems
6. Identify how neural networks, fuzzy logic, genetic algorithms, virtual reality, and intelligent agents can be used in business.
7. Give examples of several ways expert systems can be used in business decision-making situations.

SECTION I Decision Support in Business

Introduction

As companies migrate toward responsive e-business models, they are investing in new data-driven decision support application frameworks that help them respond rapidly to changing market conditions and customer needs.

To succeed in business today, companies need information systems that can support the diverse information and decision-making needs of their managers and business professionals. In this section, we will explore in more detail how this is accomplished by several types of management information, decision support, and other information systems. We concentrate our attention on how the Internet, intranets, and other Web-enabled information technologies have significantly strengthened the role that information systems play in supporting the decision-making activities of every manager and knowledge worker in business.

Read the Real World Case on the next page. We can learn a lot from this case about new trends in decision making within companies. See Figure 10.1.

Information, Decisions, and Management

Figure 10.2 emphasizes that the type of information required by decision makers in a company is directly related to the **level of management decision making** and the amount of structure in the decision situations they face. It is important to understand that the framework of the classic *managerial pyramid* shown in Figure 10.2 applies even in today's *downsized organizations* and *flattened* or nonhierarchical organizational structures. Levels of management decision making still exist, but their size, shape, and participants continue to change as today's fluid organizational structures evolve. Thus, the levels of managerial decision making that must be supported by information technology in a successful organization are:

- **Strategic Management.** Typically, a board of directors and an executive committee of the CEO and top executives develop overall organizational goals, strategies, policies, and objectives as part of a strategic planning process. They also monitor the strategic performance of the organization and its overall direction in the political, economic, and competitive business environment.
- **Tactical Management.** Increasingly, business professionals in self-directed teams as well as business unit managers develop short- and medium-range plans, schedules, and budgets and specify the policies, procedures, and business objectives for their subunits of the company. They also allocate resources and monitor the performance of their organizational subunits, including departments, divisions, process teams, project teams, and other workgroups.
- **Operational Management.** The members of self-directed teams or operating managers develop short-range plans such as weekly production schedules. They direct the use of resources and the performance of tasks according to procedures and within budgets and schedules they establish for the teams and other workgroups of the organization.

Information Quality

What characteristics of information products make them valuable and useful to you? To answer this important question, we must first examine the characteristics or attributes of **information quality.** Information that is outdated, inaccurate, or hard to understand is not very meaningful, useful, or valuable to you or other business professionals. People need information of high quality, that is, information products whose characteristics, attributes, or qualities make the information more valuable to them. It is useful to think of information as having the three dimensions of time, content, and form. Figure 10.3 summarizes the important attributes of information quality and groups them into these three dimensions.

REAL WORLD CASE 1

Valero Energy, Elkay Manufacturing, J&J, and Overstock.com: The Move Toward Fact-Based Decision Making

It's 7 a.m. in San Antonio, Texas, and Rich Marcogliese, chief operating officer of Valero Energy, is holding his usual morning meeting with the plant managers of 16 major refineries throughout the United States and Canada.

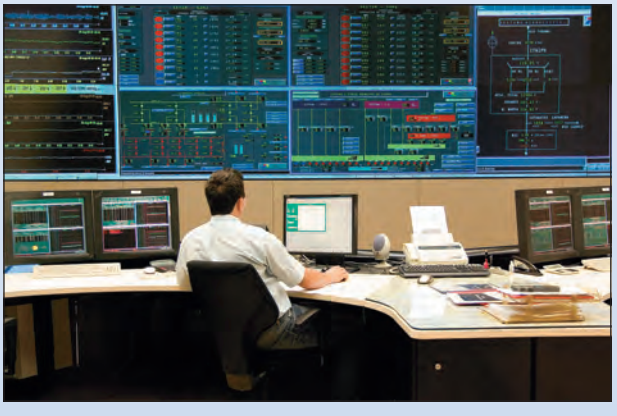
On the walls of the HQ operations center are a series of monitors centered by a giant screen with a live display of the company's Refining Dashboard. Whether the executives are in the room or connected remotely, all eyes are trained on the Web-accessible gauges and charts, which are refreshed with the latest data every five minutes.

"They review how each plant and unit is performing compared to the plan," says Valero CIO Hal Zesch, "and if there is any deviation, the manager explains what's going on at their plant."

For Valero, a surprisingly little-known Fortune 10 (that's right, one zero) company with more than $118 billion (with a "b") in revenue, just one dashboard needle moving from green to red might signal millions of dollars at stake. The point of the dashboard isn't to call managers out; it's to give executives timely information so they can take corrective action.

Valero's Refining Dashboard is just the sort of cutting-edge decision-support tool that thousands, if not tens of thousands, of companies are now attempting to create. Those companies have embraced the idea that decisions based on fact will consistently beat those based on gut. Business bestsellers including "Competing on Analytics," "Super Crunchers," and "The Numerati" have documented that it's an approach that works. Financial analysts, board members, and even the news media increasingly expect sound, data-backed analyses from top management. And when things go wrong, regulators—and in some cases, even district attorneys—follow the numbers to trace bad decisions.

FIGURE 10.1



Data are replacing gut when it comes to business decisions.

Source: © age fotostock/SuperStock.

Plenty of obstacles stand in the way of better decision support, from backward-looking metrics and ill-advised goals to antiquated budgeting approaches and technophobic executives. For management teams that can make use of the data—and these days there's always plenty of data—there are huge opportunities to improve efficiency, develop innovative products, get closer to customers, and outsell competitors.

Valero rolled out its dashboard in early 2008 at the behest of COO Marcogliese. He had launched a Commitment to Excellence program aimed at improving performance, and he wanted to see real-time data related to plant and equipment reliability, inventory management, safety, and energy consumption.

Real-time performance data are compared against daily and monthly targets, and there are executive-level, refinery-level, and even individual system-operator-level dashboard views. It's rare among business intelligence deployments to get fresh data every five minutes, but Valero has tapped directly into "process historian" systems at each plant in a six-month deployment of SAP's Manufacturing Integration and Intelligence application.

A major focus of Valero's Commitment to Excellence program is reducing energy consumption, so the company is rolling out separate dashboards that show detailed statistics on power consumption by unit and plant. "Based on the data, managers can share best practices and make changes in operations to reduce energy consumption while maintaining production levels," CIO Zesch explains. Estimated savings to date: $140 million per year for the seven plants where the dashboards are in use, with expected total savings of $230 million per year once the dashboards are rolled out at all 16 refineries.

The terms "scorecard" and "dashboard" are often used interchangeably, but there's an important distinction. Scorecards are all about tracking against defined metrics, and most scorecards are attached to a methodology, such as the Balanced Scorecard or TQM, says Mychelle Mollot, VP of worldwide marketing, analytics, and performance management at IBM. "Top executives have actually laid out a map for where they want to drive the business, and they've created metrics that will drive the behavior that will get them there," Mollot says.

Whether they call their decision-support tools scorecards or dashboards, only a small percentage of leading companies have actually mapped out enterprisewide goals with a formal methodology. Some companies come up with their own methodologies, but the key question is whether it's a comparative decision-support interface: Does it track performance trends relative to predefined goals? A much larger chunk of companies use dashboard-style interfaces that simply monitor the health of the business. "These types of decision-support tools aren't often attached to a grand methodology or linked down to the bottom of the organization," Mollot says.

At Elkay Manufacturing, a $1 billion plumbing fixture and cabinetry maker, the CFO has led the company to embrace new approaches toward evaluation and reporting. The conventional budgeting process, by contrast, often takes too long, it's a fixed contract, and "compensation schemes tied to it tend to encourage all sorts of bad behavior, like people sandbagging

or just budgeting amounts based on last year's budget," says Adam Bauer, corporate planning manager at Elkay.

Elkay's stated strategy is to grow profitably, so its sales-related scorecards and dashboards include profit metrics so salespeople don't just drive revenue at the expense of the bottom line. Controller John Hrudicka says the company's decision-support tools have identified initiatives that produced more than $13 million in hard-dollar profit improvements while "helping us transform our culture to a profit mind-set."

Elkay put most of its decision-support technologies in place over the last two years. It tapped Host Analytics' software-as-a-service financial performance management system, which it uses for budgeting, planning, reporting, and end-of-quarter financial consolidation.

The system also supported the move, completed in September, to 18-month budgeting and planning cycles. Elkay chose Acorn Performance Analyzer software for activity-based costing: analyses that reveal the true cost of delivering products (including manufacturing, distribution, sales and marketing, and warranty claims), as well as the true cost of sustaining customers (including products purchased, discounts applied, and ongoing service and support costs).

For decision support, Oracle Business Intelligence Enterprise Edition pulls information from multiple enterprise systems to deliver multilevel scorecards and dashboards. "It starts with the corporate scorecard and it rolls down from there to the divisions and all the way down to individual-employee goals that affect bonuses at the end of the year," Bauer says. Bottom-up feedback, he says, is gathered during quarterly strategy reviews.

Few companies have worked as hard or as long at data-driven decision making as Johnson & Johnson. There is an iterative process of assessing opportunities, developing goals, implementing improvements, and then monitoring their success with the aid of decision-support tools. Indeed, fact-based decision making is now "part of the culture at J&J," says Karl Schmidt, vice president of business improvement, who leads a nine-person internal management consulting group.

J&J is decentralized, so there's no single, overarching corporate dashboard. There are separate dashboards—or in some cases, balanced scorecards—within the pharmaceutical, consumer, and medical device and diagnostics product divisions, as well as the dozens of companies in each of those groups. The key performance indicators include a mix of financial metrics (revenue, net income, cash flow); customer metrics (satisfaction, loyalty, market share); internal process metrics (product development, manufacturing efficiency, fulfillment); and employee metrics (engagement, satisfaction).

"It comes down to fact-based decision making," he says. "In tough economic times, you want the best available data and analysis to make better decisions."

Some of the most decision-support-savvy executives can be found in e-commerce. For example, Patrick Byrne, CEO of Overstock.com, is said to use dashboards to help set his daily schedule. If the problem of the day is gross profit margins, that will drive who he calls in for a discussion. "If you get invited into a meeting with that kind of metrics-oriented CEO, you better have your hands on the data, including the detail at the next level down," says David Schrader, director of strategy and marketing at Teradata, the vendor behind Overstock's data warehousing environment.

Overstock can roll up its profit and loss statement every two hours, "which is absolutely world class," Schrader says. That capability gives executives accurate, up-to-date insight into the financial results they can expect, and it also drives operational decisions such as spot buys of TV advertising.

Whether a company is an e-commerce powerhouse or not, digital marketing channels like e-mail, social media, and online advertising networks are increasingly important. Thus, top executives should be watching forward-looking, upstream measures such as Web site performance, Web-driven lead generation, and sales pipeline information. Here, again, you must be careful to select the right metrics.

"A lot of people are measuring the wrong thing, like how many people came in the door," Schrader says. "What you really want to measure is how many people came in the door and became qualified leads."

And once prospects become customers, you'll want to know if they are good or bad customers. That's where analyses such as activity-based costing and customer segmentation come in. Lessons learned should come full circle and be reapplied to lead-generation campaigns and marketing offers.

Considering all the IT systems now in place, the growing dominance of Internet-based marketing, and the intensely digital nature of services-based industries, there's no doubt that data-driven decision making is the way forward. But the key questions are: How prepared are these organizations to synthesize and share key performance indicators? How prepared are executives to draw insight from information?

Source: Adapted from Doug Henschen, "Execs Want Focus on Goals, Not Just Metrics," *InformationWeek*, November 13, 2009.

CASE STUDY QUESTIONS

1. What is the difference between a "dashboard" and a "scorecard"? Why is it important that managers know the difference between the two? What can they learn from each?
2. In what ways have the companies mentioned in the case benefited from their adoption of "fact-based" decision making? Provide several examples from the case to illustrate your answer.
3. Information quality is central to the approach toward decision making taken by these organizations. What other elements must be present for this approach to be successful (technology, people, culture, and so forth)?

REAL WORLD ACTIVITIES

1. A number of major companies have launched projects geared toward improving their business analytics and decision-making capabilities in the last few years. Go online and research other examples in this trend. What are the similarities with the ones chronicled in the case? What are the differences? Prepare a report that includes a section contrasting your new examples with the ones in the case.
2. If you had to apply the ideas discussed in the case to your academic career, what would your dashboard and/or scorecard look like? What would be the sources of information? How you would measure whether you are making progress toward attaining your goals? Break into small groups to discuss these issues.

FIGURE 10.2 Information requirements of decision makers. The type of information required by directors, executives, managers, and members of self-directed teams is directly related to the level of management decision making involved and the structure of decision situations they face.

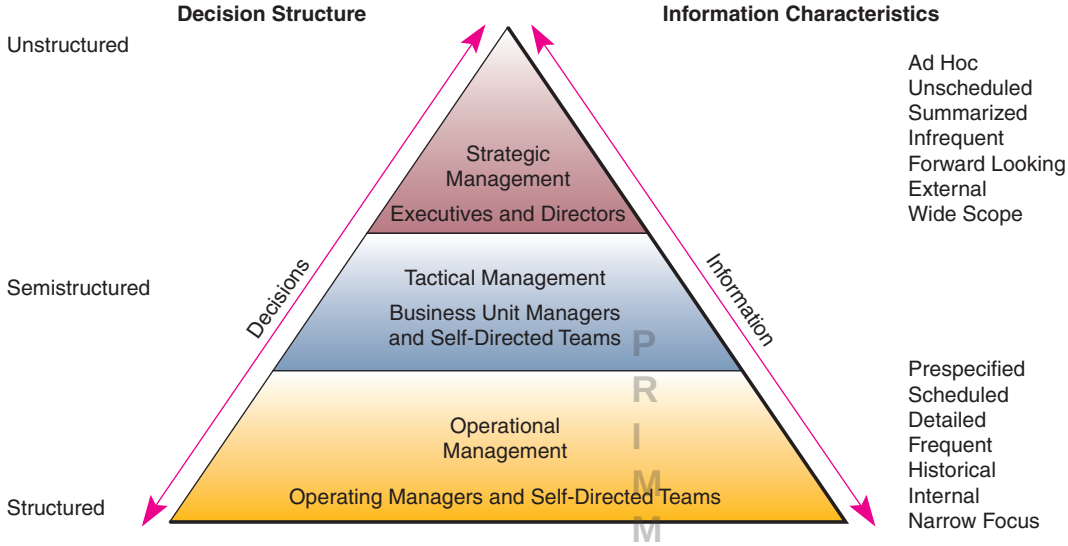
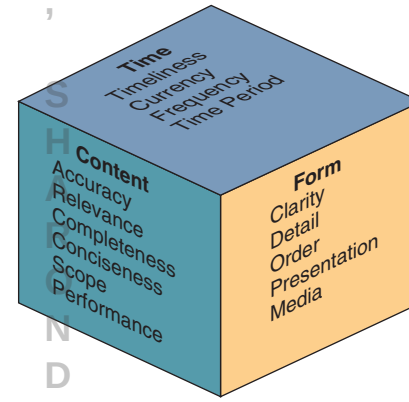


FIGURE 10.3 A summary of the attributes of information quality. This figure outlines the attributes that should be present in high-quality information products.



Time Dimension	
Timeliness	Information should be provided when it is needed.
Currency	Information should be up-to-date when it is provided.
Frequency	Information should be provided as often as needed.
Time Period	Information can be provided about past, present, and future time periods.
Content Dimension	
Accuracy	Information should be free from errors.
Relevance	Information should be related to the information needs of a specific recipient for a specific situation.
Completeness	All the information that is needed should be provided.
Conciseness	Only the information that is needed should be provided.
Scope	Information can have a broad or narrow scope, or an internal or external focus.
Performance	Information can reveal performance by measuring activities accomplished, progress made, or resources accumulated.
Form Dimension	
Clarity	Information should be provided in a form that is easy to understand.
Detail	Information can be provided in detail or summary form.
Order	Information can be arranged in a predetermined sequence.
Presentation	Information can be presented in narrative, numeric, graphic, or other forms.
Media	Information can be provided in the form of printed paper documents, video displays, or other media.

FIGURE 10.4 Examples of decisions by the type of decision structure and level of management.

Decision Strategic	Operational Management	Tactical Management	Structure Management
Unstructured	Cash management	Business process reengineering Workgroup performance analysis	New e-business initiatives Company reorganization
Semistructured	Credit management Production scheduling Daily work assignment	Employee performance appraisal Capital budgeting Program budgeting	Product planning Mergers and acquisitions Site location
Structured	Inventory control	Program control	

Decision Structure

One way to understand decision making is to look at **decision structure**. Decisions made at the operational management level tend to be more *structured*, those at the tactical level are more *semistructured*, and those at the strategic management level are more *unstructured*. Structured decisions involve situations in which the procedures to follow, when a decision is needed, can be specified in advance. The inventory reorder decisions that most businesses face are a typical example. Unstructured decisions involve decision situations in which it is not possible to specify in advance most of the decision procedures to follow. Most decisions related to long-term strategy can be thought of as unstructured (e.g., "What product lines should we develop over the next five years?"). Most business decision situations are semistructured; that is, some decision procedures can be prespecified but not enough to lead to a definite recommended decision. For example, decisions involved in starting a new line of e-commerce services or making major changes to employee benefits would probably range from unstructured to semistructured. Finally, decisions that are unstructured are those for which no procedures or rules exist to guide the decision makers toward the correct decision. In these types of decisions, many sources of information must be accessed, and the decision often rests on experience and "gut feeling." One example of an unstructured decision might be the answer to the question, "What business should we be in 10 years from now?" Figure 10.4 provides a variety of examples of business decisions by type of decision structure and level of management.

Therefore, information systems must be designed to produce a variety of information products to meet the changing needs of decision makers throughout an organization. For example, decision makers at the strategic management level may look to *decision support systems* to provide them with more summarized, ad hoc, unscheduled reports, forecasts, and external intelligence to support their more unstructured planning and policymaking responsibilities. Decision makers at the operational management level, in contrast, may depend on *management information systems* to supply more prespecified internal reports emphasizing detailed current and historical data comparisons that support their more structured responsibilities in day-to-day operations. Figure 10.5 compares the information and decision support capabilities of management information systems and decision support systems, which we will explore in this chapter.

Decision Support Trends

The emerging class of applications focuses on personalized decision support, modeling, information retrieval, data warehousing, what-if scenarios, and reporting.

As we discussed in Chapter 1, using information systems to support business decision making has been one of the primary thrusts of the business use of information technology. During the 1990s, however, both academic researchers and business practitioners began to report that the traditional managerial focus originating in classic management information systems (1960s), decision support systems (1970s), and executive information systems (1980s) was expanding. The fast pace of new information technologies like PC hardware and software suites, client/server networks, and networked PC versions of DSS

FIGURE 10.5
Comparing the major differences in the information and decision support capabilities of management information systems and decision support systems.

	Management Information Systems	Decision Support Systems
• Decision support provided	Provide information about the performance of the organization	Provide information and decision support techniques to analyze specific problems or opportunities
• Information form and frequency	Periodic, exception, demand, and push reports and responses	Interactive inquiries and responses
• Information format	Prespecified, fixed format	Ad hoc, flexible, and adaptable format
• Information processing methodology	Information produced by extraction and manipulation of business data	Information produced by analytical modeling of business data

software made decision support available to lower levels of management, as well as to nonmanagerial individuals and self-directed teams of business professionals.

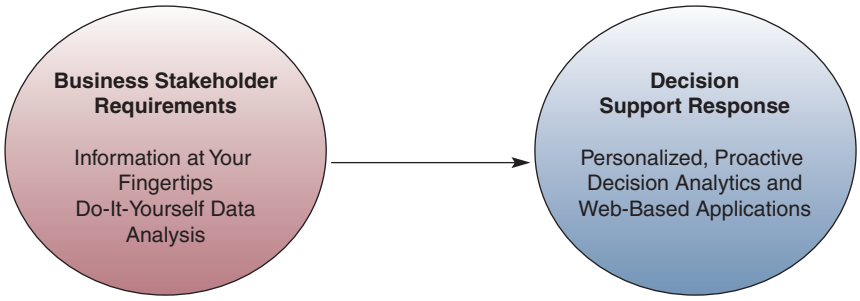
This trend has accelerated with the dramatic growth of the Internet, as well as of intranets and extranets that inter-network with companies and their stakeholders. The e-business and e-commerce initiatives that are being implemented by many companies are also expanding the information and decision support uses and the expectations of a company's employees, managers, customers, suppliers, and other business partners. Figure 10.6 illustrates that all business stakeholders expect easy and instant access to information and Web-enabled self-service data analysis. Today's businesses are responding with a variety of personalized and proactive Web-based analytical techniques to support the decision-making requirements of all of their constituents.

Thus, the growth of corporate intranets and extranets, as well as the Web, has accelerated the development and use of "executive-class" information delivery and decision support software tools by lower levels of management and by individuals and teams of business professionals. In addition, this dramatic expansion has opened the door to the use of such **business intelligence (BI)** tools by the suppliers, customers, and other business stakeholders of a company for customer relationship management, supply chain management, and other e-business applications.

In 1989, Howard Dresner (later a Gartner Group analyst) proposed BI as an umbrella term to describe "concepts and methods to improve business decision making by using fact-based support systems." It was not until the late 1990s that this usage became widespread. Today, BI is considered a necessary and mission critical element in crafting and executing a firm's strategy. Consider the following findings from a 2009 Gartner Group study:

- Because of lack of information, processes, and tools, through 2012, more than 35 percent of the top 5,000 global companies will regularly fail to make insightful decisions about significant changes in their business and markets.

FIGURE 10.6
A business must meet the information and data analysis requirements of its stakeholders with more personalized and proactive Web-based decision support.



- By 2012, business units will control at least 40 percent of the total budget for business intelligence.
- By 2010, 20 percent of organizations will have an industry-specific analytic application, delivered via software as a service, as a standard component of their business intelligence portfolio.
- In 2009, collaborative decision making will emerge as a new product category that combines social software with business intelligence platform capabilities.

When you consider some of these findings, it becomes easy to see that BI is rapidly becoming the mainstay for business decision making in the modern organization. Before long, it will evolve into a competitive necessity for many industries.

As with all concepts in business-related technologies, business intelligence has evolved from Dresner's original definition focusing on concepts and methods to a more action-oriented approach referred to as *business analytics*. Business analytics (BA) refers to the skills, technologies, applications, and practices applied to a continuous iterative exploration and investigation of a business's historical performance to gain insight and drive the strategic business planning process. Business analytics focuses on developing new insights and understanding of business performance based on data and statistical methods. In contrast, business intelligence traditionally focuses on using a consistent set of metrics to both measure past performance and guide business planning, which is also based on data and statistical methods.

Business analytics makes much more extensive use of data, statistical and quantitative analysis, explanatory and predictive modeling, and fact-based management to drive decision making. Analytics may be used as input for human decisions or may drive fully automated decisions. Business intelligence is more associated with querying, reporting, online analytical processing (OLAP), and "alerts." In other words, querying, reporting, OLAP, and alert tools can answer the questions: *what happened; how many; how often; where; where exactly is the problem;* and *what actions are needed*. Business analytics, in contrast, can answer the questions: *why is this happening; what if these trends continue; what will happen next (that is, predict);* and *what is the best that can happen (that is, optimize)*. One of the most common techniques and approaches associated with business analytics is data mining, a concept introduced in Chapter 5 and discussed again later in this chapter.

Figure 10.7 highlights several major information technologies that are being customized, personalized, and Web-enabled to provide key business information and analytical tools for managers, business professionals, and business stakeholders. We highlight the trends toward such business intelligence applications in the various types of information and decision support systems that are discussed in this chapter.

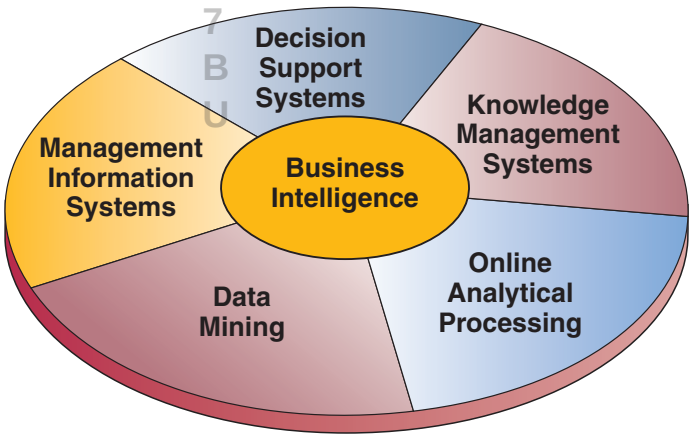


FIGURE 10.7
Business intelligence applications are based on personalized and Web-enabled information analysis, knowledge management, and decision support technologies.

Hyatt Hotels: Dashboards Integrate Financial and Operational Information

A few years ago, executives at Chicago-based Hyatt Hotels decided the company needed a way to consolidate its disparate financial data so that it could more easily forecast future sales and plan its business accordingly. In other words, the company wanted to install a typical financial performance management layer, with dashboards and scorecards for top-level managers. But after some discussion on the matter, the installation grew to be not so typical.

Gebhard Rainer, Hyatt's vice president of hotel finance and systems, wanted to combine these financial elements—budgeting, planning, modeling, and reporting—with operational data from the hotels themselves. The idea was that a complete picture of the company's business, available on a daily basis to executives as well as hotel managers, was not possible without having the two together in the same dashboard.

Motivating the concept was a changing world, with terrorist risks and natural disasters causing an ever-shifting array of business variables. Rainer, in a Middle Eastern country in the aftermath of a terrorist attack several years ago, confronted these issues firsthand—as did the company, which owns hotels in New Orleans and along the hurricane-ravaged Gulf Coast. The first line of business is the safety of hotel guests. But in terms of the big picture, hotel companies must re-forecast their business goals from the ground up based on a set of entirely new metrics dealing with issues from resource allocation to skittish tourists rethinking their travel plans. It wasn't a job for spreadsheets.

Hyatt was among the first of Hyperion's customers to adopt System 9. The company selected Hyperion based on its "integrateability" with its source systems, as well as its user-friendliness. At first, Hyatt wanted a small-scale installation, delivering the System 9 dashboards to about 40 executive users. "This phase was a 'show-me-what-you-can-do' thing," says Sufel Barkat, Hyatt's assistant vice president for financial systems. "We simply wanted to understand the capability of the tools. The next stage will have a much bigger impact." The ultimate plan is to spread the system throughout the Hyatt organization to its many subsidiaries, in the United States and abroad, and to its individual properties—full-blown operational BI. Eventually, hotel managers will have access to dashboards so that everyone is on the same page, and so that local employees can make local decisions based on the same information viewed at headquarters.

Hyatt ended up using a data warehouse from Teradata to cleanse operational information coming from the decentralized ERP systems of Hyatt's individual hotels around the world. The company also uses the warehouse to store and cleanse external marketing data, such as what the competition is up to, or market share in each region.

On the financial side, other sources include the proprietary company's general ledger system and an Oracle database—systems already consolidated and unified through Hyatt's original performance management outlay.

The next step will be to deliver the dashboards to between 500 and 600 users at Hyatt—all the way down to the regional manager level. The full-blown operational BI rollout will target around 3,000 users. So far, in these early stages, Barkat hasn't been able to quantify the results of System 9 with any real figures. But, he says, users have been providing feedback on metrics, which, to him, indicates a strong "cultural and business adaptation" among Hyatt's executive class.

Source: Adapted from Scott Eden, "Hyatt Merges Financial, Ops Data," *InformationWeek*, January 17, 2006.

Decision Support Systems

Decision support systems are computer-based information systems that provide interactive information support to managers and business professionals during the decision-making process. Decision support systems use (1) analytical models, (2) specialized databases, (3) a decision maker's own insights and judgments, and (4) an interactive, computer-based modeling process to support semistructured business decisions.

Example

An example might help at this point. Sales managers typically rely on management information systems to produce sales analysis reports. These reports contain sales performance figures by product line, salesperson, sales region, and so on. A decision support system (DSS), however, would also interactively show a sales manager the effects on sales performance of changes in a variety of factors (e.g., promotion expense and salesperson compensation). The DSS could then use several criteria (e.g., expected gross margin and market share) to evaluate and rank alternative combinations of sales performance factors.

Therefore, DSS are designed to be ad hoc, quick-response systems that are initiated and controlled by business decision makers. Decision support systems are thus able to support directly the specific types of decisions and the personal decision-making styles and needs of individual executives, managers, and business professionals.

DSS Components

Unlike management information systems, decision support systems rely on **model bases**, as well as databases, as vital system resources. A DSS model base is a software component that consists of models used in computational and analytical routines that mathematically express relationships among variables. For example, a spreadsheet program might contain models that express simple accounting relationships among variables, such as Revenue 2 Expenses 5 Profit. A DSS model base could also include models and analytical techniques used to express much more complex relationships. For example, it might contain linear programming models, multiple regression forecasting models, and capital budgeting present value models. Such models may be stored in the form of spreadsheet models or templates, or statistical and mathematical programs and program modules. See Figure 10.8.

In addition, DSS software packages can combine model components to create integrated models that support specific types of decisions. DSS software typically contains built-in analytical modeling routines and also enables you to build your own models. Many DSS packages are now available in microcomputer and Web-enabled versions. Of course, electronic spreadsheet packages also provide some of the model building (spreadsheet models) and analytical modeling (what-if and goal-seeking analysis) offered by more powerful DSS software. As businesses become more aware of the power of decision support systems, they are using them in ever-increasing areas of the business. See Figure 10.9.

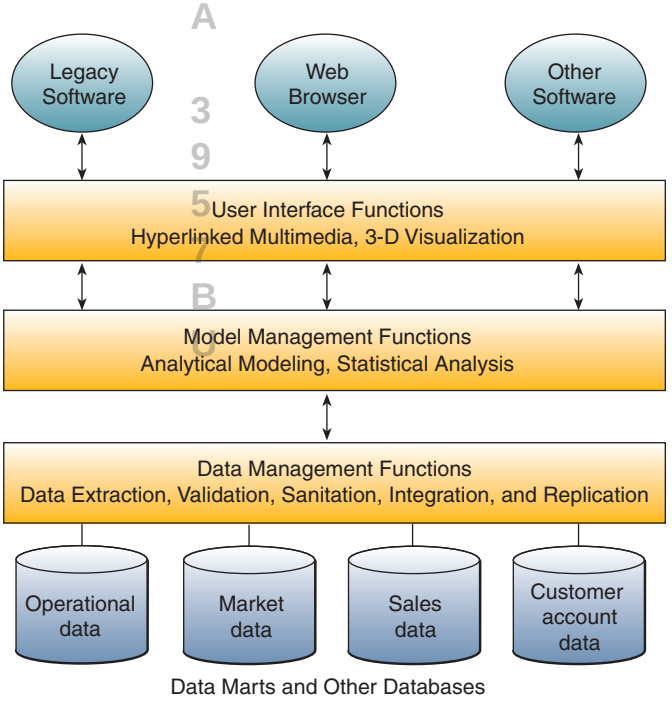


FIGURE 10.8
Components of a Web-enabled marketing decision support system. Note the hardware, software, model, data, and network resources involved.

FIGURE 10.9 Many businesses are turning to decision support systems and their underlying models to improve a wide variety of business functions.

Analytics competitors make expert use of statistics and modeling to improve a wide variety of functions. Here are some common applications:		
Function	**Description**	**Exemplars**
Supply chain	Simulate and optimize supply chain flows; reduce inventory and stockouts.	Dell, Walmart, Amazon
Customer selection, loyalty, and service	Identify customers with the greatest profit potential; increase likelihood that they will want the product or service offering; retain their loyalty.	Harrah's, Capital One, Barclays
Pricing	Identify the price that will maximize yield or profit.	Progressive, Marriott
Human capital	Select the best employees for particular tasks or jobs at particular compensation levels.	New England Patriots, Oakland A's, Boston Red Sox
Product and service quality	Detect quality problems early and minimize them.	Honda, Intel
Financial performance	Better understand the drivers of financial performance and the effects of nonfinancial factors.	MCI, Verizon
Research and development	Improve quality, efficacy, and, where applicable, safety of products and services.	Novartis, Amazon, Yahoo

Source: Adapted from Thomas H. Davenport, "Competing on Analytics," *Harvard Business Review*, January 2006.

United Agri Products: Making Better Decisions Using Models and Data

You give employees electronic reports, maybe even a dashboard. But are you helping them make better day-to-day decisions?

Companies can't report their way to great results—though you wouldn't know it from their accumulation of underused reports and dashboards. Companies that get this critical point are moving away from IT-centric business intelligence (BI) programs and toward results-focused performance management. True: BI does more than just generate reports. But add in query and analysis tools, and sophisticated predictive and statistical analytics, and those tools and technologies are overwhelmingly under IT's control.

In contrast, performance management, or PM, is defined by business needs, providing decision makers with the data they need to make the right moves, ones that fit with company strategy.

Most often, companies incorporate performance management into their budgeting and financial processes, in what's called corporate or financial PM. The next step is operational PM, where they apply BI to practical, day-to-day decisions in the supply chain, sales, customer service, and other areas.

That's what's happening at United Agri Products (UAP), a unit of $5 billion-a-year chemical and fertilizer supplier Agrium, which started doing operational PM projects using IBM's Cognos BI platform. "After years of IT preaching the value of BI to business, we reached a point of maturity where the roles started to reverse, and the business started coming to us with ideas," says David Wheat, UAP's director of decision support systems.

UAP's director of operations brought one such project to IT. The CEO had asked him to cut end-of-year inventory by $25 million, a difficult task for an agricultural company given ever-changing weather conditions, crop disease, and insect infestations, all happening across a variety of regions.

"The operations director sketched out exactly what he wanted on a whiteboard," Wheat says. Then he said, "If I can know at any point in time what I have in inventory and can forecast what the consumption will be through the end of the season, I'll know what dollar amount I'll have left and I can go after the high-dollar overages."

With that context, Wheat laid out a model for a PM system that included what data he needed and when he had to have it in order to make decisions. And his model came complete with a financial target.

UAP lacked a sales forecasting application, so Wheat's team developed one by integrating relevant information—current inventory levels, open purchase orders, prior-year purchase histories, and predicted overages or shortages—into a single report. The application includes a daily alert that notifies managers in four regions whenever a purchase order has the potential to create excess season-ending inventory.

"All that data presented in one place, with exceptions highlighted in color, made problems jump right to the top for the director and his regional managers," Wheat says. That information led managers to investigate open, unconfirmed purchase orders to see if they're justified. The result: "Within two weeks, UAP had canceled $2 million worth of POs for products that weren't needed."

Source: Adapted from Dough Henschen, "Decision Time," *InformationWeek*, November 24, 2008.

Management Information Systems

Recall from Chapter 1 that **management information systems** were the original type of information system developed to support managerial decision making. An MIS produces information products that support many of the day-to-day decision-making needs of managers and business professionals. Reports, displays, and responses produced by management information systems provide information that these decision makers have specified in advance as adequately meeting their information needs. Such predefined information products satisfy the information needs of decision makers at the operational and tactical levels of the organization who are faced with more structured types of decision situations. For example, sales managers rely heavily on sales analysis reports to evaluate differences in performance among salespeople who sell the same types of products to the same types of customers. They have a pretty good idea of the kinds of information about sales results (by product line, sales territory, customer, salesperson, and so on) that they need to manage sales performance effectively.

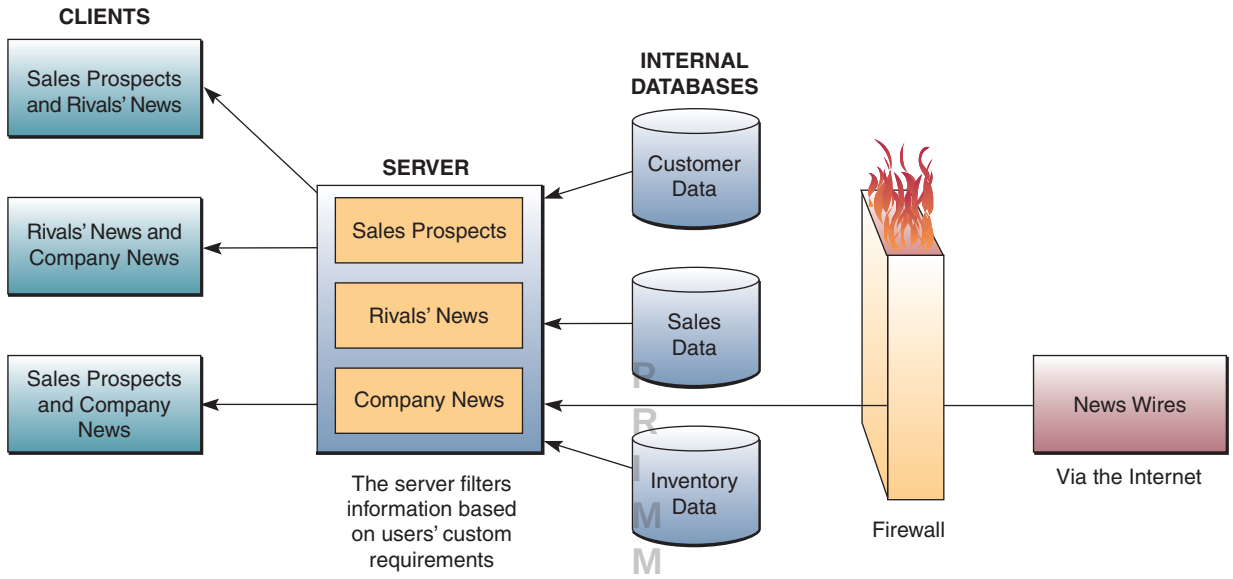
Managers and other decision makers use an MIS to request information at their networked workstations that supports their decision-making activities. This information takes the form of periodic, exception, and demand reports and immediate responses to inquiries. Web browsers, application programs, and database management software provide access to information in the intranet and other operational databases of the organization. Remember, operational databases are maintained by transaction processing systems. Data about the business environment are obtained from Internet or extranet databases when necessary.

Management Reporting Alternatives

Management information systems provide a variety of information products to managers. Four major **reporting alternatives** are provided by such systems.

- **Periodic Scheduled Reports.** This traditional form of providing information to managers uses a prespecified format designed to provide managers with information on a regular basis. Typical examples of such periodic scheduled reports are daily or weekly sales analysis reports and monthly financial statements.
- **Exception Reports.** In some cases, reports are produced only when exceptional conditions occur. In other cases, reports are produced periodically but contain information only about these exceptional conditions. For example, a credit manager can be provided with a report that contains only information on customers who have exceeded their credit limits. Exception reporting reduces *information overload* instead of overwhelming decision makers with periodic detailed reports of business activity.
- **Demand Reports and Responses.** Information is available whenever a manager demands it. For example, Web browsers, DBMS query languages, and report generators enable managers at PC workstations to get immediate responses or to find and obtain customized reports as a result of their requests for the information they need. Thus, managers do not have to wait for periodic reports to arrive as scheduled.
- **Push Reporting.** Information is *pushed* to a manager's networked workstation. Thus, many companies are using Webcasting software to broadcast selectively reports

FIGURE 10.10 An example of the components in a marketing intelligence system that uses the Internet and a corporate intranet system to "push" information to employees.



and other information to the networked PCs of managers and specialists over their corporate intranets. See Figure 10.10.

Online Analytical Processing

At a stockholder meeting, the former CEO of PepsiCo, D. Wayne Calloway, said: "Ten years ago I could have told you how Doritos were selling west of the Mississippi. Today, not only can I tell you how well Doritos sell west of the Mississippi, I can also tell you how well they are selling in California, in Orange County, in the town of Irvine, in the local Vons supermarket, in the special promotion, at the end of Aisle 4, on Thursdays."

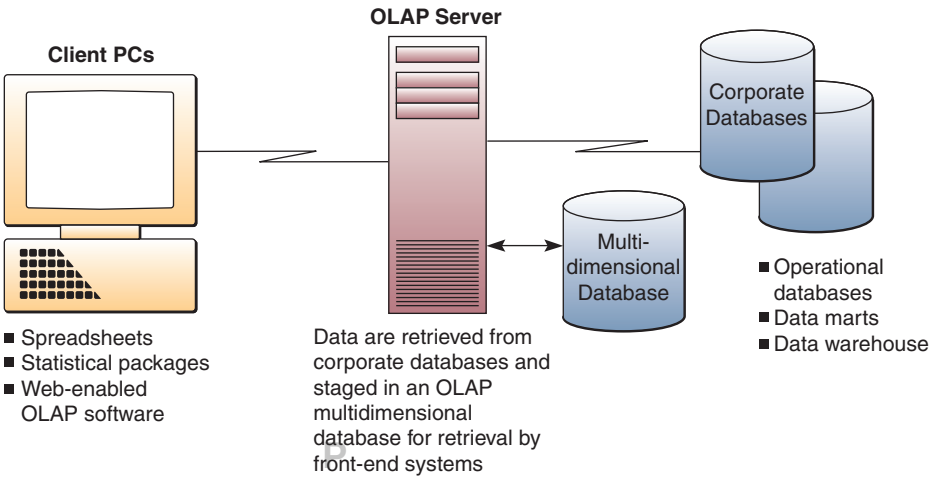
The competitive and dynamic nature of today's global business environment is driving demands by business managers and analysts for information systems that can provide fast answers to complex business queries. The IS industry has responded to these demands with developments like analytical databases, data marts, data warehouses, data mining techniques, and multidimensional database structures (discussed in Chapter 5), and with specialized servers and Web-enabled software products that support **online analytical processing (OLAP)**.

Online analytical processing enables managers and analysts to interactively examine and manipulate large amounts of detailed and consolidated data from many perspectives. OLAP involves analyzing complex relationships among thousands or even millions of data items stored in data marts, data warehouses, and other multidimensional databases to discover patterns, trends, and exception conditions. An OLAP session takes place online in real time, with rapid responses to a manager's or analyst's queries, so that the analytical or decision-making process is undisturbed. See Figure 10.11.

Online analytical processing involves several basic analytical operations, including consolidation, "drill-down," and "slicing and dicing." See Figure 10.12.

- **Consolidation.** Consolidation involves the aggregation of data, which can involve simple roll-ups or complex groupings involving interrelated data. For example, data about sales offices can be rolled up to the district level, and the district-level data can be rolled up to provide a regional-level perspective.
- **Drill-down.** OLAP can also go in the reverse direction and automatically display detailed data that comprise consolidated data. This process is called drill-down. For example, the sales by individual products or sales reps that make up a region's sales totals could be easily accessed.

FIGURE 10.11
Online analytical processing may involve the use of specialized servers and multidimensional databases. OLAP provides fast answers to complex queries posed by managers and analysts using traditional and Web-enabled OLAP software.



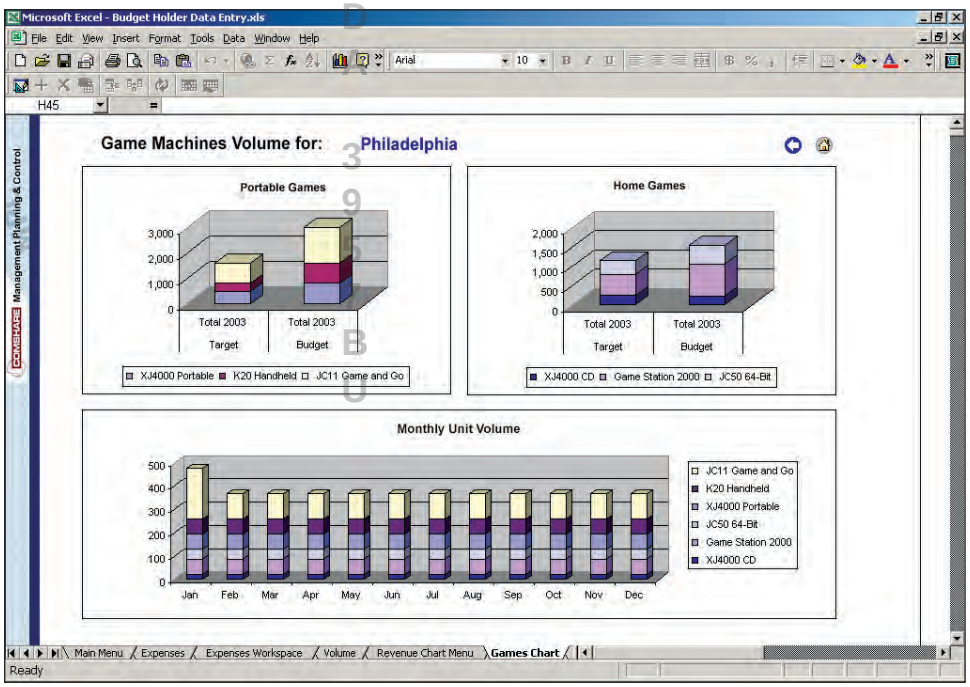
- **Slicing and Dicing.** Slicing and dicing refers to the ability to look at the database from different viewpoints. One slice of the sales database might show all sales of a product type within regions. Another slice might show all sales by sales channel within each product type. Slicing and dicing is often performed along a time axis to analyze trends and find time-based patterns in the data.

OLAP Examples

Probably the best way to understand the power of OLAP fully is to look at common business applications of the technique. The real power of OLAP comes from the marriage of data and models on a large scale. Through this marriage, managers can solve a variety of problems that previously would be considered too complex to tackle effectively. Common business areas where OLAP can solve complex problems include:

- Marketing and sales analysis
- Clickstream data
- Database marketing
- Budgeting

FIGURE 10.12
Comshare's Management Planning and Control software enables business professionals to use Microsoft Excel as their user interface for Web-enabled online analytical processing.



Source: Used with permission from Microsoft®.

- Financial reporting and consolidation
- Profitability analysis
- Quality analysis

Let's look at one or two examples of how OLAP can be used in the modern business setting.

It is near the end of a business quarter, and senior management is worried about the market acceptance of several new products. A marketing analyst is asked to provide an update to senior management. The problem is that the update must be delivered in less than an hour due to a last-minute request from the CEO. The analyst really only has a few minutes to analyze the market acceptance of several new products, so she decides to group 20 products that were introduced between six and nine months ago and compare their sales with a comparable group of 50 products introduced between two and three years ago. The analyst just defines two new, on-the-fly, product groupings and creates a ratio of the new group to the older group. She can then track this ratio of sales revenue or volume by any level of location, over time, by customer sector or by sales group. Defining the new groupings and the ratio takes a couple of minutes, and any of the analyses take a matter of a few seconds to generate, even though the database has tens of thousands of products and hundreds of locations. It takes no more than a total of 15 minutes to spot that some regions have not accepted the new products as fast as others.

Then, the analyst investigates whether this was because of inadequate promotion, unsuitability of the new products, lack of briefings of the sales force in the slow areas, or whether some areas always accept new products more slowly than others. Looking at other new product introductions by creating new groupings of products of different ages, she finds that the same areas are always conservative when introducing expensive new products. She then uses this information to see if the growth in the slow areas is in line with history and finds that some areas have taken off even more slowly than previously. Given the results of this analysis, senior management decides it is premature in its concern and tables further discussion until the next quarterly sales data can be assessed.

In another example, let's consider a general merchandise retailer who has joined the e-tailing ranks, wants the company Web site to be as "sticky" as possible, and has begun to analyze clickstream data to surmise why customers might leave the site prematurely. The company sharpened its analysis to determine the value of abandoned shopping carts. When a customer leaves the site in the middle of a shopping trip, for whatever reason, the company looks to see what products were in the abandoned cart. The data are then compared with similar data from other carts to examine:

- How much revenue the abandoned carts represented (in other words, the amount of revenue that was lost because of the customer's early departure).
- Whether the products in the cart were high-profit items or loss leaders.
- Whether the same products were found in other abandoned carts.
- The volume of products and the number of different product categories in the cart.
- Whether the total bill for the abandoned carts consistently fell within a certain dollar range.
- How the average and total bills for abandoned carts compared with unabandoned carts (those that made it through the checkout process).

The results of using OLAP to conduct this analysis trigger some interesting theories. For instance, it is possible that none of the products in the cart was appealing enough to a particular customer to keep that customer shopping. The customer might have been annoyed by frequent inquiries, such as "Are you ready to check out?" At a particular dollar total, the customer might have changed his or her mind about the entire shopping trip and left. It's also possible that a number or mix of products in a cart reminded the customer of another site that might offer a steeper discount for similar purchases.

Admittedly, some of these theories are mere guesses. After all, maybe the customer's Internet connection was on the fritz, or the site had a bug that abruptly booted the user. When examined regularly and with consistent metrics, however, clickstreams can reveal interesting patterns. After several analyses, the e-tailer decides to make some changes to the Web site.

First, the e-tailer tweaks the site to show a rolling total as items are added to the cart, thereby allowing the customer to see the total charge during the shopping time and to check out once the magic budget limit is reached. In addition, rather than requiring the customer to go to another page for specific product information, the site now invites the customer to see pop-up product information with a click of the right mouse button, keeping the buy mode alive. Finally, the vendor decides to integrate the clickstream data with more specific customer behavior information, including information from the CRM system.

Rather than just examining a customer's navigation patterns and guessing about which actions to take, the e-tailer can combine those patterns with more specific customer data (such as previous purchases in that product category, key demographic and psychographic data, or lifetime value score) to provide a complete view of that customer's value and interests. That kind of analysis will show you whether the lost customer was a one-time-only shopper or a high-value customer. A tailored e-mail message or electronic coupon—perhaps targeting one of the products left behind on a prior trip—could make all the difference the next time that high-value customer logs on.

Here's a real-world example of how OLAP can help solve complex business problems.

Direct Energy: Mining BI to Keep Its Customers

Even before bad debt shook the mortgage industry, Direct Energy was feeling its effects, including eroding revenue streams due to customer churn. Until then, the company effectively mined its way out in the best fashion: business intelligence. "Various groups were pulling data from various systems and not having integrated information," explains John Katsinos, vice president of IS for Direct Energy's mass markets operations. "There was no way to tie together a customer's end-to-end lifecycle."

Without that holistic view of customer records, it was difficult for Direct Energy analysts to understand, let alone prevent, customer churn. So began BI Jumpstart, the company's initiative to give its analysts insight into customer actions that precipitate into the dropping of Direct Energy services, as well as tools for forecasting bad debt. The result has been savings of tens of millions of dollars and a more proactive approach to customer retention via more accurate pricing, forecasting, and targeted marketing.

"We wanted to mitigate the risk to our business and customer base, and to grow our customer base and revenue," Katsinos adds.

"That meant being able to understand customer data at a level where we can forecast and predict behavior." Katsinos kicked off BI Jumpstart by assembling a crack analytics team consisting of an IS project manager, a data modeler, a pair of ETL developers, an analytic developer, a BI architect, and a BI administrator. That group then implemented a "multilayered business intelligence" strategy that, Katsinos explains, comprises data warehousing, data marts, OLAP repositories, and ETL.

The result is a data miner's dream: Direct Energy analysts can use the integrated BI program to predict what customers in which areas are likely to turn over, and then adjust the company's services, pricing, and marketing campaigns accordingly.

For example, with BI Jumpstart in place, Direct Energy can now determine why one of its offerings experiences a 2 percent churn while another sees 20 percent of its customers dropping the service.

More than an initiative geared toward new revenue streams, BI Jumpstart helps Direct Energy make the most of what it already has. "Now, we can slice and dice any way we want," Katsinos says.

Source: Adapted from Tom Sullivan, "Direct Energy Mines BI to Conserve Revenue Streams," *InfoWorld*, November 17, 2008.

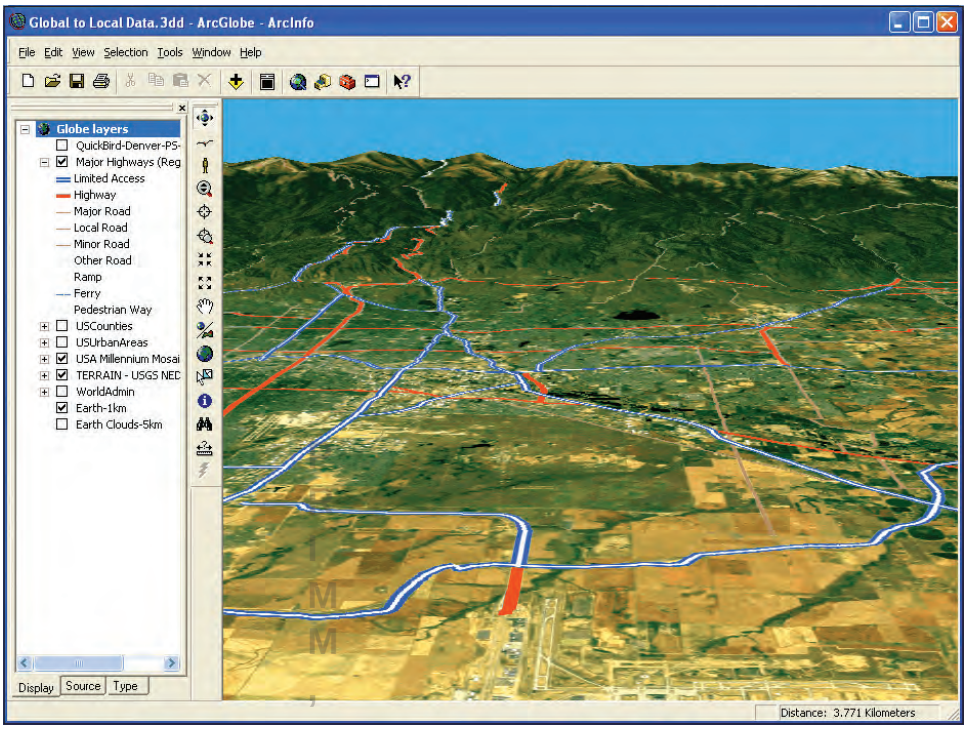


FIGURE 10.13
Geographic information systems facilitate the mining and visualization of data associated with a geophysical location.

Source: Courtesy of Rockware Inc.

Geographic Information and Data Visualization Systems

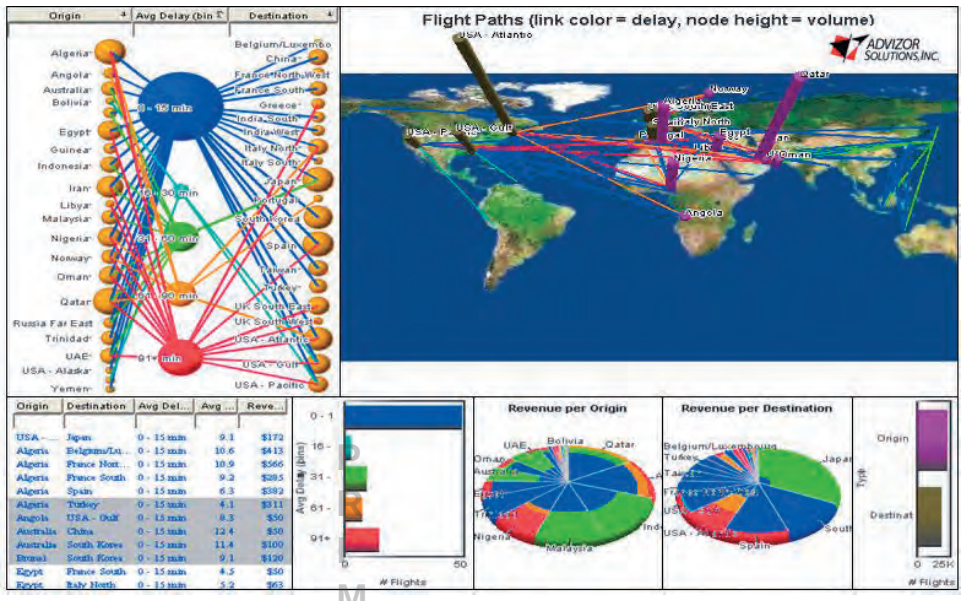
Geographic information systems (GIS) and **data visualization systems (DVS)** are special categories of DSS that integrate computer graphics with other DSS features. A geographic information system is a DSS that uses *geographic databases* to construct and display maps, as well as other graphics displays that support decisions affecting the geographic distribution of people and other resources. Many companies are using GIS technology along with *global positioning system* (GPS) devices to help them choose new retail store locations, optimize distribution routes, or analyze the demographics of their target audiences. For example, companies like Levi Strauss, Arby's, Consolidated Rail, and Federal Express use GIS packages to integrate maps, graphics, and other geographic data with business data from spreadsheets and statistical packages. GIS software such as MapInfo and Atlas GIS is used for most business GIS applications. See Figure 10.13.

Data visualization systems represent complex data using interactive, three-dimensional, graphical forms such as charts, graphs, and maps. DVS tools help users interactively sort, subdivide, combine, and organize data while the data are in their graphical form. This assistance helps users discover patterns, links, and anomalies in business or scientific data in an interactive knowledge discovery and decision support process. Business applications like data mining typically use interactive graphs that let users drill down in real time and manipulate the underlying data of a business model to help clarify their meaning for business decision making. Figure 10.14 is an example of airline flight analysis by a data visualization system.

The concept of the geographic information system and data visualization is not a new one. One of the first recorded uses of the concept occurred in September 1854. During a 10-day period, 500 people, all from the same section of London, England, died of cholera. Dr. John Snow, a local physician, had been studying this cholera epidemic for some time. In trying to determine the source of the cholera, Dr. Snow located every cholera death in the Soho district of London by marking the location of the home of each victim with a dot on a map he had drawn. Figure 10.15 contains a replica of his original map.

As can be seen on the map, Dr. Snow marked the deaths with dots, and the 11 *X*s represent water pumps. By examining the scattering and clustering of the dots, Dr. Snow observed that the victims of the cholera shared one common attribute: They all lived

FIGURE 10.14
Using a data visualization system to analyze airplane flights by segment and average delay, with drill-down to details.



Source: Courtesy of ADVIZOR Solutions, Inc. www.advisorsolutions.com.

FIGURE 10.15
Replica of Dr. John Snow's cholera epidemic map.

Source: E.R. Tufte, *The Visual Display of Quantitative Information*, 2nd ed. (Cheshire, Connecticut; Graphics Press, 2001), p. 24.

near—and drank from—the Broad Street water pump. To test his hypothesis, Dr. Snow requested that the handle of the pump be removed, thus rendering it inoperable. Within a very short time, the cholera epidemic, which claimed more than 500 lives, was over.

JPMorgan and Panopticon: Data Visualization Helps Fixed Income Traders

Visualizing and understanding vast quantities of credit market data can be overwhelming using traditional techniques such as charts and tables. Navigating through this data to find specific reports and analytical information can also prove daunting, and traditional information delivery mechanisms have tended to provide unruly volumes of data.

The Internet is today the obvious delivery mechanism for such market data and proprietary analyses, yet the providers of such services must deliver more intuitive visualization and navigation to provide better value to their customers.

Fixed income research and analytics providers are looking at new means of visualizing data to provide more valuable and intuitive services to their users by going beyond simple online tables, charts, and document repositories.

JPMorgan created their CreditMap application using Panopticon Developer in order to provide their customers with a graphical representation of real-time activity in the corporate bond market. JPMorgan blurred the lines between providing informative research and valuable analytics, which has enabled them to win the Euromoney award for "Best Online Fixed Income Research."

JPMorgan was able to provide their users with quicker access to their existing online information using new visualization and navigation tools. To do this, they implemented Panopticon's interactive treemap visualization as a presentation layer and navigation system that provides a bird's-eye view of the data, at the same time allowing the user to drill down to specific reports and analytics.

JPMorgan's CreditMap allows users to visualize information through the use of color, size, and proximity in any way they desire with an easily customizable interface. This interface acts as a catalyst, enabling users to recognize patterns, analyze information, and make decisions more quickly and more accurately than ever before. Before CreditMap, the brokerage firm's customers could read text reports on the corporate bond market and view various tables of statistical information. But the market is so extensive that it could be difficult to keep things in perspective or to be aware of many of the investment opportunities.

CreditMap presents the corporate bond universe as a quilt of rectangles on a computer screen. The quilt is divided into industry sectors, and the rectangles within each sector represent bond issues. The size of the rectangle indicates the size of the issue, and the color indicates the issue's performance. So at a glance, investors can see which sectors and which individual issues are hot, and whether an issue's size fits their investment needs. Clicking on a rectangle opens a window that gives basic information on the issue—including its ratings and the name and phone number of the analyst who covers the issue—along with a drop-down menu offering detailed research.

"Panopticon treemaps have greatly enhanced our users' ability to visualize the credit markets and utilize analytics—it was an important contributing factor to us winning the Euromoney award," says Lee McGinty, head of European Portfolio & Index Strategy at JPMorgan.

Source: Adapted from *Case Study: JPMorgan CreditMap*, www.panopticon.com, March 2008.

Using Decision Support Systems

A decision support system involves an interactive **analytical modeling** process. For example, using a DSS software package for decision support may result in a series of displays in response to alternative what-if changes entered by a manager. This differs from the demand responses of management information systems because decision makers are not demanding prespecified information; rather, they are exploring possible alternatives. Thus, they do not have to specify their information needs in advance. Instead, they use the DSS to find the information they need to help them make a decision. This is the essence of the decision support system concept.

Four basic types of analytical modeling activities are involved in using a decision support system: (1) what-if analysis, (2) sensitivity analysis, (3) goal-seeking analysis, and (4) optimization analysis. Let's briefly look at each type of analytical modeling that can be used for decision support. See Figure 10.16.

What-If Analysis

In **what-if analysis**, a user makes changes to variables, or relationships among variables, and observes the resulting changes in the values of other variables. For example, if you were using a spreadsheet, you might change a revenue amount (a variable) or a tax rate formula (a relationship among variables) in a simple financial spreadsheet model. Then you could command the spreadsheet program to recalculate all affected variables in the

FIGURE 10.16
Activities and examples of the major types of analytical modeling.

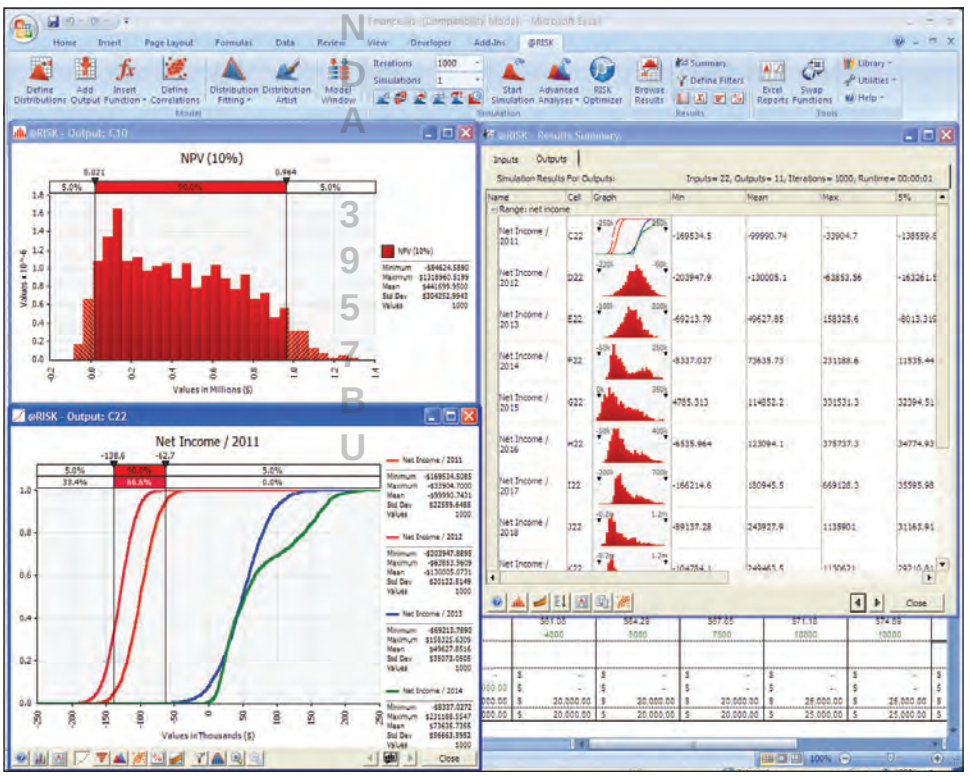
Type of Analytical Modeling	Activities and Examples
What-if analysis	Observing how changes to selected variables affect other variables. *Example:* What if we cut advertising by 10 percent? What would happen to sales?
Sensitivity analysis	Observing how repeated changes to a single variable affect other variables. *Example:* Let's cut advertising by $100 repeatedly so we can see its relationship to sales.
Goal-seeking analysis	Making repeated changes to selected variables until a chosen variable reaches a target value. *Example:* Let's try increases in advertising until sales reach $1 million.
Optimization analysis	Finding an optimum value for selected variables, given certain constraints. *Example:* What's the best amount of advertising to have, given our budget and choice of media?

spreadsheet instantly. A managerial user would be able to observe and evaluate any changes that occurred to the values in the spreadsheet, especially to a variable such as net profit after taxes. To many managers, net profit after taxes is an example of the *bottom line*, that is, a key factor in making many types of decisions. This type of analysis would be repeated until the manager was satisfied with what the results revealed about the effects of various possible decisions. Figure 10.17 is an example of what-if analysis.

Sensitivity Analysis

Sensitivity analysis is a special case of what-if analysis. Typically, the value of only one variable is changed repeatedly, and the resulting changes on other variables are observed. As such, sensitivity analysis is really a case of what-if analysis that involves repeated changes to only one variable at a time. Some DSS packages automatically make

FIGURE 10.17
This what-if analysis, performed by @RISK for Excel, involves the evaluation of probability distributions of net income and net present value (NPV) generated by changes to values for sales, competitors, product development, and capital expenses.



Source: @RISK software. Image courtesy of Palisade Corporation.

repeated small changes to a variable when asked to perform sensitivity analysis. Typically, decision makers use sensitivity analysis when they are uncertain about the assumptions made in estimating the value of certain key variables. In our previous spreadsheet example, the value of revenue could be changed repeatedly in small increments, and the effects on other spreadsheet variables observed and evaluated. This process would help a manager understand the impact of various revenue levels on other factors involved in decisions being considered. A typical example might be determining at what point the interest rate on a loan makes a project no longer feasible. By varying the interest rate used in a net present value calcuation, for example, a manager can determine the range of acceptable interest rates under which a project can move forward. Approaching the problem this way allows the manager to make decisions about a forthcoming project without knowing the actual cost of the money being borrowed.

Goal-Seeking Analysis

Goal-seeking analysis reverses the direction of the analysis done in what-if and sensitivity analyses. Instead of observing how changes in a variable affect other variables, goal-seeking analysis (also called *how-can* analysis) sets a target value (goal) for a variable and then repeatedly changes other variables until the target value is achieved. For example, you could specify a target value (goal) of $2 million in net profit after taxes for a business venture. Then you could repeatedly change the value of revenue or expenses in a spreadsheet model until you achieve a result of $2 million. Thus, you would discover the amount of revenue or level of expenses the business venture needs to reach the goal of $2 million in after-tax profits. Therefore, this form of analytical modeling would help answer the question, "How can we achieve $2 million in net profit after taxes?" instead of the question, "What happens if we change revenue or expenses?" So, goal-seeking analysis is another important method of decision support.

Optimization Analysis

Optimization analysis is a more complex extension of goal-seeking analysis. Instead of setting a specific target value for a variable, the goal is to find the optimum value for one or more target variables, given certain constraints. Then one or more other variables are changed repeatedly, subject to the specified constraints, until you discover the best values for the target variables. For example, you could try to determine the highest possible level of profits that could be achieved by varying the values for selected revenue sources and expense categories. Changes to such variables could be subject to constraints, such as the limited capacity of a production process or limits to available financing. Optimization typically is accomplished using software like the Solver tool in Microsoft Excel and other software packages for optimization techniques, such as linear programming.

Casual Male Retail Group: On-Demand Business Intelligence

Ask Dennis Hernreich, COO and CFO of Casual Male Retail Group, what his life was like before he switched to an on-demand business intelligence reporting application, and he remembers the frustration all too easily.

Casual Male Retail Group, a specialty retailer of big and tall men's apparel with $464 million in annual sales, was using a legacy on-premise reporting application for its catalog operations. (The company also has 520 retail outlets and e-commerce operations.) Yet the reporting features built into the system were "extremely poor," as Hernreich describes them: "Visibility to the business? Terrible. Real-time information? Doesn't exist. How are we doing with certain styles by size? Don't know."

"It was unacceptable," Hernreich says. In addition, you could only view those "canned" reports (which lacked features such as exception reporting) by making a trip to the printer for a stack of printouts. "It was hundreds of pages," he recalls. "That's just not how you operate today."

It's not as though Casual Male didn't have all this information; it just didn't have an intuitive and easy way to see the sales and inventory trends for its catalog business in real time. That changed in 2004, when Casual Male began to use a on-demand BI tool from vendor Oco (www.oco-inc.com), which takes all of Casual Male's data, builds and maintains a data warehouse for it off-site, and creates "responsive, real-time

reporting dashboards that give us and our business users information at their fingertips," Hernreich says.

Today, Hernreich and Casual Male's merchandise planners and buyers have access to easy-to-consume dashboards full of catalog data: "What styles are selling today? How much inventory are we selling today? Where are we short? Where do we need to order? How are we selling by size? What are we out of stock in?" he says. "All of these basic questions, in terms of running the business—that's what we're learning every day from these reports."

Best of all, those annoying trips to the printer have ended.

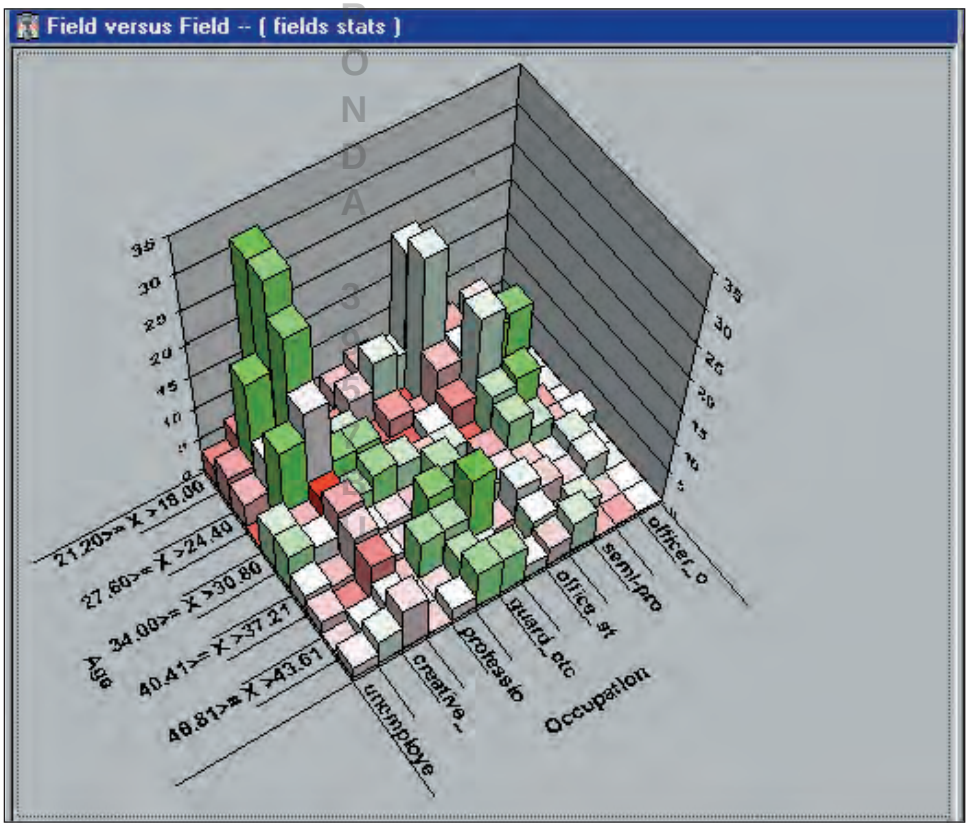
Source: Adapted from Thomas Wailgum, "Business Intelligence and On-Demand: The Perfect Marriage?" *CIO Magazine*, March 27, 2008.

Data Mining for Decision Support

We discussed **data mining** and data warehouses in Chapter 5 as vital tools for organizing and exploiting the data resources of a company. Thus, data mining's main purpose is to provide decision support to managers and business professionals through a process referred to as *knowledge discovery*. Data mining software analyzes the vast stores of historical business data that have been prepared for analysis in corporate data warehouses and tries to discover patterns, trends, and correlations hidden in the data that can help a company improve its business performance.

Data mining software may perform regression, decision tree, neural network, cluster detection, or market basket analysis for a business. See Figure 10.18. The data mining process can highlight buying patterns, reveal customer tendencies, cut redundant costs, or uncover unseen profitable relationships and opportunities. For example, many companies use data mining to find more profitable ways to perform successful direct mailings, including e-mailings, or discover better ways to display products in a store,

FIGURE 10.18
Data mining software helps discover patterns in business data, like this analysis of customer demographic information.



Source: Courtesy of XpertRule Software.

design a better e-commerce Web site, reach untapped profitable customers, or recognize customers or products that are unprofitable or marginal.

Market basket analysis (MBA) is one of the most common and useful types of data mining for marketing and is a key technique in business analytics. The purpose of market basket analysis is to determine which products customers purchase together with other products. MBA takes its name from the concept of customers throwing all of their purchases into a shopping cart (a market basket) during grocery shopping. It can be very helpful for a retailer or any other company to know which products people purchase as a group. A store could use this information to place products frequently sold together into the same area, and a catalog or World Wide Web merchant could use it to determine the layouts of a catalog and order form. Direct marketers could use the basket analysis results to determine which new products to offer their prior customers.

In some cases, the fact that items are sold together is obvious; every fast-food restaurant asks its customers "Would you like fries with that?" whenever a customer orders a sandwich. Sometimes, however, the fact that certain items would be sold together is far from obvious. A well-known example is the relationship between beer and diapers. A supermarket performing a basket analysis discovered that diapers and beer sell well together on Thursdays. Although the result makes some sense—couples stock up on supplies for themselves and for their children before the weekend starts—it's far from intuitive. The strength of market basket analysis is as follows: By using computer data mining tools, it's not necessary for a person to think of which products consumers would logically buy together; instead, the customers' sales data speak for themselves. This is a good example of data-driven marketing.

Consider some of the typical applications of MBA:

- **Cross Selling.** Offer the associated items when customer buys any items from your store.
- **Product Placement.** Items that are associated (such as bread and butter, tissues and cold medicine, potato chips and beer) can be put near each other. If the customers see them, it has higher probability that they will purchase them together.
- **Affinity Promotion.** Design the promotional events based on associated products.
- **Survey Analysis.** The fact that both independent and dependent variables of market basket analysis are nominal (categorical) data type makes MBA very useful to analyze questionnaire data.
- **Fraud Detection.** Based on credit card usage data, we may be able to detect certain purchase behaviors that can be associated with fraud.
- **Customer Behavior.** Associating purchase with demographic, and socioeconomic data (such as age, gender, and preference) may produce very useful results for marketing.

Once it is known that customers who buy one product are likely to buy another, it is possible for a company to market the products together or make the purchasers of one product target prospects for another. If customers who purchase diapers are already likely to purchase beer, they'll be even more likely to buy beer if there happens to be a beer display just outside the diaper aisle. Likewise, if it's known that customers who buy a sweater from a certain mail-order catalog have a propensity toward buying a jacket from the same catalog, sales of jackets can be increased by having the telephone representatives describe and offer the jacket to anyone who calls in to order the sweater. By targeting customers who are already known to be likely buyers, the effectiveness of a given marketing effort is significantly increased—regardless of whether the marketing takes the form of in-store displays, catalog layout design, or direct offers to customers.

Boston Celtics: Using Data Analytics to Price Tickets

Boston Celtics executives are taking advantage of a data analytics tool in their annual January task of setting prices for the 18,600 seats in TD Banknorth Garden. The NBA team installed the StratBridge.net tool from StratBridge Inc. to monitor consumer demand through real-time displays of sold and available seats in its home arena. Now team officials are also using the tool during the month-long project to set base ticket prices for the next season.

The new tool has helped the organization quickly develop promotions and sales strategies to fill available seats and to analyze revenue based on long-term sales trends, says Daryl Morey, senior vice president of operations and information for the Celtics. "Until we had this tool, it was very difficult to create dynamic packages because our ticket providers didn't have a rapid way to see which seats were open," Morey says. "Now we can actually see in real time every single seat and how much it is sold for."

The basketball team has already seen a "seven figure" return on investment fueled by five-figure revenue boosts every one to two weeks since it began to use StratBridge.net in 2006, according to Morey. Before using data analytics, sales executives used Excel spreadsheets to adjust pricing. In that system, pricing could be adjusted only for all the seats within each of 12 large sections in the arena. "It was a leap of faith looking at the data at that level," says Morey.

Using the analytics tool, for example, planners found that ticket buyers tended to favor aisle seating in certain sections; as a result, the team now focuses on marketing the inner seats. Now, in the ticket office, group- and individual-ticket sellers can see an image of the arena seating chart on a plasma TV screen with different color blocks indicating real-time availability and revenue for home games. Sales executives can access this information from their desktops to study buying trends and design new promotions.

StratBridge.net extracts data from internal and external sources and displays it visually in Internet browsers and Microsoft Office applications. The analysis can be presented to users in Word, Excel, PowerPoint, and Adobe PDF files. Bill Hostmann, an analyst at Gartner Inc., said companies trying to market "perishable" products like basketball games, hotel rooms, or live television broadcasts are beginning to turn to this type of data analysis, which was first perfected in the airline industry. "You're seeing more and more of this kind of analytical functionality being embedded in the application itself as a part of the process, as opposed to being done on a quarterly or weekly basis," Hostmann said. "The ROI is very fast on these types of applications."

Source: Adapted from Heather Havenstein, "Celtics Turn to Data Analytics Tool for Help Pricing Tickets," *Computerworld*, January 6, 2006.

Executive Information Systems

Executive information systems (EIS) are information systems that combine many of the features of management information systems and decision support systems. When they were first developed, their focus was on meeting the strategic information needs of top management. Thus, the first goal of executive information systems was to provide top executives with immediate and easy access to information about a firm's *critical success factors* (CSFs), that is, key factors that are critical to accomplishing an organization's strategic objectives. For example, the executives of a retail store chain would probably consider factors such as its e-commerce versus traditional sales results or its product line mix to be critical to its survival and success.

Yet managers, analysts, and other knowledge workers use executive information systems so widely that they are sometimes humorously called "everyone's information systems." More popular alternative names are enterprise information systems (EIS) and executive support systems (ESS). These names also reflect the fact that more features, such as Web browsing, e-mail, groupware tools, and DSS and expert system capabilities, are being added to many systems to make them more useful to managers and business professionals.

Features of an EIS

In an EIS, information is presented in forms tailored to the preferences of the executives using the system. For example, most executive information systems emphasize the use of a graphical user interface, as well as graphics displays that can be customized to

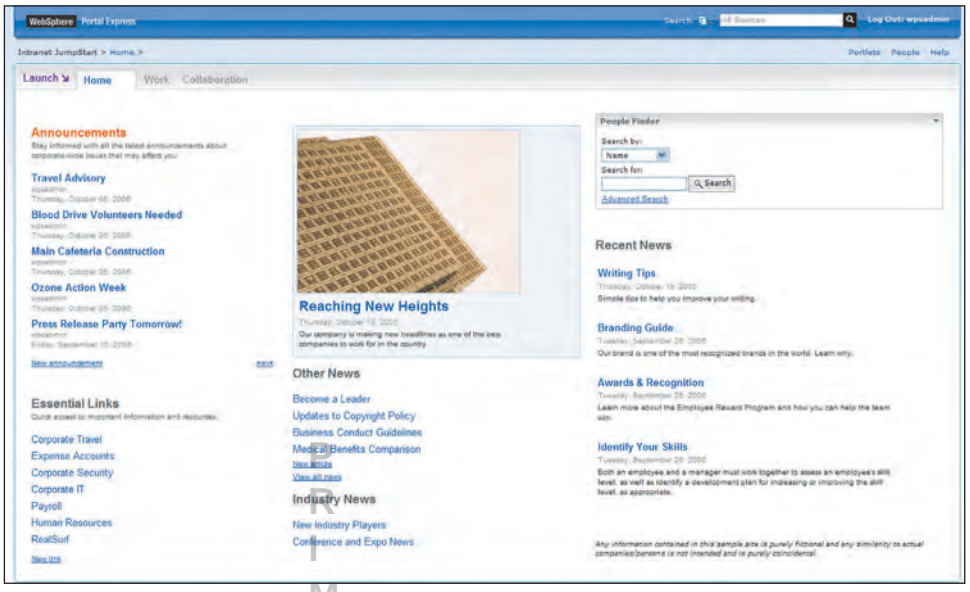


FIGURE 10.19
This Web-based executive information system provides managers and business professionals with a variety of personalized information and analytical tools for decision support.

Source: Courtesy of International Business Machines Corporation.

the information preferences of executives using the EIS. Other information presentation methods used by an EIS include exception reporting and trend analysis. The ability to *drill down*, which allows executives to retrieve displays of related information quickly at lower levels of detail, is another important capability.

Figure 10.19 shows one of the displays provided by the Web-enabled Hyperion executive information system. Notice that this display is simple and brief, and note how it provides users of the system with the ability to drill down quickly to lower levels of detail in areas of particular interest to them. In addition to the drill-down capability, the Hyperion EIS emphasizes trend analysis and exception reporting. Thus, a business user can quickly discover the direction in which key factors are heading and the extent to which critical factors are deviating from expected results.

Executive information systems have spread into the ranks of middle management and business professionals as their feasibility and benefits have been recognized and as less expensive systems for client/server networks and corporate intranets became available. For example, one popular EIS software package reports that only 3 percent of its users are top executives.

PureSense and Farming: Watering Plans Based on Minute-by-Minute Data

Derk VanKonynenburg used to think the information he got from measuring the soil moisture every 15 minutes on his 1,500-acre fruit and almond orchard was as precise as he could possibly need. He gets the data from probes that measure moisture in the soil and send readings over a wireless link to a collection station. From there, it's relayed to a data center, and VanKonynenburg accesses the data online from a PC, helping him decide when and how much to water the trees.

Once VanKonynenburg and his partners got accustomed to the feed, however, they wanted even more data, and they wanted it better. "We decided we needed a measurement every minute," he says.

That's right. On this one midsize farm around Modesto, California, a farmer is measuring the soil moisture every single minute of the day to make irrigation decisions.

Understand that VanKonynenburg isn't looking at that moisture count minute-by-minute like a stock ticker, waiting to hit the water switch. He looks about once a day to create an irrigation plan. But because the farm irrigates in bursts—say, seven minutes on and 14 minutes off—collecting readings every 15 minutes wasn't accurate enough. With better understanding of moisture needs, "We think it may allow us to lower our water use another 10 percent," says VanKonynenburg, "and 10 percent is a huge number."

PureSense was founded by a team of technologists and farmers determined to give farmers a better sense of what's going on in the ground on their farms, beyond just giving them weather data and related calculations. Farmers have been "running blind for years," says John Williamson, cofounder and chief operating officer of PureSense, which says it has about 200 customers, mostly in California.

VanKonynenburg is also looking for more uses for the data he's collecting on soil moisture, temperature, and sunshine. He'd like to use the dashboard he gets from PureSense, which is focused on irrigation decisions, to determine risks for certain pests, fungus, and bacteria to determine the best time to spray for them. Like any busy executive, he wants one decision-making dashboard.

Irrigation, like most elements of farming, won't become automated. Soil moisture provides insight into what's happening in the fields and allows more informed decisions, but there are still critical judgments to be made. "You need data and then you need smart people with enough experience to interpret that," VanKonynenburg says. "A lot of those decisions are subjective."

Although he could access his moisture sensor data on an iPhone, he laughs off the idea. "I'm 69 years old," he says, adding that checking data once a day on the computer is fine. Then, a moment later, VanKonynenburg can't help but confess: "I suspect that a year from now, I will be carrying one."

Source: Adapted from Chris Murphy, "Make Every Drop Count," *InformationWeek*, November 16, 2009.

Enterprise Portals and Decision Support

Don't confuse portals with the executive information systems that have been used in some industries for many years. Portals are for everyone in the company, and not just for executives. You want people on the front lines making decisions using browsers and portals rather than just executives using specialized executive information system software.

We mentioned previously in this chapter that major changes and expansions are taking place in traditional MIS, DSS, and EIS tools for providing the information and modeling managers need to support their decision making. Decision support in business is changing, driven by rapid developments in end-user computing and networking; Internet and Web technologies; and Web-enabled business applications. One of the key changes taking place in management information and decision support systems in business is the rapid growth of enterprise information portals.

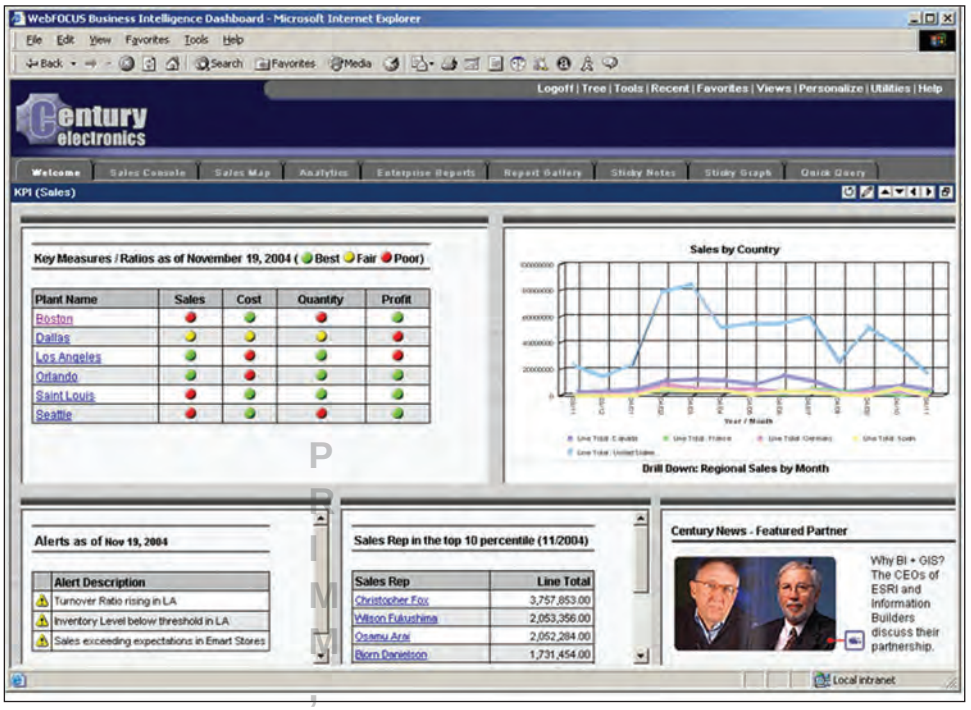
Enterprise Information Portals

A user checks his e-mail, looks up the current company stock price, checks his available vacation days, and receives an order from a customer—all from the browser on his desktop. That is the next-generation intranet, also known as a corporate or enterprise information portal. With it, the browser becomes the dashboard to daily business tasks.

An **enterprise information portal (EIP)** is a Web-based interface and integration of MIS, DSS, EIS, and other technologies that give all intranet users and selected extranet users access to a variety of internal and external business applications and services. For example, internal applications might include access to e-mail, project Web sites, and discussion groups; human resources Web self-services; customer, inventory, and other corporate databases; decision support systems; and knowledge management systems. External applications might include industry, financial, and other Internet news services; links to industry discussion groups; and links to customer and supplier Internet and extranet Web sites. Enterprise information portals are typically tailored or personalized to the needs of individual business users or groups of users, giving them a personalized *digital dashboard* of information sources and applications. See Figure 10.20.

The business benefits of enterprise information portals include providing more specific and selective information to business users, providing easy access to key corporate intranet Web site resources, delivering industry and business news, and providing better access to company data for selected customers, suppliers, or business partners. Enterprise information portals can also help avoid excessive surfing by employees across company

FIGURE 10.20
An enterprise information portal can provide a business professional with a personalized workplace of information sources, administrative and analytical tools, and relevant business applications.

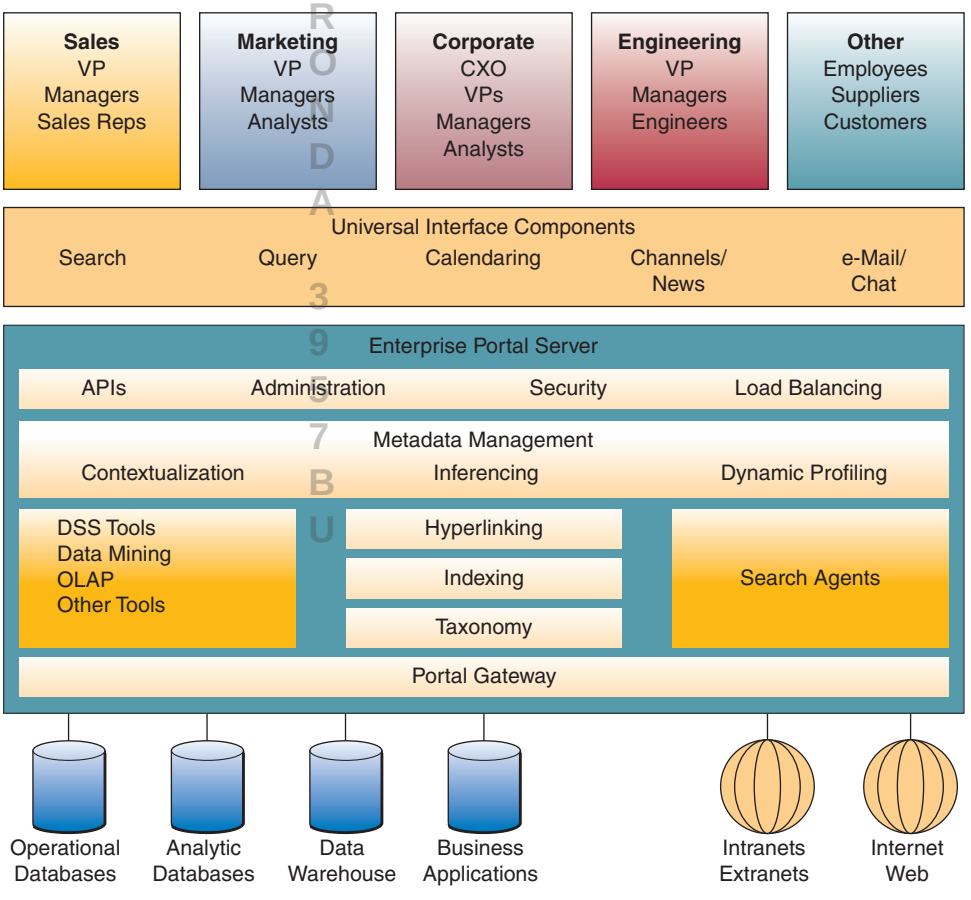


Source: Courtesy of Information Builders.

and Internet Web sites by making it easier for them to receive or find the information and services they need, thus improving the productivity of a company's workforce.

Figure 10.21 illustrates how companies are developing enterprise information portals as a way to provide Web-enabled information, knowledge, and decision

FIGURE 10.21
The components of this enterprise information portal identify it as a Web-enabled decision support system that can be personalized for executives, managers, employees, suppliers, customers, and other business partners.



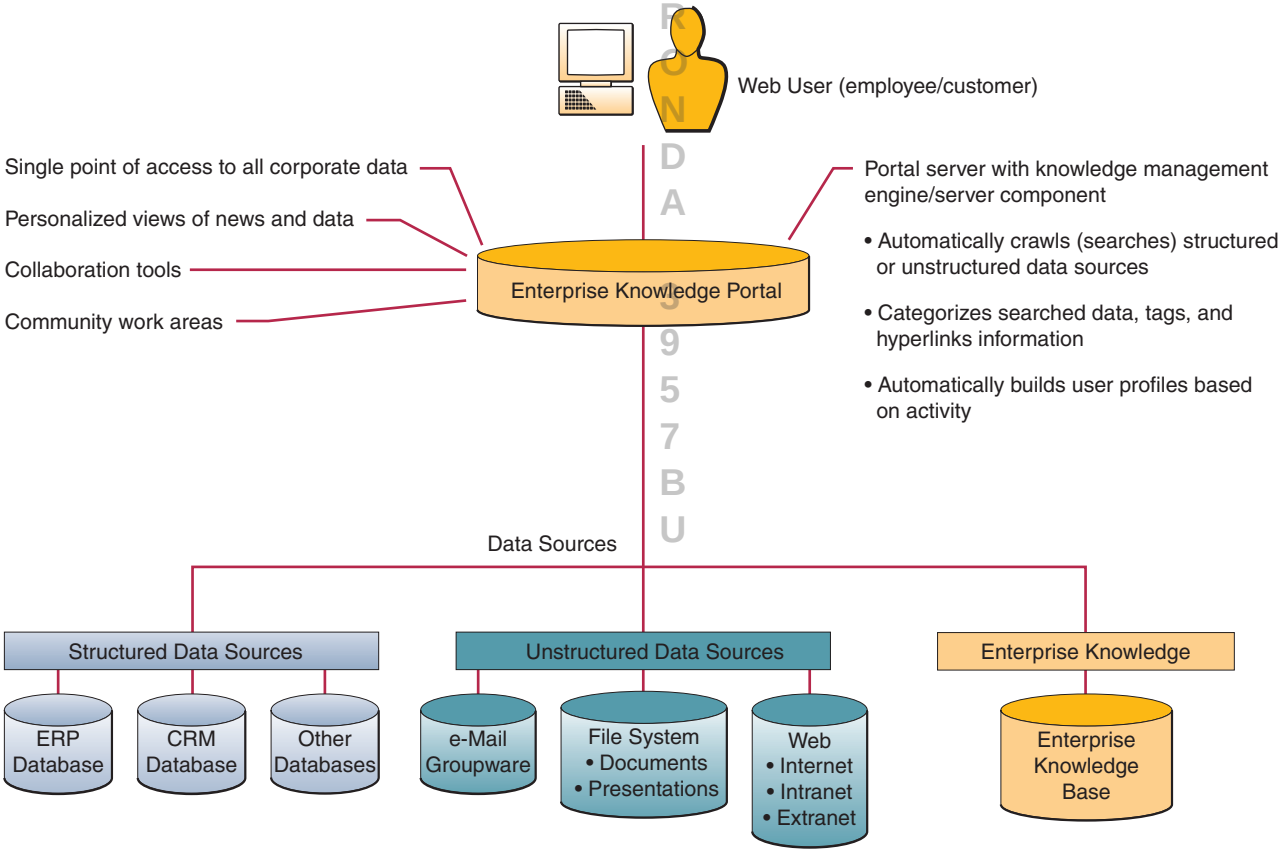
support to their executives, managers, employees, suppliers, customers, and other business partners. The enterprise information portal is a customized and personalized Web-based interface for corporate intranets, which gives users easy access to a variety of internal and external business applications, databases, and services. For example, the EIP in Figure 10.20 might give a qualified user secure access to DSS, data mining, and OLAP tools; the Internet and the Web; the corporate intranet; supplier or customer extranets; operational and analytical databases; a data warehouse; and a variety of business applications.

Knowledge Management Systems

We introduced **knowledge management systems** in Chapter 2 as the use of information technology to help gather, organize, and share business knowledge within an organization. In many organizations, hypermedia databases at corporate intranet Web sites have become the *knowledge bases* for storage and dissemination of business knowledge. This knowledge frequently takes the form of best practices, policies, and business solutions at the project, team, business unit, and enterprise levels of the company.

For many companies, enterprise information portals are the entry to corporate intranets that serve as their knowledge management systems. That's why such portals are called **enterprise knowledge portals** by their vendors. Thus, enterprise knowledge portals play an essential role in helping companies use their intranets as knowledge management systems to share and disseminate knowledge in support of business decision making by managers and business professionals. See Figure 10.22. Now let's look at an example of a knowledge management system in business.

FIGURE 10.22 This example of the capabilities and components of an enterprise knowledge portal emphasizes its use as a Web-based knowledge management system.



Northrop Grumman: Passing Knowledge Down through Generations

In 1997, with the Cold War well behind them, thousand of engineers who had helped design and maintain the B-2 bomber were asked to leave the integrated systems sector of Northrop Grumman. As the nearly 12,000 workers filed out the door, leaving only 1,200 from a staff of 13,000, they took with them years of experience and in-depth knowledge about what was considered at the time to be the most complex aircraft ever built.

Northrop Grumman knew it had to keep enough of that know-how to support the division's long-term maintenance of the B-2 bomber, so a newly formed knowledge management team identified top experts and videotaped interviews with them before they left. But it was hard to get everything in a single interview, says Scott Shaffar, Northrop Grumman's director of knowledge management for the Western region of the integrated systems sector. "We did lose some of that knowledge," says Shaffar. "In an exit interview, you can capture certain things, but not a lifetime of experience."

Several years later, the company uses a variety of tools to retain and transfer knowledge from its engineers—well before they retire. Shaffar and his team have put in place document management systems and common work spaces that record how an engineer did his job for future reference. They have started programs that bring together older and younger engineers across the country to exchange information via e-mail or in person about technical problems, and they are using software that helps people find experts within the company.

Although most companies won't face the sudden departure of thousands of skilled workers, as Northrop Grumman did in the late 1990s, they and government agencies alike will need to prepare for the loss of important experience and technical knowledge as the baby boomer generation gets ready to retire over the coming decade. By 2010, more than half of all workers in the United States will be over 40. While most top managers are aware that they'll soon have a lot of workers retiring, few are doing much to prepare for the event. That's often because it's hard to quantify the cost of losing knowledge.

At Northrop Grumman, times have changed since its massive downsizing in the 1990s. Although a large percentage of its workforce is nearing retirement, the average age of employees has dropped from the high 40s to the mid 40s in the past four years since the company started hiring more college grads. Shaffar says he is now working on balancing the more gradual transfer of knowledge from older to younger workers, with the need to capture some crucial expertise quickly before it's too late. For example, Northrop Grumman engineers who are competing on a proposal for a "crew exploration vehicle," which is being designed to replace the space shuttle and travel to the moon (and eventually to Mars), met with a group of retirees who worked on the Apollo program that sent men to the moon more than 35 years ago.

Using a PC program called Quindi and a camera attached to a laptop, a facilitator recorded retirees telling stories about how they grappled with the technical problems of sending a man to the moon. These tales will be available as Web pages for engineers working on this project. Shaffar acknowledges that employees would rather go to another person than a system for advice, but he says the exercise helped capture knowledge that otherwise soon would be gone.

Most important, Shaffar has learned that the problem goes beyond looking at what skills you have right now. "There have always been new generations, and we're not any different in that way," he says. "Mentoring, training and passing on knowledge is not something you can do at the last minute. You have to plan ahead."

Source: Adapted from Susannah Patton, "How to Beat the Baby Boomer Retirement Blues," *CIO Magazine*, January 15, 2006.

SECTION II Artificial Intelligence Technologies in Business

Business and AI

Artificial intelligence (AI) technologies are being used in a variety of ways to improve the decision support provided to managers and business professionals in many companies. See Figure 10.23. For example:

> *AI-enabled applications are at work in information distribution and retrieval, database mining, product design, manufacturing, inspection, training, user support, surgical planning, resource scheduling, and complex resource management.*
>
> *Indeed, for anyone who schedules, plans, allocates resources, designs new products, uses the Internet, develops software, is responsible for product quality, is an investment professional, heads up IT, uses IT, or operates in any of a score of other capacities and arenas, AI technologies already may be in place and providing competitive advantage.*

Read the Real World Case on the next page. We can learn a lot about innovative uses of virtual reality in business from this example.

An Overview of Artificial Intelligence

What is artificial intelligence? **Artificial intelligence (AI)** is a field of science and technology based on disciplines such as computer science, biology, psychology, linguistics, mathematics, and engineering. The goal of AI is to develop computers that can simulate the ability to think, as well as see, hear, walk, talk, and feel. A major thrust of artificial intelligence is the simulation of computer functions normally associated with human intelligence, such as reasoning, learning, and problem solving, as summarized in Figure 10.24.

Debate has raged about artificial intelligence since serious work in the field began in the 1950s. Technological, moral, and philosophical questions about the possibility of intelligent, thinking machines are numerous. For example, British AI pioneer Alan Turing in 1950 proposed a test to determine whether machines could think. According to the Turing test, a computer could demonstrate intelligence if a human interviewer, conversing with an unseen human and an unseen computer, could not tell which was which. Although much work has been done in many of the subgroups that fall under the AI umbrella, critics believe that no computer can truly pass the Turing test. They claim that it is just not possible to develop intelligence to impart true humanlike capabilities to computers, but progress continues. Only time will tell whether we will achieve the ambitious goals of artificial intelligence and equal the popular images found in science fiction.

One derivative of the Turing test that is providing real value to the online community is a CAPTCHA. A **CAPTCHA** (Completely Automated Public Turing test to tell Computers and Humans Apart) is a type of challenge-response test used in a wide variety of computing applications to determine that the user is really a human and not a computer posing as one. A CAPTCHA is sometimes described as a reverse Turing test because it is administered by a machine and targeted to a human, in contrast to the standard Turing test that is typically administered by a human and targeted to a machine. The process involves one computer (such as a server for a retail Web site) asking a user to complete a simple test that the computer is able to generate and grade. Because other computers are unable to solve the CAPTCHA, any user entering a correct solution is presumed to be human. A common type of CAPTCHA requires that the user type the letters of a distorted image, sometimes with the addition of an obscured sequence of letters or digits that appears on the screen. No doubt you have seen this when registering for a new account with a merchant or checking out from an online purchase. Figure 10.25 shows several common examples of CAPTCHA patterns.

REAL WORLD CASE 2

Kimberly-Clark Corp.: Shopping for Virtual Products in Virtual Stores

Using a new tool developed by Kimberly-Clark Corp., a woman stood surrounded by three screens showing a store aisle, a retina-tracking device recording her every glance. At Kimberly-Clark, innovation doesn't stop with developing more-absorbent diapers or stronger paper towels. The consumer-goods maker also is using IT to help retailers market and sell products—and not just the ones made by Kimberly-Clark.

Virtual reality technology has found its footing in many industries and applications, including health care, automotive, and aerospace. Now, consumer goods manufacturer Kimberly-Clark has incorporated proprietary virtual reality technology into its new Innovation Design Studio, and it expects big payback from its technological leap.

Asked by a Kimberly-Clark researcher to find a big box of Huggies Natural Fit diapers in size three, the woman pushed forward on a handle like that of a shopping cart, and the video simulated her progress down the aisle. Spotting the distinctive red packages of Huggies, she turned the handle to the right to face a dizzying array of diapers. After pushing a button to get a kneeling view of the shelves, she reached forward and tapped the screen to put the box she wanted in her virtual cart.

Kimberly-Clark hopes these virtual shopping aisles will help it better understand consumer behavior and make the testing of new products faster, more convenient, and more precise.

The mobile testing unit is usually based in a new high-tech studio that Kimberly-Clark completed in the basement of a nondescript office building in Appleton, Wisconsin. The cavernous room also features a U-shaped floor-to-ceiling screen that re-creates in vivid detail interiors of the big retailers that sell the company's products—a tool that the company will use in presentations to executives in bids to win shelf space. A separate area is reserved for real replicas of store interiors, which can be customized to match the flooring, light fixtures, and shelves of retailers such as Target Corp. and Walmart Stores Inc.

As the fragmented television market raises doubts about the effectiveness of traditional ads and competition for shelf space increases, manufacturers and retailers are intensifying their focus on ways to get consumers' attention while they are in the store.

The efforts go well beyond the usual cardboard displays and sample handouts. A group including manufacturers Procter & Gamble Co., Coca-Cola Co., and General Mills Inc., and retailers Kroger Co. and Walmart announced the results of a test that tracked shoppers' movement in stores using a combination of infrared beams and human observation.

Nielsen Co. plans to syndicate such data and sell it to clients, much as it does with television ratings.

"By engaging ourselves and our customers in this virtual world, we can spark better ideas to improve the shopping experience and collaborate on new product concepts and innovations," says Ramin Elvaz, Kimberly-Clark vice president of North Atlantic Insight, Strategy and Growth.

Kimberly-Clark says its studio allows researchers and designers to get a fast read on new product designs and displays without having to stage real-life tests in the early stages of development. Doing the research in a windowless basement, rather than an actual test market, also avoids tipping off competitors early in the development process.

"We're trying to test ideas faster, cheaper, and better," says Ramin Eivaz, a vice president at Kimberly-Clark focusing on strategy.

Before, new product testing typically took eight months to two years. Now, that time is cut in half, he says. Projects that test well with the virtual-reality tools will be fast-tracked to real-store trials, Mr. Eivaz says.

Once product design options have been determined, Kimberly-Clark brings retail executives into the studio so they can see how the new product would actually look on the shelf and fit in with the existing assortment—an important factor in decisions the retailers make on space.

The company declined to reveal how much it spent to build the Appleton studio. "We made a significant investment in the studio and expect it will yield a positive return with our customers in the future," a spokesman says.

The battle for shelf space is accelerating as consumer-products companies have introduced more and more new products. Meanwhile, retailers are churning out more of their own private-label products. The rate of new-product launches has grown steadily since 2000, with more than 40,000 new packaged-goods introductions in 2007, says Tom

FIGURE 10.23

Virtual reality technologies enable companies to develop and test new products without actually making them.

Source: © Toru Hanai/Reuters/Landov.

Vierhile, director of Productscan Online, market research firm Datamonitor's database of new products.

However, Kimberly-Clark is particularly enthusiastic about how the design center can help its retail partners improve their in-store designs and merchandising. For example, using the virtual reality technology and K-C SmartStation, the manufacturer can create store models, allowing retailers to envision hypothetical store designs and merchandising concepts. Likewise, eye-tracking technology in the high-tech kiosk allows the study of consumers' reactions in simulated shopping settings to determine how different environments or packaging affect buying decisions.

Inside the center's virtual reality theater, visitors are surrounded by screens on which rear-projection equipment displays virtual images powered by applications running on eight Hewlett-Packard high-end rack-mount PCs. The system's 3-D capabilities were developed with RedDotSquare. Sensors embedded in the walls, ceilings, and floor detect the visitors' movements, track their locations, and can even tell exactly what they're looking at, says Kurt Schweitzer, director, IT business partner for marketing, strategy, and innovation. This allows the system to further immerse visitors by making things happen around them, such as opening a door near where they're standing or changing their perspective on what's going on, he says.

The center lets store managers use "multiple senses and not just visualization" to assess product display effectiveness, Schweitzer says. The front screen of the immersion center is more than 20 feet wide and is flanked by two side screens that rest at 45-degree angles, creating a wraparound effect.

The wings can move inward to 90-degree angles, forming a three-sided box. "When you step into that 8-foot-high physical space, the word immersive takes on a whole new meaning," Schweitzer says.

To sell retailers on new products, manufacturers are revealing more about their product pipelines to drum up interest early on. Over the past several months, Kimberly-Clark says it has brought in executives from major chains, including Target, Walmart and Kroger, to see the Appleton facility. Kimberly-Clark uses the data from its virtual-reality tests with consumers to tout how products in development perform.

"It no longer works to show up on a retailer's doorstep with your new product and say, 'Isn't this pretty?'" Mr. Eivaz says. "We need to be an indispensable partner to our retailers and show we can do more for them."

When grocery chain Safeway Inc. asked its major manufacturers for display suggestions to lift traffic through its center aisles in late 2005, Kimberly-Clark used an early version of the virtual-reality modeling technology it was developing for the new studio to pitch for more room for its Huggies diapers and other baby products. The company created three-dimensional models of a store display that resembled a nursery, complete with a giant, colorful bathtub.

The company had consumers navigate the store virtually, testing how easily they could find certain items in the area.

"We hadn't seen that type of technology applied to that type of traditional merchandising and store decor before," says Michael Minasi, Safeway's president of marketing. When it tested the display inside its stores, sales of items in that section increased. Nevertheless, in the end, reality set limits. "Some of the decor and decoration components were easier to do virtually than they were to do in the real world, mostly from a cost and implementation standpoint," Minasi says. However, a version of Kimberly-Clark's concept was put in place at a handful of Safeway stores.

In the store-model section of its new studio, Kimberly-Clark goes to elaborate lengths with its re-creations aimed to impress retail executives. Once, the company readied the studio for visitors from Target. The store's branded shopping carts were lined up at the doorway, next to a stand holding recent Target sales fliers and a faux ATM. Standing behind a pharmacy counter was a Kimberly-Clark employee outfitted in a lab coat with a Target logo. Target's standard white tiles covered the floor, its beige light fixtures hung above, and Target store shelves were fully stocked with diapers and other baby products made by Kimberly-Clark and its competitors.

"What if you just spent a lot of money on a package's shade of red but it doesn't look good in their store?" says Don Quigley, president of Kimberly-Clark's consumer sales and customer development, North America. "This is where you can spot that, before you ship a single case of product."

Source: Adapted from Ellen Byron, "A Virtual View of the Store Aisle," *Wall Street Journal*, October 3, 2007; Jill Jusko, "Kimberly-Clark Embraces Virtual Reality," *IndustryWeek*, December 1, 2007; and Marianne Kolbasuk McGee, "InformationWeek 500: Kimberly-Clark's Virtual Product Demo Center Yields Real Ideas on How to Sell More Products," *InformationWeek*, September 17, 2007.

CASE STUDY QUESTIONS

1. What are the business benefits derived from the technology implementation described in the case? Also discuss benefits other than those explicitly mentioned in the case.
2. Are virtual stores like this one just an incremental innovation on the way marketing tests new product designs? Or do they have the potential to radically reinvent the way these companies work? Explain your reasons.
3. What other industries could benefit from deployments of virtual reality like the one discussed in the case? Leaving aside the cost of the technology, what new products or services could you envision within those industries? Provide several examples.

REAL WORLD ACTIVITIES

1. What is the current cutting-edge technology in virtual reality, and how are companies using it? Go online to research this topic and prepare a presentation to share your work.
2. With technologies like these, will consumers entirely do away with retailers sometime in the future, shopping only through virtual representations of a retail store? Will consumers even want it to look like a retail store? Break into small groups to propose arguments for and against these questions.

FIGURE 10.24
Some of the attributes of intelligent behavior. AI is attempting to duplicate these capabilities in computer-based systems.

Attributes of Intelligent Behavior
• Think and reason.
• Use reason to solve problems.
• Learn or understand from experience.
• Acquire and apply knowledge.
• Exhibit creativity and imagination.
• Deal with complex or perplexing situations.
• Respond quickly and successfully to new situations.
• Recognize the relative importance of elements in a situation.
• Handle ambiguous, incomplete, or erroneous information.

The Domains of Artificial Intelligence

Figure 10.26 illustrates the major **domains** of AI research and development. Note that AI **applications** can be grouped under three major areas—cognitive science, robotics, and natural interfaces—though these classifications do overlap, and other classifications can be used. Also note that expert systems are just one of many important AI applications. Let's briefly review each of these major areas of AI and some of their current technologies. Figure 10.27 outlines some of the latest developments in commercial applications of artificial intelligence.

Cognitive Science. This area of artificial intelligence is based on research in biology, neurology, psychology, mathematics, and many allied disciplines. It focuses on researching how the human brain works and how humans think and learn. The results of such research in *human information processing* are the basis for the development of a variety of computer-based applications in artificial intelligence.

Applications in the cognitive science area of AI include the development of *expert systems* and other *knowledge-based systems* that add a knowledge base and some reasoning capability to information systems. Also included are *adaptive learning systems* that can modify their behaviors on the basis of information they acquire as they operate. Chess-playing systems are primitive examples of such applications, though many more applications are being implemented. *Fuzzy logic* systems can process data that are incomplete or ambiguous, that is, *fuzzy data*. Thus, they can solve semistructured

FIGURE 10.25
Examples of typical CAPTCHA patterns that can be easily solved by humans but prove difficult to detect by a computer.

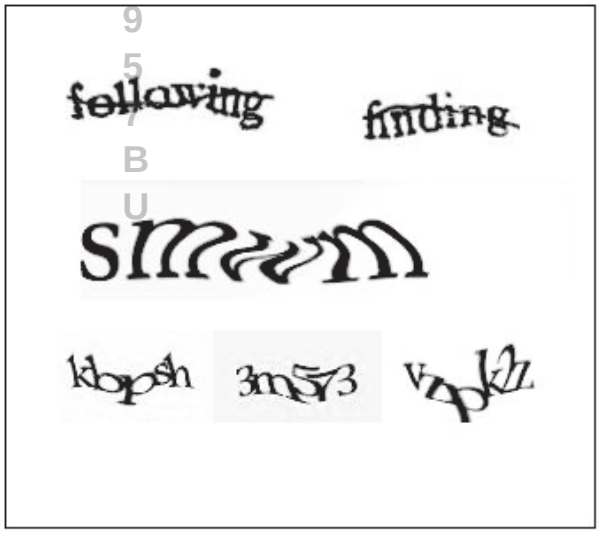
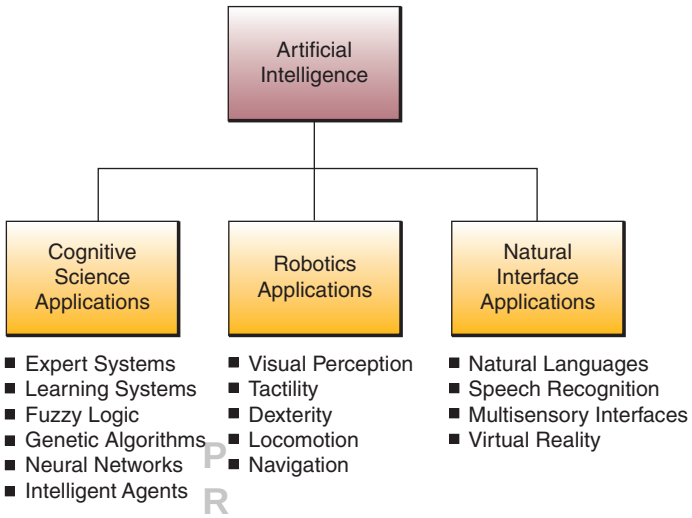


FIGURE 10.26
The major application areas of artificial intelligence. Note that the many applications of AI can be grouped into the three major areas of cognitive science, robotics, and natural interfaces.



problems with incomplete knowledge by developing approximate inferences and answers, as humans do. *Neural network* software can learn by processing sample problems and their solutions. As neural nets start to recognize patterns, they can begin to program themselves to solve such problems on their own. *Genetic algorithm* software uses Darwinian (survival of the fittest), randomizing, and other mathematics functions

FIGURE 10.27
Examples of some of the latest commercial applications of AI.

Commercial Applications of AI
Decision Support • Intelligent work environment that will help you capture the *why* as well as the *what* of engineered design and decision making. • Intelligent human–computer interface (HCI) systems that can understand spoken language and gestures, and facilitate problem solving by supporting organizationwide collaborations to solve particular problems. • Situation assessment and resource allocation software for uses that range from airlines and airports to logistics centers.
Information Retrieval • AI-based intranet and Internet systems that distill tidal waves of information into simple presentations. • Natural language technology to retrieve any sort of online information, from text to pictures, videos, maps, and audio clips, in response to English questions. • Database mining for marketing trend analysis, financial forecasting, maintenance cost reduction, and more.
Virtual Reality • X-ray–like vision enabled by enhanced-reality visualization that allows brain surgeons to "see through" intervening tissue to operate, monitor, and evaluate disease progression. • Automated animation interfaces that allow users to interact with virtual objects via touch (e.g., medical students can "feel" what it's like to suture severed aortas).
Robotics • Machine-vision inspections systems for gauging, guiding, identifying, and inspecting products and providing competitive advantage in manufacturing. • Cutting-edge robotics systems, from microrobots and hands and legs to cognitive robotic and trainable modular vision systems.

to simulate evolutionary processes that can generate increasingly better solutions to problems. In addition, *intelligent agents* use expert system and other AI technologies to serve as software surrogates for a variety of end-user applications.

Robotics. AI, engineering, and physiology are the basic disciplines of **robotics.** This technology produces robot machines with computer intelligence and computer-controlled, humanlike physical capabilities. This area thus includes applications designed to give robots the powers of sight, or visual perception; touch, or tactile capabilities; dexterity, or skill in handling and manipulation; locomotion, or the physical ability to move over any terrain; and navigation, or the intelligence to find one's way to a destination.

Natural Interfaces. The development of natural interfaces is considered a major area of AI applications and is essential to the natural use of computers by humans. For example, the development of *natural languages* and speech recognition are major thrusts of this area of AI. Being able to talk to computers and robots in conversational human languages and have them "understand" us as easily as we understand each other is a goal of AI research. This goal involves research and development in linguistics, psychology, computer science, and other disciplines. Other natural interface research applications include the development of multisensory devices that use a variety of body movements to operate computers, which is related to the emerging application area of *virtual reality*. Virtual reality involves using multisensory human–computer interfaces that enable human users to experience computer-simulated objects, spaces, activities, and "worlds" as if they actually exist. Now, let's look at some examples of how AI is becoming increasingly more relevant in the business world.

Artificial Intelligence Gets Down to Business

Today, AI systems can perform useful work in "a very large and complex world," says Eric Horvitz, an AI researcher at Microsoft Research (MSR). "Because these small software agents don't have a complete representation of the world, they are uncertain about their actions. So they learn to understand the probabilities of various things happening, they learn the preferences of users and costs of outcomes and, perhaps most important, they are becoming self-aware."

These abilities derive from something called machine learning, which is at the heart of many modern AI applications. In essence, a programmer starts with a crude model of the problem he's trying to solve but builds in the ability for the software to adapt and improve with experience.

Speech recognition software gets better as it learns the nuances of your voice, for example, and over time Amazon.com more accurately predicts your preferences as you shop online. Machine learning is enabled by clever algorithms, of course, but what has driven it to prominence in recent years is the availability of huge amounts of data, both from the Internet and, more recently, from a proliferation of physical sensors.

For instance, Microsoft Research has combined sensors, machine learning, and analysis of human behavior in a road traffic prediction model. Predicting traffic bottlenecks would seem to be an obvious and not very difficult application of sensors and computer forecasting. But MSR realized that most drivers hardly need to be warned that the interstate heading out of town will be jammed at 5 p.m. on Monday. What they really need to know is where and when anomalies, or "surprises," are occurring and, perhaps more important, where they will occur. So MSR built a "surprise forecasting" model that learns from traffic history to predict surprises 30 minutes in advance based on actual traffic flows captured by sensors. In tests, it has been able to predict about 50 percent of the surprises on roads in the Seattle

area, and it is in use now by several thousand drivers who receive alerts on their Windows Mobile devices.

Few organizations need to make sense of as much data as do search engine companies. For example, if a user searches Google for "toy car" and then clicks on a Walmart ad that appears at the top of the results, what's that worth to Walmart, and how much should Google charge for that click? The answers lie in an AI specialty that employs "digital trading agents," which companies like Walmart and Google use in automated online auctions.

Michael Wellman, a University of Michigan professor and an expert in these markets, explains: "There are millions of keywords, and one advertiser may be interested in hundreds or thousands of them. They have to monitor the prices of the keywords and decide how to allocate their budget, and it's too hard for Google or Yahoo to figure out what a certain keyword is worth. They let the market decide that through an auction process."

When the "toy car" query is submitted, in a fraction of a second Google looks up which advertisers are interested in those keywords, then looks at their bids and decides whose ads to display and where to put them on the page. "The problem I'm especially interested in," Wellman says, "is how should an advertiser decide which keywords to bid on, how much to bid and how to learn over time—based on how effective their ads are—how much competition there is for each keyword."

Source: Adapted from Gary Anthes, "Future Watch: A.I. Comes of Age," *Computerworld*, January 26, 2009.

Expert Systems

One of the most practical and widely implemented applications of artificial intelligence in business is the development of expert systems and other knowledge-based information systems. A knowledge-based information system (KBIS) adds a knowledge base to the major components found in other types of computer-based information systems. An **expert system (ES)** is a knowledge-based information system that uses its knowledge about a specific, complex application area to act as an expert consultant to end users. Expert systems provide answers to questions in a very specific problem area by making humanlike inferences about knowledge contained in a specialized knowledge base. They must also be able to explain their reasoning process and conclusions to a user, so expert systems can provide decision support to end users in the form of advice from an expert consultant in a specific problem area.

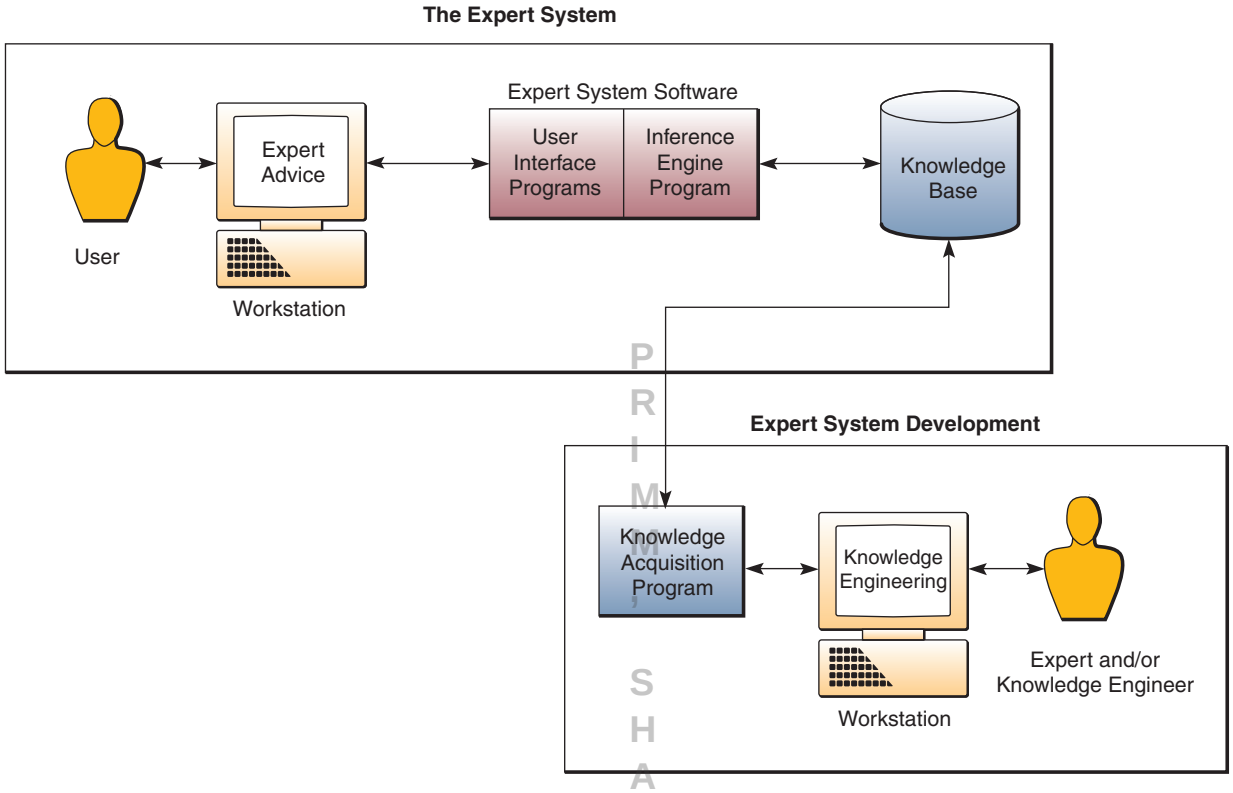
Components of an Expert System

The components of an expert system include a knowledge base and software modules that perform inferences on the knowledge in the knowledge base and communicate answers to a user's questions. Figure 10.28 illustrates the interrelated components of an expert system. Note the following components:

FIGURE 10.28
A summary of four ways that knowledge can be represented in an expert system's knowledge base.

Methods of Knowledge Representation
• **Case-Based Reasoning.** Representing knowledge in an expert system's knowledge base in the form of cases, that is, examples of past performance, occurrences, and experiences.
• **Frame-Based Knowledge.** Knowledge represented in the form of a hierarchy or network of *frames*. A frame is a collection of knowledge about an entity consisting of a complex package of data values describing its attributes.
• **Object-Based Knowledge.** Knowledge represented as a network of objects. An object is a data element that includes both data and the methods or processes that act on those data.
• **Rule-Based Knowledge.** Knowledge represented in the form of rules and statements of fact. Rules are statements that typically take the form of a premise and a conclusion, such as If (condition), Then (conclusion).

FIGURE 10.29 Components of an expert system. The software modules perform inferences on a knowledge base built by an expert and/or knowledge engineer. This provides expert answers to an end user's questions in an interactive process.



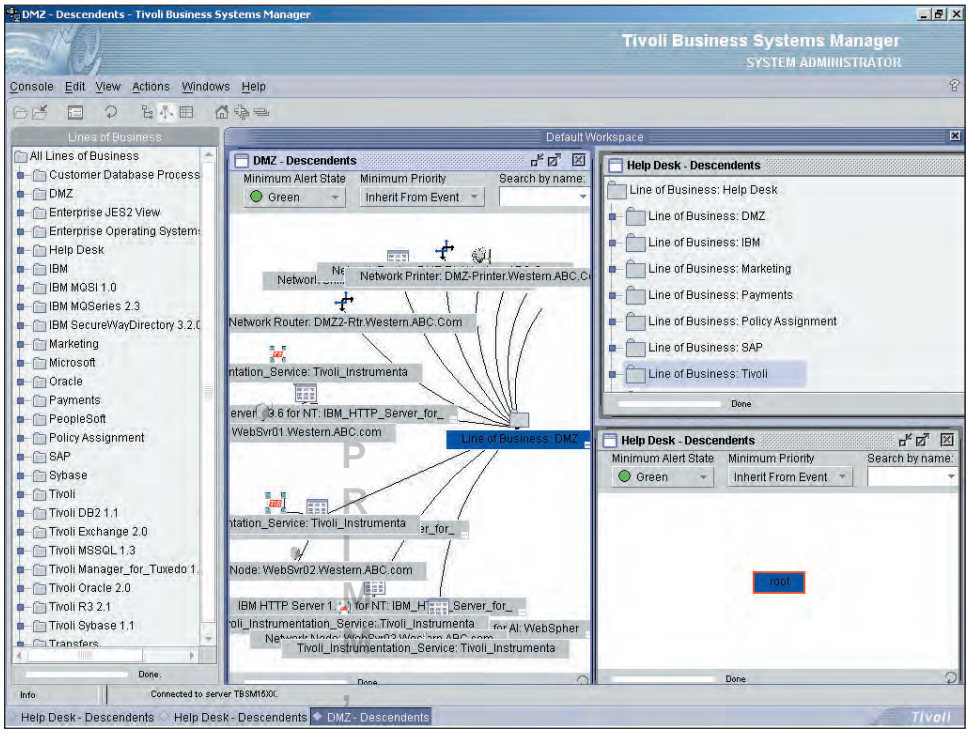
- **Knowledge Base**. The knowledge base of an expert system contains (1) facts about a specific subject area (e.g., *John is an analyst*) and (2) heuristics (rules of thumb) that express the reasoning procedures of an expert on the subject (e.g., *IF John is an analyst, THEN he needs a workstation*). There are many ways that such knowledge is represented in expert systems. Examples are *rule-based*, *frame-based*, *object-based*, and *case-based* methods of knowledge representation. See Figure 10.29.
- **Software Resources.** An expert system software package contains an inference engine and other programs for refining knowledge and communicating with users. The **inference engine** program processes the knowledge (such as rules and facts) related to a specific problem. It then makes associations and inferences resulting in recommended courses of action for a user. User interface programs for communicating with end users are also needed, including an explanation program to explain the reasoning process to a user if requested. Knowledge acquisition programs are not part of an expert system but are software tools for knowledge base development, as are *expert system shells*, which are used for developing expert systems.

Expert System Applications

Using an expert system involves an interactive computer-based session in which the solution to a problem is explored, with the expert system acting as a consultant to an end user. The expert system asks questions of the user, searches its knowledge base for facts and rules or other knowledge, explains its reasoning process when asked, and gives expert advice to the user in the subject area being explored. For example, Figure 10.30 illustrates an expert system application.

Expert systems are being used for many different types of applications, and the variety of applications is expected to continue to increase. You should realize, however,

FIGURE 10.30
Tivoli Business Systems Manager by IBM automatically monitors and manages the computers in a network with proactive expert system software components based on IBM's extensive mainframe systems management expertise.



Source: Courtesy of International Business Machines Corporation.

that expert systems typically accomplish one or more generic uses. Figure 10.31 outlines five generic categories of expert system activities, with specific examples of actual expert system applications. As you can see, expert systems are being used in many different fields, including medicine, engineering, the physical sciences, and business. Expert systems now help diagnose illnesses, search for minerals, analyze compounds, recommend repairs, and do financial planning. So from a strategic business standpoint, expert systems can be and are being used to improve every step of the product cycle of a business, from finding customers to shipping products to providing customer service.

Benefits of Expert Systems

An expert system captures the expertise of an expert or group of experts in a computer-based information system. Thus, it can outperform a single human expert in many problem situations. That's because an expert system is faster and more consistent, can have the knowledge of several experts, and does not get tired or distracted by overwork or stress. Expert systems also help preserve and reproduce the knowledge of experts. They allow a company to preserve the expertise of an expert before she leaves the organization. This expertise can then be shared by reproducing the software and knowledge base of the expert system.

Limitations of Expert Systems

The major limitations of expert systems arise from their limited focus, inability to learn, maintenance problems, and developmental cost. Expert systems excel only in solving specific types of problems in a limited domain of knowledge. They fail miserably in solving problems requiring a broad knowledge base and subjective problem solving. They do well with specific types of operational or analytical tasks but falter at subjective managerial decision making.

Expert systems may also be difficult and costly to develop and maintain. The costs of knowledge engineers, lost expert time, and hardware and software resources may be too high to offset the benefits expected from some applications. Also, expert systems can't maintain themselves; that is, they can't learn from experience but instead must be

FIGURE 10.31
Major application categories and examples of typical expert systems. Note the variety of applications that can be supported by such systems.

Application Categories of Expert Systems
• **Decision Management.** Systems that appraise situations or consider alternatives and make recommendations based on criteria supplied during the discovery process: Loan portfolio analysis Employee performance evaluation Insurance underwriting Demographic forecasts
• **Diagnostic/Troubleshooting.** Systems that infer underlying causes from reported symptoms and history: Equipment calibration Help desk operations Software debugging Medical diagnosis
• **Design/Configuration.** Systems that help configure equipment components, given existing constraints: Computer option installation Manufacturability studies Communications networks Optimum assembly plan
• **Selection/Classification.** Systems that help users choose products or processes, often from among large or complex sets of alternatives: Material selection Delinquent account identification Information classification Suspect identification
• **Process Monitoring/Control.** Systems that monitor and control procedures or processes: Machine control (including robotics) Inventory control Production monitoring Chemical testing

taught new knowledge and modified as new expertise is needed to match developments in their subject areas.

Although there are practical applications for expert systems, applications have been limited and specific because, as discussed, expert systems are narrow in their domain of knowledge. An amusing example of this is the user who used an expert system designed to diagnose skin diseases to conclude that his rusty old car had likely developed measles. In addition, once some of the novelty had worn off, most programmers and developers realized that common expert systems were just more elaborate versions of the same decision logic used in most computer programs. Today, many of the techniques used to develop expert systems can now be found in most complex programs without any fuss about them.

Healthways: Applying Expert Systems to Health Care

Healthways, the U.S. leader in health and care support for well and chronically ill populations, relies on SAS to identify high-risk patients and implement preventative actions. The company knows that a key to successful disease management is the correct identification of those members in greatest need of care. Using SAS, Healthways reduces costs and helps to improve member health outcomes by predicting who is at most risk for developing specific health problems. In doing so, it is able to coordinate intervention plans that address care designed to avoid complications down the road.

Healthways provides disease and care management to more than two million health-plan members in all 50 states, the District of Columbia, Guam, and Puerto Rico. The company provides its services on behalf of the nation's leading health plans. It employs thousands of nurses at call centers throughout the country who collect data and provide clinical support to health-plan members and their physicians.

At Healthways, the goal is to empower health-plan members to manage their health effectively. The company achieves its objective using SAS for data mining and a group of robust artificial intelligence neural networks. To support predictive analytics, Healthways accesses hundreds of data points involving care for millions of health-plan members.

"We want to develop predictive models that not only identify and classify patients who are at risk, but also anticipate who is at the highest risk for specific diseases and complications and then determine which of those are most likely to comply with recommended standards of care," says Adam Hobgood, Director of Statistics at Healthways' Center for Health Research. "Most of all we want to predict their likelihood of success with our support programs. By identifying high-risk patients and implementing preventative actions against future conditions, we hope to head off the increased costs of care before they occur."

With SAS, Healthways builds predictive models that assess patient risk for certain outcomes and establishes starting points for providing services. Once Healthways loads patient risk-stratification levels into its own "clinical expert system," the system evaluates clinical information from hospitals, data that nurses collect by phone, and information that employer groups and health-plan members report.

Finally, the clinical expert system adjusts the initial risk-stratification levels based on the new inputs and expert clinical judgment. The resulting approach to member stratification is a hybrid solution that incorporates sophisticated artificial intelligence neural network predictive models, clinically relevant rule-based models, and expert clinician judgment.

"It's a very powerful hybrid solution, and we have worked closely with clinical experts in the company to integrate the neural network predictive model with our world-class clinical expert system," says Matthew McGinnis, Senior Director of Healthways' Center for Health Research. "The ability of our highly experienced clinicians to use their expert clinical judgment further complements the model and rounds out our hybrid approach to stratification. We believe that sophisticated statistical models are necessary to help risk-stratify our significant member populations, and by coupling this with the expertly trained clinical mind, we have created a hybrid solution that is unrivaled in the industry."

Source: Adapted from "Healthways Heads Off Increased Costs with SAS," www.sas.com, accessed April 25, 2009.

Developing Expert Systems

What types of problems are most suitable to expert system solutions? One way to answer this question is to look at examples of the applications of current expert systems, including the generic tasks they can accomplish, as were summarized in Figure 10.31. Another way is to identify criteria that make a problem situation suitable for an expert system. Figure 10.32 outlines some important criteria.

Figure 10.32 emphasizes that many real-world situations do not fit the suitability criteria for expert system solutions. Hundreds of rules may be required to capture the assumptions, facts, and reasoning that are involved in even simple problem situations. For example, a task that might take an expert a few minutes to accomplish might require an expert system with hundreds of rules and take several months to develop.

The easiest way to develop an expert system is to use an **expert system shell** as a developmental tool. An expert system shell is a software package consisting of an expert system without its kernel, that is, its knowledge base. This leaves a *shell* of

FIGURE 10.32
Criteria for applications that are suitable for expert systems development.

Suitability Criteria for Expert Systems
• **Domain.** The domain, or subject area, of the problem is relatively small and limited to a well-defined problem area.
• **Expertise.** Solutions to the problem require the efforts of an expert. That is, a body of knowledge, techniques, and intuition is needed that only a few people possess.
• **Complexity.** Solution of the problem is a complex task that requires logical inference processing, which would not be handled as well by conventional information processing.
• **Structure.** The solution process must be able to cope with ill-structured, uncertain, missing, and conflicting data, and a problem situation that changes with the passage of time.
• **Availability.** An expert exists who is articulate and cooperative, and who has the support of the management and end users involved in the development of the proposed system.

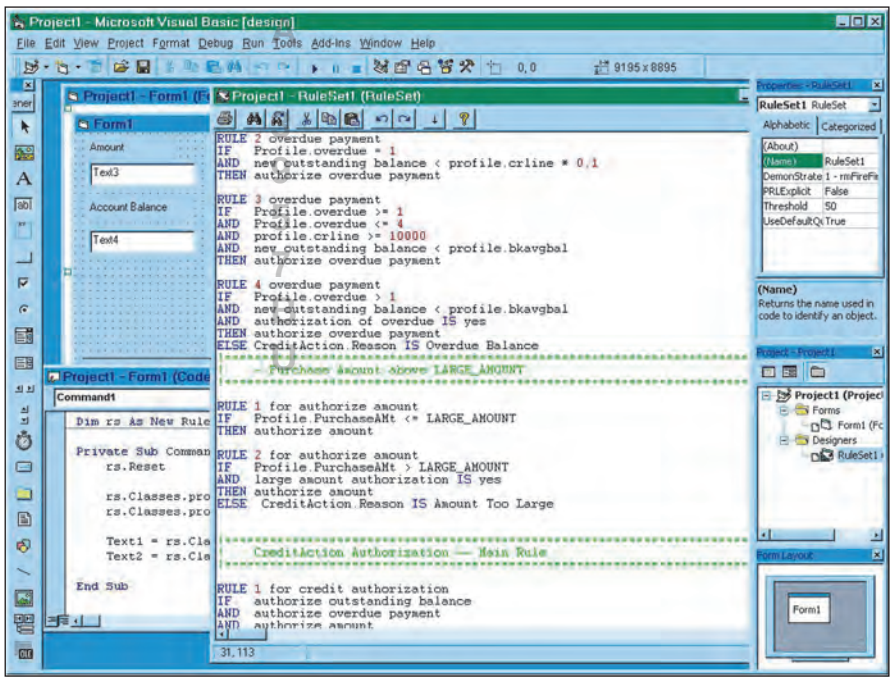
software (the inference engine and user interface programs) with generic inferencing and user interface capabilities. Other development tools (e.g., rule editors, user interface generators) are added in making the shell a powerful expert system development tool.

Expert system shells are now available as relatively low-cost software packages that help users develop their own expert systems on microcomputers. They allow trained users to develop the knowledge base for a specific expert system application. For example, one shell uses a spreadsheet format to help end users develop IF–THEN rules, automatically generating rules based on examples furnished by a user. Once a knowledge base is constructed, it is used with the shell's inference engine and user interface modules as a complete expert system on a specific subject area. Other software tools may require an IT specialist to develop expert systems. See Figure 10.33.

Knowledge Engineering

A **knowledge engineer** is a professional who works with experts to capture the knowledge (facts and rules of thumb) they possess. The knowledge engineer then builds the knowledge base (and the rest of the expert system if necessary), using an iterative, prototyping process until the expert system is acceptable. Thus, knowledge engineers perform a role similar to that of systems analysts in conventional information systems development.

FIGURE 10.33
Using the Visual Rule Studio and Visual Basic to develop rules for a credit management expert system.



Once the decision is made to develop an expert system, a team of one or more domain experts and a knowledge engineer may be formed. Experts skilled in the use of expert system shells could also develop their own expert systems. If a shell is used, facts and rules of thumb about a specific domain can be defined and entered into a knowledge base with the help of a rule editor or other knowledge acquisition tool. A limited working prototype of the knowledge base is then constructed, tested, and evaluated using the inference engine and user interface programs of the shell. The knowledge engineer and domain experts can modify the knowledge base, and then retest the system and evaluate the results. This process is repeated until the knowledge base and the shell result in an acceptable expert system.

Neural Networks

Neural networks are computing systems modeled after the brain's meshlike network of interconnected processing elements, called *neurons*. Of course, neural networks are a lot simpler in architecture (the human brain is estimated to have more than 100 billion neuron brain cells!). Like the brain, however, the interconnected processors in a neural network operate in parallel and interact dynamically. This interaction enables the network to "learn" from data it processes. That is, it learns to recognize patterns and relationships in these data. The more data examples it receives as input, the better it can learn to duplicate the results of the examples it processes. Thus, the neural network will change the strengths of the interconnections between the processing elements in response to changing patterns in the data it receives and the results that occur. See Figure 10.34.

Modern Neurosurgery: Neural Nets Help Save Lives

Neurosurgery, surgery performed on the brain and spinal cord, has advanced to extraordinary levels of skill and success in just the last decade. One of the most common applications of neurosurgical techniques is the removal of brain tumors. Currently, surgeons search for tumors manually using a metal biopsy needle inserted into the brain. Guided by ultrasound and modern imaging techniques such as MRI/CT scans, they primarily use tactile feedback to localize the tumor. This method, however, can be imprecise, as the tumors can easily shift during surgery, causing

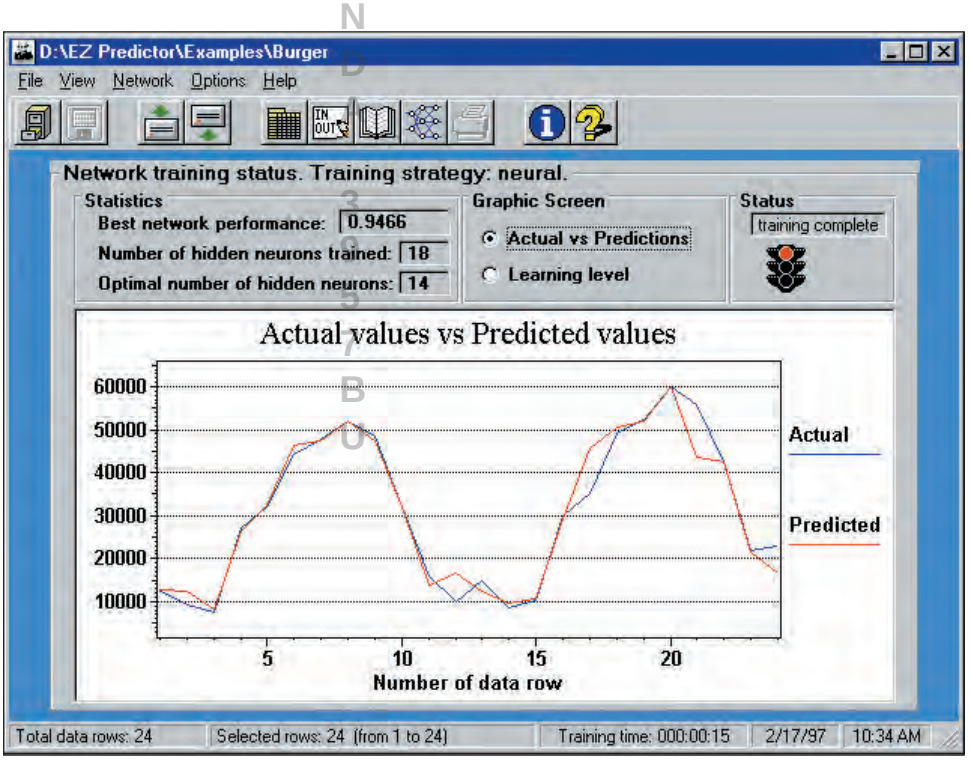


FIGURE 10.34
Evaluating the training status of a neural network application.

healthy tissue to be mistakenly treated as tumorous tissue. This inaccuracy can increase the risk of a stroke should a needle accidentally sever an artery.

A new technique, which is a combination of hardware and software, has been developed that gives neurosurgeons the ability to find their way through the brain while doing less damage as they operate. The primary piece of the hardware is a robotic probe that has on its tip several miniature sensors: an endoscope that transmits images and instruments that measure tissue density and blood flow. This probe is inserted into the brain and guided through it by a robotic mechanism that is more precise and accurate than human hands.

The real power in this miracle technique, however, is the sophisticated, adaptable neural network software that provides an instant in-depth analysis of the data gathered by the probe. Surgeons are able to look at a computer screen in the operating room and see a vast array of useful real-time information about what is going on in the patient's brain, such as whether the probe is encountering healthy tissue, blood vessels, or a tumor. The neural net software is adaptable in that it learns from experience the difference between normal tissue and tumorous tissue. Laboratory biopsy test results are used to validate the data used for training the neural net software. Once trained, the neural net can be used to identify in real time abnormal tissues encountered during surgical operations. Once learned, the probe is robotically advanced and stops immediately when it detects a signature significantly different from what was learned to be normal tissue. At this point, tissue identification is performed automatically, and the results presented to the surgeon. The surgeon can then treat the abnormal tissue appropriately and without delay.

This new technique gives surgeons finer control of surgical instruments during delicate brain operations. Overall, the new technique will increase the safety, accuracy, and efficiency of surgical procedures.

Source: Adapted from Bioluminate Inc., Press Release, "Bioluminate to Develop 'Smart Probe' for Early Breast Cancer Detection," December 5, 2002; and "NASA Ames Research Center Report," Smart Surgical Probe, Bioluminate Inc., 2003.

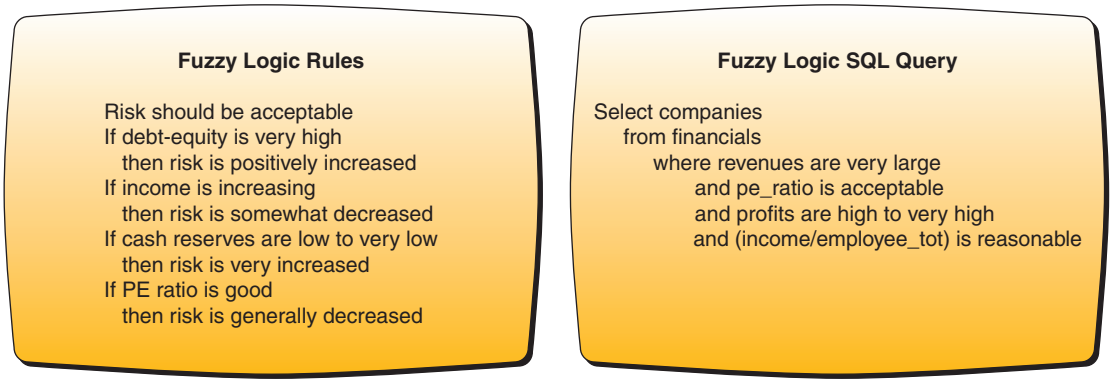
For example, a neural network can be trained to learn which credit characteristics result in good or bad loans. Developers of a credit evaluation neural network could provide it with data from many examples of credit applications and loan results to process, with opportunities to adjust the signal strengths between its neurons. The neural network would continue to be trained until it demonstrated a high degree of accuracy in correctly duplicating the results of recent cases. At that point, it would be trained enough to begin making credit evaluations of its own.

Fuzzy Logic Systems

In spite of their funny name, **fuzzy logic** systems represent a small, but serious, application of AI in business. Fuzzy logic is a method of reasoning that resembles human reasoning, in that it allows for approximate values and inferences (fuzzy logic) and incomplete or ambiguous data (fuzzy data) instead of relying only on *crisp data*, such as binary (yes/no) choices. For example, Figure 10.35 illustrates a partial set of rules (fuzzy rules) and a fuzzy SQL query for analyzing and extracting credit risk information on businesses that are being evaluated for selection as investments.

Notice how fuzzy logic uses terminology that is deliberately imprecise, such as *very high*, *increasing*, *somewhat decreased*, *reasonable*, and *very low*. This language enables fuzzy systems to process incomplete data and quickly provide approximate, but acceptable, solutions to problems that are difficult for other methods to solve. Thus, fuzzy logic queries of a database, such as the SQL query shown in Figure 10.35, promise to improve the extraction of data from business databases. It is important to note that fuzzy logic isn't fuzzy or imprecise thinking. Fuzzy logic actually brings precision to decision scenarios where it previously didn't exist.

FIGURE 10.35 An example of fuzzy logic rules and a fuzzy logic SQL query in a credit risk analysis application.



Fuzzy Logic in Business

Examples of applications of fuzzy logic are numerous in Japan but rare in the United States. The United States has preferred to use AI solutions like expert systems or neural networks, but Japan has implemented many fuzzy logic applications, especially the use of special-purpose fuzzy logic microprocessor chips, called fuzzy process controllers. Thus, the Japanese ride on subway trains, use elevators, and drive cars that are guided or supported by fuzzy process controllers made by Hitachi and Toshiba. Many models of Japanese-made products also feature fuzzy logic microprocessors. The list is growing and includes autofocus cameras, autostabilizing camcorders, energy-efficient air conditioners, self-adjusting washing machines, and automatic transmissions.

Genetic Algorithms

The use of **genetic algorithms** is a growing application of artificial intelligence. Genetic algorithm software uses Darwinian (survival of the fittest), randomizing, and other mathematical functions to simulate an evolutionary process that can yield increasingly better solutions to a problem. Genetic algorithms were first used to simulate millions of years in biological, geological, and ecosystem evolution in just a few minutes on a computer. Genetic algorithm software is being used to model a variety of scientific, technical, and business processes.

Genetic algorithms are especially useful for situations in which thousands of solutions are possible and must be evaluated to produce an optimal solution. Genetic algorithm software uses sets of mathematical process rules (*algorithms*) that specify how combinations of process components or steps are to be formed. This process may involve trying random process combinations (*mutation*), combining parts of several good processes (*crossover*), and selecting good sets of processes and discarding poor ones (*selection*) to generate increasingly better solutions. Figure 10.36 illustrates a business use of genetic algorithm software.

United Distillers: Moving Casks Around with Genetic Algorithms

United Distillers (now part of Diageo PLC) is the largest and most profitable spirits company in the world. United Distillers' two grain distilleries account for more than one-third of total grain whiskey production, and the company's Johnnie Walker brand is the world's top whiskey, achieving sales of up to 120 million bottles a year.

Nevertheless, Christine Wright, Inventory and Supply Manager at United Distillers, points out that some parts of the business attract less attention than others: "Each week, 20,000 casks are moved in and out of our 49 warehouses throughout Scotland to provide the whiskey needed for the blending program. Warehousing is a physical and laborious process and has tended to be the forgotten side of the business." The introduction of genetic algorithm computer technology, however, during the past year has given a fillip to the blend selection process at United Distillers.

"We want to maximize our operational efficiency without compromising the quality," states Christine Wright. United Distillers' Blackgrange warehouse site alone houses approximately 3 million casks, indicating the scale of the challenge. Of the 20,000 casks that are moved each week, 10,000 are not used but are moved only to allow access to those

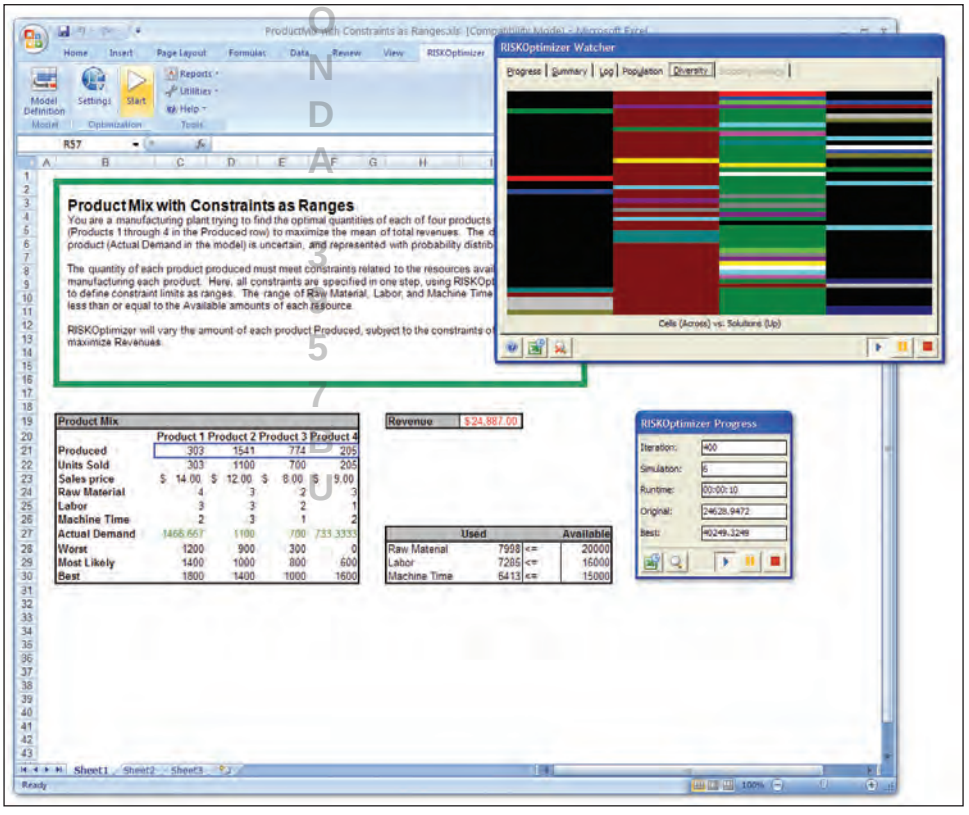
identified by the selection process. "Although we had 100 percent accurate positional information about all the stock, casks had to be selected numerically. Given the practical challenges involved in warehouse management, casks are seldom stored numerically."

Information held on the system about recipes, site constraints, and the blending program is given to the XpertRule package, which works out the best combinations of stocks to produce the blends. This information is supplemented with positional information about the casks. The system then optimizes the selection of required casks, keeping to a minimum the number of "doors" (warehouse sections) from which the casks must be taken and the number of casks that need to be moved to clear the way. Other constraints must be satisfied, such as the current working capacity of each warehouse and the maintenance and restocking work that may be in progress. Lancashire-based expert systems specialist XpertRule Software Limited has worked closely with United Distillers to develop the software application using XpertRule. The system is based on the use of genetic algorithms and adopts the Darwinian principle of natural selection to optimize the selection process.

"The incidence of non-productive cask movements has plummeted from a high of around 50 percent to a negligible level of around 4 percent and our cask handling rates have almost doubled." She adds: "The new technology enables staff to concentrate on what they want to achieve, rather than the mechanism of how to go about it. They can concentrate on the constraints that they wish to impose and get the system to do the leg work of finding the best scenario within those constraints. It means that the business can be driven by primary objectives." "Not only does the lack of wasted effort allow warehouse staff to get on with their work, but it enables them to plan ahead and organize long-term maintenance programs. It encourages a mind-set that is strategic, rather than reactive, and empowers managers to manage their own sites."

Source: Adapted from XpertRule Case Study, "A Break from Tradition in Blend Selection at United Distillers & Vintners," http://www.xpertrule.com/pages/case_ud.htm, accessed April 23, 2008.

FIGURE 10.36
Risk Optimizer software combines genetic algorithms with a risk simulation function in this airline yield optimization application.



Source: RISKOptimizer software. Image courtesy of Palisade Corporation.

Virtual Reality

Virtual reality (VR) is computer-simulated reality. Virtual reality is a fast-growing area of artificial intelligence that had its origins in efforts to build more natural, realistic, multisensory human–computer interfaces. So virtual reality relies on multisensory input/output devices such as a tracking headset with video goggles and stereo earphones, a *data glove* or jumpsuit with fiber-optic sensors that track your body movements, and a *walker* that monitors the movement of your feet. Then you can experience computer-simulated "virtual worlds" three-dimensionally through sight, sound, and touch. Virtual reality is also called *telepresence*. For example, you can enter a computer-generated virtual world, look around and observe its contents, pick up and move objects, and move around in it at will. Thus, virtual reality allows you to interact with computer-simulated objects, entities, and environments as if they actually exist. See Figure 10.37.

VR Applications

Current applications of virtual reality are wide-ranging and include computer-aided design (CAD), medical diagnostics and treatment, scientific experimentation in many physical and biological sciences, flight simulation for training pilots and astronauts, product demonstrations, employee training, and entertainment, especially 3-D video arcade games. CAD is the most widely used industrial VR application. It enables architects and other designers to design and test electronic 3-D models of products and structures by entering the models themselves and examining, touching, and manipulating sections and parts from all angles. This scientific-visualization capability is also used by pharmaceutical and biotechnology firms to develop and observe the behavior of computerized models of new drugs and materials and by medical researchers to develop ways for physicians to enter and examine a virtual reality of a patient's body.

VR becomes *telepresence* when users, who can be anywhere in the world, use VR systems to work alone or together at a remote site. Typically, this involves using a VR system to enhance the sight and touch of a human who is remotely manipulating equipment to accomplish a task. Examples range from virtual surgery, where surgeon and patient may be on either side of the globe, to the remote use of equipment in hazardous environments such as chemical plants or nuclear reactors.

The hottest VR application today is Linden Lab's *Second Life*. Here, users can create avatars to represent them, teleport to any of the thousands of locations in *Second Life*, build personal domains, "buy" land, and live out their wildest fantasies. *Second Life* has grown to enormous proportions, although actual statistics regarding size and

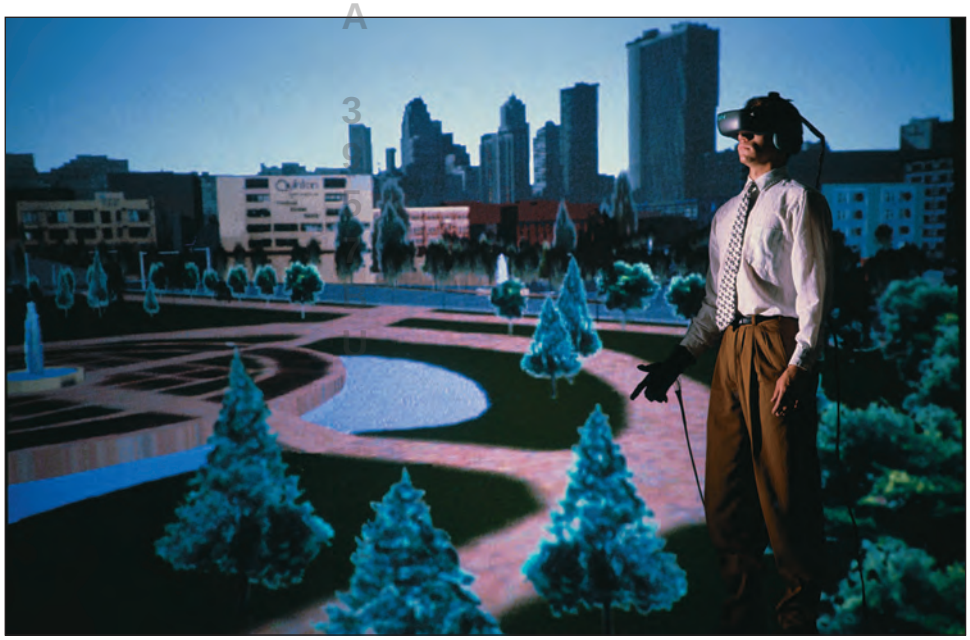


FIGURE 10.37
This landscape architect uses a virtual reality system to view and move through the design of the Seattle Commons, an urban design proposal for downtown Seattle.

Source: © George Steinmetz/Corbis.

number of users are constantly in dispute. Today, *Second Life* is home to individuals, commercial organizations, universities, governments (the Maldives was the first country to open an embassy in *Second Life*), churches, sports entertainment, art exhibits, live music, and theater. Just about anything goes in *Second Life* and, as technologies advance, the lines between your first life and your second one may begin to blur—stay tuned.

There has been increasing interest in the potential social impact of new virtual reality technologies. It is believed by many that virtual reality will lead to a number of important changes in human life and activity. For example:

- Virtual reality will be integrated into daily life and activity and will be used in various human ways.
- Techniques will be developed to influence human behavior, interpersonal communication, and cognition (i.e., virtual genetics).
- As we spend more and more time in virtual space, there will be a gradual "migration to virtual space," resulting in important changes in economics, worldview, and culture.
- The design of virtual environments may be used to extend basic human rights into virtual space, to promote human freedom and well-being or to promote social stability as we move from one stage in sociopolitical development to the next.
- Virtual reality will soon engage all of the senses including smell, taste, and touch.

Norsk Hydro: Drilling Decisions Made in a Virtual Oil Field

Norsk Hydro, based in Oslo, Norway, is a *Fortune* 500 energy and aluminum supplier operating in more than 40 countries worldwide. It is a leading offshore producer of oil and gas, the world's third-largest aluminum supplier, and a leader in the development of renewable energy sources. Norsk Hydro is also an innovator in the use of virtual reality technology. It uses VR to make decisions that, if wrong, could cost the company millions in lost revenues and, more important, could harm the environment. One example of its successful use of VR is the Troll Oil Field project.

The Troll Oil Field is located in the North Sea. The eastern part of the field has an oil column only 39–46 feet wide, but with in-place reserves of approximately 2.2 billion barrels. The oil is produced by horizontal wells located 1.5–5 feet above the point where the oil and seawater make contact.

During one drilling of a horizontal well, the drill bit was in sand of relatively low quality. No further good-quality reservoir sands were predicted from the geological model along the planned well track. Approximately 820 feet remained to the planned total depth, so a major decision to terminate the well required confirmation. If the decision to terminate the well was the right decision, the cost of drilling to that date would be lost, but no further loss or damage to the environment would occur. If, however, the decision to terminate the well was the wrong decision, valuable oil reserves would be lost forever.

Virtual reality technology was fundamental in deciding whether to terminate the well. All relevant data were loaded into the system for review. During a virtual reality session, the well team discovered a mismatch between the seismic data and the geological model. Based on this observation, they made a quick reinterpretation of some key seismic horizons and updated the geological model locally around the well.

The updated model changed the prognosis for the remaining section of the well from poor-quality sand to high-quality sand. It was decided to continue drilling, and the new prognosis was proven correct. As a result, 175 meters of extra-high-quality sand with an estimated production volume of 100,000 standard cubic meters of oil were drilled in the last section of the well.

Source: Adapted from Norsk Hydro Corporate Background, www.hydro.com, 2004; and Schlumberger Information Solutions, "Norsk Hydro Makes a Valuable Drilling Decision," Schlumberger Technical Report GMP-5911, 2002.

FIGURE 10.38
Examples of different types of intelligent agents.

Types of Intelligent Agents

User Interface Agents

- **Interface Tutors.** Observe user computer operations, correct user mistakes, and provide hints and advice on efficient software use.
- **Presentation Agents.** Show information in a variety of reporting and presentation forms and media based on user preferences.
- **Network Navigation Agents.** Discover paths to information and provide ways to view information that are preferred by a user.
- **Role-Playing Agents.** Play what-if games and other roles to help users understand information and make better decisions.

Information Management Agents

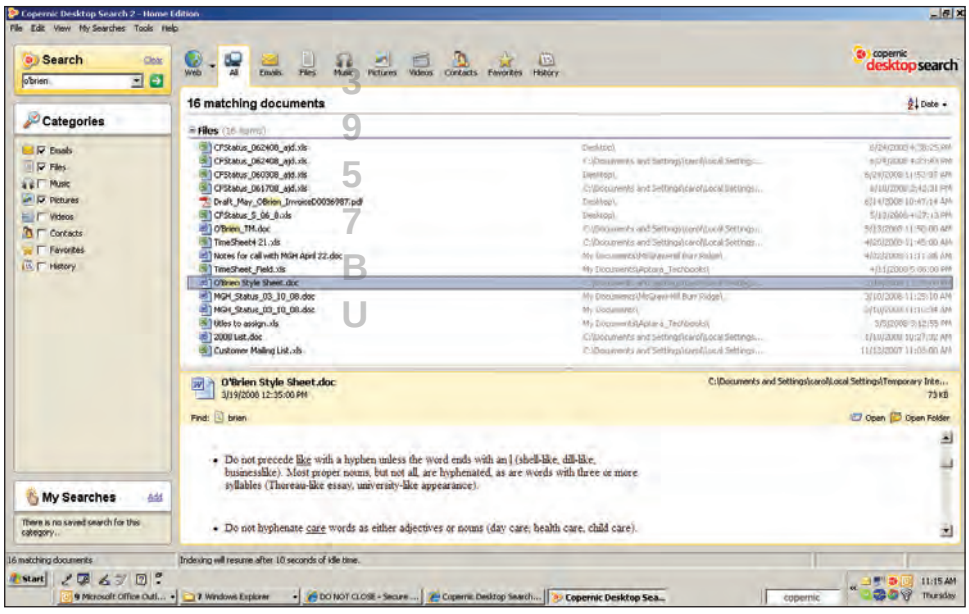
- **Search Agents.** Help users find files and databases, search for desired information, and suggest and find new types of information products, media, and resources.
- **Information Brokers.** Provide commercial services to discover and develop information resources that fit the business or personal needs of a user.
- **Information Filters.** Receive, find, filter, discard, save, forward, and notify users about products received or desired, including e-mail, voice mail, and all other information media.

Intelligent Agents

Intelligent agents are growing in popularity as a way to use artificial intelligence routines in software to help users accomplish many kinds of tasks in e-business and e-commerce. An intelligent agent is a *software surrogate* for an end user or a process that fulfills a stated need or activity. An intelligent agent uses its built-in and learned knowledge base about a person or process to make decisions and accomplish tasks in a way that fulfills the intentions of a user. Sometimes an intelligent agent is given a graphic representation or persona, such as Einstein for a science advisor, Sherlock Holmes for an information search agent, and so on. Thus, intelligent agents (also called *software robots* or "bots") are special-purpose, knowledge-based information systems that accomplish specific tasks for users. Figure 10.38 summarizes major types of intelligent agents.

The wizards found in Microsoft Office and other software suites are among the most well-known examples of intelligent agents. These wizards are built-in capabilities

FIGURE 10.39
Intelligent agent software such as Copernic can help you access information from a variety of categories and form a variety of sources.



Source: Courtesy of Copernic.

that can analyze how an end user is using a software package and offer suggestions on how to complete various tasks. Thus, wizards might help you change document margins, format spreadsheet cells, query a database, or construct a graph. Wizards and other software agents are also designed to adjust to your way of using a software package so that they can anticipate when you will need their assistance. See Figure 10.39.

The use of intelligent agents is growing rapidly as a way to simplify software use, search Web sites on the Internet and corporate intranets, and help customers do comparison shopping among the many e-commerce sites on the Web. Intelligent agents are becoming necessary as software packages become more sophisticated and powerful, as the Internet and the World Wide Web become more vast and complex, and as information sources and e-commerce alternatives proliferate exponentially. In fact, some commentators forecast that much of the future of computing will consist of intelligent agents performing their work for users.

Security Uses of Intelligent Software Agents

In 2002, the Army began to use intelligent software agents instead of people to route the background files of soldiers who required security clearance to the proper authorities for review. *The result*: A process that once took days now takes 24 hours. The Army reduced its year-long backlog, and the Army Central Clearance Facility in Fort Meade, Maryland, can now handle 30 percent more requests a year. The intelligent agent retrieves the necessary background information from existing records and builds an electronic folder for each case. It then examines the file to determine whether it's a clean case or there are warning signs, such as financial problems, arrests, or anything to indicate that a person might be susceptible to improper influence. Human investigators take closer looks at the tough cases.

Intelligent agents are semiautonomous, proactive, and adaptive software systems that can act on a user's behalf. Give an intelligent agent a goal, such as to help a U.S. ambassador pick a safe evacuation route following a terrorist attack in a foreign country, and it creates the best plan after gathering weather information, news reports, airplane schedules, road information, and police reports.

Such agents can also help investigators identify unusual patterns of activity, says Henry Lieberman, research scientist and leader of the Software Agents Group at the MIT Media Lab in Cambridge, Massachusetts. "Law enforcement can say to an intelligent agent, 'Let me know when any person arrived from a sensitive Middle Eastern country that was recently involved in a large bank transfer.' Or government agencies like the Securities and Exchange Commission can use them to monitor financial statements for fraud. Maybe they could have caught the whole Enron thing earlier."

Nevertheless, the issue of trust may deter their widespread adoption in business. "People just aren't used to using these kinds of things yet," says Lieberman. "When you first start using one of these agents, you have to watch it closely to make sure it's doing what you want. But performance improves over time. And the agent just makes a proposal. Then it's up to you."

Source: Adapted from Stephanie Overby, "Security Strategy Includes Intelligent Software Agents," *CIO Magazine*, January 1, 2003.

Summary

- **Information, Decisions, and Management.** Information systems can support a variety of management decision-making levels and decisions. These include the three levels of management activity (strategic, tactical, and operational decision making) and three types of decision structures (structured, semistructured, and unstructured). Information systems provide a wide range of information products to support these types of decisions at all levels of the organization.
- **Decision Support Trends.** Major changes are taking place in traditional MIS, DSS, and EIS tools for providing the information, and modeling managers need to

support their decision making. Decision support in business is changing, driven by rapid developments in end-user computing and networking; Internet and Web technologies; and Web-enabled business applications. The growth of corporate intranets and extranets, as well as the Web, has accelerated the development of "executive-class" interfaces like enterprise information portals and Web-enabled business intelligence software tools, as well as their use by lower levels of management and individuals and teams of business professionals. In addition, the growth of e-commerce and e-business applications has expanded the use of enterprise portals and DSS tools by the suppliers, customers, and other business stakeholders of a company.

- **Management Information Systems.** Management information systems provide prespecified reports and responses to managers on a periodic, exception, demand, or push reporting basis to meet their need for information to support decision making.
- **OLAP and Data Mining.** Online analytical processing interactively analyzes complex relationships among large amounts of data stored in multidimensional databases. Data mining analyzes the vast amounts of historical data that have been prepared for analysis in data warehouses. Both technologies discover patterns, trends, and exception conditions in a company's data that support business analysis and decision making.
- **Decision Support Systems.** Decision support systems are interactive, computer-based information systems that use DSS software and a model base and database to provide information tailored to support semistructured and unstructured decisions faced by individual managers. They are designed to use a decision maker's own insights and judgments in an ad hoc, interactive, analytical modeling process leading to a specific decision.
- **Executive Information Systems.** Executive information systems are information systems originally designed to support the strategic information needs of top management; however, their use is spreading to lower levels of management and business professionals. EIS are easy to use and enable executives to retrieve information tailored to their needs and preferences. Thus, EIS can provide information about a company's critical success factors to executives to support their planning and control responsibilities.
- **Enterprise Information and Knowledge Portals.** Enterprise information portals provide a customized and personalized Web-based interface for corporate intranets to give their users easy access to a variety of internal and external business applications, databases, and information services that are tailored to their individual preferences and information needs. Thus, an EIP can supply personalized Web-enabled information, knowledge, and decision support to executives, managers, and business professionals, as well as to customers, suppliers, and other business partners. An enterprise knowledge portal is a corporate intranet portal that extends the use of an EIP to include knowledge management functions and knowledge base resources so that it becomes a major form of knowledge management system for a company.
- **Artificial Intelligence.** The major application domains of artificial intelligence (AI) include a variety of applications in cognitive science, robotics, and natural interfaces. The goal of AI is the development of computer functions normally associated with human physical and mental capabilities, such as robots that see, hear, talk, feel, and move, and software capable of reasoning, learning, and problem solving. Thus, AI is being applied to many applications in business operations and managerial decision making, as well as in many other fields.
- **AI Technologies.** The many application areas of AI are summarized in Figure 10.26, including neural networks, fuzzy logic, genetic algorithms, virtual reality, and intelligent agents. Neural nets are hardware or software systems based on simple models of the brain's neuron structure that can learn to recognize patterns in data. Fuzzy logic systems use rules of approximate reasoning to solve problems when data are incomplete or ambiguous. Genetic algorithms use selection, randomizing, and other mathematic functions to simulate an evolutionary process that can yield increasingly better solutions to problems. Virtual reality systems are multisensory systems that enable human users to experience computer-simulated environments as if they actually existed. Intelligent agents are knowledge-based software surrogates for a user or process in the accomplishment of selected tasks.
- **Expert Systems.** Expert systems are knowledge-based information systems that use software and a knowledge base about a specific, complex application area to act as expert consultants to users in many business and technical applications. Software includes an inference engine program that makes inferences based on the facts and rules stored in the knowledge base. A knowledge base consists of facts about a specific subject area and heuristics (rules of thumb) that express the reasoning procedures of an expert. The benefits of expert systems (such as preservation and replication of expertise) must be balanced with their limited applicability in many problem situations.

Key Terms and Concepts

These are the key terms and concepts of this chapter. The page number of their first explanation is in parentheses.

1. Analytical modeling (407)
   a. Goal-seeking analysis (409)
   b. Optimization analysis (409)
   c. Sensitivity analysis (408)
   d. What-if analysis (407)
2. Artificial intelligence (AI) (418)
3. Business intelligence (BI) (395)
4. Data mining (410)
5. Data visualization system (DVS) (405)

6. Decision structure (394)
7. Decision support system (397)
8. Enterprise information portal (EIP) (414)
9. Enterprise knowledge portal (416)
10. Executive information system (EIS) (412)
11. Expert system (ES) (424)
12. Expert system shell (428)
13. Fuzzy logic (431)
14. Genetic algorithms (432)
15. Geographic information system (GIS) (405)
16. Inference engine (425)
17. Intelligent agent (436)
18. Knowledge base (425)
19. Knowledge engineer (429)
20. Knowledge management system (416)
21. Management information system (400)
22. Model base (398)
23. Neural network (430)
24. Online analytical processing (OLAP) (401)
25. Robotics (423)
26. Virtual reality (VR) (434)

Review Quiz

Match one of the key terms and concepts listed previously with one of the brief examples or definitions that follow. Try to find the best fit for answers that seem to fit more than one term or concept. Defend your choices.

____ 1. Decision-making procedures cannot be specified in advance for some complex decision situations.

____ 2. Information systems for the strategic information needs of top and middle managers.

____ 3. Systems that produce predefined reports for management.

____ 4. Provide an interactive modeling capability tailored to the specific information needs of managers.

____ 5. Provides business information and analytical tools for managers, business professionals, and business stakeholders.

____ 6. A collection of mathematical models and analytical techniques.

____ 7. Analyzing the effect of changing variables and relationships and manipulating a mathematical model.

____ 8. Changing revenues and tax rates to see the effect on net profit after taxes.

____ 9. Changing revenues in many small increments to see revenue's effect on net profit after taxes.

____ 10. Changing revenues and expenses to find how you could achieve a specific amount of net profit after taxes.

____ 11. Changing revenues and expenses subject to certain constraints to achieve the highest profit after taxes.

____ 12. Real-time analysis of complex business data.

____ 13. Attempts to find patterns hidden in business data in a data warehouse.

____ 14. Represents complex data using three-dimensional graphical forms.

____ 15. A customized and personalized Web interface to internal and external information resources available through a corporate intranet.

____ 16. Using intranets to gather, store, and share a company's best practices among employees.

____ 17. An enterprise information portal that can access knowledge management functions and company knowledge bases.

____ 18. Information technology that focuses on the development of computer functions normally associated with human physical and mental capabilities.

____ 19. Development of computer-based machines that possess capabilities such as sight, hearing, dexterity, and movement.

____ 20. Computers that can provide you with computer-simulated experiences.

____ 21. An information system that integrates computer graphics, geographic databases, and DSS capabilities.

____ 22. A knowledge-based information system that acts as an expert consultant to users in a specific application area.

____ 23. A collection of facts and reasoning procedures in a specific subject area.

____ 24. A software package that manipulates a knowledge base and makes associations and inferences leading to a recommended course of action.

____ 25. A software package consisting of an inference engine and user interface programs used as an expert system development tool.

____ 26. An analyst who interviews experts to develop a knowledge base about a specific application area.

____ 27. AI systems that use neuron structures to recognize patterns in data.

____ 28. AI systems that use approximate reasoning to process ambiguous data.

____ 29. Knowledge-based software surrogates that do things for you.

____ 30. Software that uses mathematical functions to simulate an evolutionary process.

Discussion Questions

1. Are the form and use of information and decision support systems for managers and business professionals changing and expanding? Why or why not?
2. Has the growth of self-directed teams to manage work in organizations changed the need for strategic, tactical, and operational decision making in business?
3. What is the difference between the ability of a manager to retrieve information instantly on demand using an MIS and the capabilities provided by a DSS?
4. Refer to the Real World Case on Valero Energy and others in the chapter. Information is one part (albeit a very important one) of decision making, with managers being the other. What experiences and qualifications are important in preparing managers for "fact-based" decision making? How are those obtained?
5. In what ways does using an electronic spreadsheet package provide you with the capabilities of a decision support system?
6. Are enterprise information portals making executive information systems unnecessary? Explain your reasoning.
7. Refer to the Real World Case on Kimberly-Clark and virtual reality in the chapter. Is the company fixing something that was not broken? Explain.
8. Can computers think? Will they ever be able to? Explain why or why not.
9. Which applications of AI have the most potential value for use in the operations and management of a business? Defend your choices.
10. What are some of the limitations or dangers you see in the use of AI technologies such as expert systems, virtual reality, and intelligent agents? What could be done to minimize such effects?

Analysis Exercises

1. e-Commerce Web Site Reviews
BizRate.com
BizRate (www.bizrate.com) instantly provides information about hundreds of online stores. Supported product lines include books, music, electronics, clothes, hardware, gifts, and more. Customer reviews help shoppers select products and retailers with confidence. BizRate also features a "Smart Choice" tag that balances retailer reviews, price, and other variables to recommend a "best buy."

a. Use BizRate.com to check out a product of interest. How thorough, valid, and valuable were the product and retailer reviews to you? Explain.
b. How could nonretail businesses use a similar Web-enabled review system? Give an example.
c. How is BizRate's Web site functionality similar to a decision support system (DSS)?

2. Enterprise Application Integration
Digital Desktops
Information coming from a variety of business systems can appear on the executive desktop as a consolidated whole. Often referred to as a digital dashboard, the information contained in such a view might include the executive's schedule, current e-mail, a brief list of production delays, major accounts past due, current sales summaries, and a financial market summary. Although it isn't possible to fit all of an organization's information on a single screen, it is possible to summarize data in ways specified by the executive and then act as a launching point or portal for further point-and-click enquiries.

How might such a system look? Portals such as my.Excite.com, my.MSN.com, iGoogle (www.google.com/ig), and my.Yahoo.com make good general-purpose information portals. These Web sites contain characteristics in common with their business-oriented brethren. They provide information from many different sources such as e-mail, instant messages, calendars, tasks lists, stock quotes, weather, and news. They allow users to determine what information sources they see; for example, a user may choose to list only business-related news and omit sports, lottery results, and horoscopes. They also allow users to filter the information they see; for example, a user may choose to view only local weather, news containing specific key words, or market results only for stocks the user owns. They allow users to arrange their own information space so that information a user finds most important appears in the right place. Finally, they allow users to drill down into the information they find important to receive more detail.

Once a user has set up an account and identified his or her preferences, these public portals remember the user's preferences and deliver only what the user has requested. Users may change their preferences as often as they wish, and the controls to make these changes require only point-and-click programming skills.

a. Visit one of the portal sites listed above. Configure the site to meet your own information needs. Provide a printout of the result.
b. Look up Digital Dashboard on the 20/20 Software Web site (www.2020software), read about products with this feature, and describe these products in your own words.

3. Case-Based Marketing

Selling on Amazon.com

A case-based reasoning system is a type of expert system. It attempts to match the facts on hand to a database of prior cases. When a case-based reasoning system finds one or more cases in its database that closely match the facts at hand, it then evaluates and reports the most common outcomes. Given enough cases, such a system can prove very useful. Even better, if a case-based system automatically captures cases as they occur, then it will become a powerful tool that continually fine-tunes its results as it gains "experience."

Amazon.com relies on just such a system to refer books to its customers. Like many e-commerce sites, Amazon allows visitors to search for, buy, and review books. Amazon.com takes its database interactivity a step further. Given a particular book title, its case-based reasoning engine examines all past sales of that book to see if the customers who bought that book shared other book purchases in common. It then produces a short list and presents that list to the user. The overall effect approaches that of a sales clerk who says, "Oh! If you like this book, then you'll really like reading these as well." Amazon's system has the experience of hundreds of millions more transactions than even the most wizened and well-read sales clerk.

Equipped with this information, customers may consider purchasing additional books, or the information may increase customers' confidence that they have selected the right book. Better information increases customers' confidence in their purchases and encourages additional sales.

a. What is the source of expertise behind Amazon's online book recommendations?

b. How do you feel about online merchants tracking your purchases and using this information to recommend additional purchases?

c. What measures protect consumers from the government's obtaining their personal shopping histories maintained by Amazon?

d. Although Amazon doesn't share personal information, it still capitalizes on its customers' shopping data. Is this ethical? Should Amazon offer its customers the right to opt out of this information-gathering?

4. Palm City Police Department

Goal Seeking

The Palm City Police Department has eight defined precincts. The police station in each precinct has primary responsibility for all activities in its precinct area. The table lists the current population of each precinct, the number of violent crimes committed in each precinct, and the number of officers assigned to each precinct. The department has established a goal of equalizing access to police services. Ratios of population per police officer and violent crimes per police officer should be calculated for each precinct. These ratios for the city as a whole are shown at right.

a. Build a spreadsheet to perform this analysis and print it out.

b. Currently, no funds are available to hire additional officers. On the basis of the citywide ratios, the department has decided to develop a plan to shift resources as needed to ensure that no precinct has more than 1,100 residents per police officer and no precinct has more than seven violent crimes per police officer. The department will transfer officers from precincts that easily meet these goals to precincts that violate one or both of these ratios. Use "goal seeking" on your spreadsheet to move police officers between precincts until the goals are met. You can use the goal-seek tool to see how many officers would be required to bring each precinct into compliance and then judgmentally reduce officers in precincts that are substantially within the criteria. Print out a set of results that allow the departments to comply with these ratios and a memorandum to your instructor summarizing your results and the process you used to develop them.

Precinct	Violent Population	Police Crimes	Officers
Shea Blvd.	96,552	318	85
Lakeland Heights	99,223	582	108
Sunnydale	68,432	206	77
Old Town	47,732	496	55
Mountainview	101,233	359	82
Financial District	58,102	511	70
Riverdale	78,903	537	70
Cole Memorial	75,801	306	82
Total	**625,978**	**3,315**	**629**
Per Officer	**995.196**	**5.270**	

REAL WORLD CASE 3

Goodyear, JEA, OSUMC, and Monsanto: Cool Technologies Driving Competitive Advantage

If necessity is the mother of invention, then capitalism is surely the mother of innovation. Companies are being driven to develop unique applications of undeniably cool technologies by the drive to create a sustainable competitive advantage. "At the end of the day, as cool as this thing we've developed is, it's a tool," says Stephanie Wernet, Goodyear's CIO. "It is meant to serve a business end. In our case, this tool lets us put out new, more innovative products faster than the competition."

Working with Sandia National Labs, Goodyear's IT department developed software to design and test tires virtually. In the past, the company built physical prototypes and tested them by driving thousands of miles on tracks. Using a mathematical model, the software simulates tire behavior in different driving conditions so that the designer can see how the tire gets pushed, pulled, and stretched as it rolls down a road, hits bumps, turns corners, screeches to a halt, and grips the road in wet, dry, and icy conditions. Goodyear wanted to shorten that time to get its products to market more quickly.

Three research and development employees advanced the idea of testing prototypes using computer simulations, which could do the job faster.

The company had never done simulations but figured initial investments and subsequent maintenance costs were worth the payoff. Goodyear's cost of goods sold, as well as its sales, decreased by 2.6 percent from 2003 to 2004, the year its first fully simulated tires hit the market. Meanwhile, the research and development (R&D) budget for tire testing and design decreased by 25 percent.

Custom-built software runs on hundreds of processors on hundreds of Linux computers in a massively parallel computing environment. Goodyear invested more than $6 million to build this high-powered computing environment. It plans to expand and upgrade its Linux clusters to meet business demands for new tires and to improve the fidelity of its virtual tests. The company believes it is the first tire maker to use computers to design and test its wheels. Although the auto industry has done computer-assisted design work since the 1980s, the technology had not been applied to tires because their malleable materials made simulation difficult.

Designers can perform 10 times more tests, reducing a new tire's time to market from two years to as little as nine months. Goodyear attributes its sales growth from $15 billion in 2003 to $20 billion in 2005 to new products introduced as a result of this change.

Public utility JEA uses neural network technology to create an artificial intelligence system it has recently implemented. The system automatically determines the optimal combinations of oil and natural gas the utility's boilers need to produce electricity cost-effectively, given fuel prices and the amount of electricity required. It also ensures that the amount of nitrous oxide (N2O) emitted during the generation process does not exceed government regulations.

JEA needed to decrease operating expenses, in particular fuel costs, as oil and gas prices began their precipitous ascent in 2002. Forty percent of JEA's $1.3 billion budget goes to the purchase of oil and gas to power its boilers, so a small change in the way electricity is produced could add millions of dollars to the bottom line. Neural network technology models the process of producing electricity. Optimization software from NeuCo determines the right combinations of oil and gas to produce electricity at low cost while minimizing emissions.

JEA, which serves more than 360,000 customers in Jacksonville and three neighboring Florida counties, is the first utility in the world to apply neural network technology to the production of electricity in circulating fluidized-bed boilers. It built a system that makes decisions based on historical operating data and as many as 100 inputs associated with the combustion process, including air flows and megawatt outputs. The system learns which fuel combinations are optimal by making adjustments to the boiler in real time; it also forecasts what to do in the future based on specific fuel cost assumptions. "We had issues with oil prices. At the same time, gas prices went from $4 a BTU to over $14. We need to use gas because it decreases emissions. This solution helped us balance all of those items," says Wanyonyi Kendrick, JEA's CIO.

The project, which IT drove, cost $800,000 and paid for itself in eight weeks. The system reduced the quantity of natural gas that is used to control N_2O emissions by 15 percent, an estimated annual savings of $4.8 million. With natural gas prices at $11 per BTU, JEA expects to save $13 million on fuel in 2006. What's more, JEA has discovered it can use the new technology applications for its water business.

The Ohio State University Medical Center (OSUMC) replaced its overhead rail transport system with 46 self-guided robotic vehicles to move linens, meals, trash, and medical supplies throughout the 1,000-bed hospital. The robots do not interact with patients; they carry out routine tasks that hospital staff used to do. Faced with declining revenue and rising costs, OSUMC needed to save money while improving patient care. A steering committee comprising IT, other hospital departments, consultants, and vendors drove this project. They convinced medical staff of its value by demonstrating the technology and communicating how it improved working conditions and patient care. Materials transport was identified as a place to cut costs since the hospital needed to upgrade the existing system.

The robots, made by FMC Technologies, are guided by a wireless infrared network from Cisco Systems. The network is embedded in corridor walls and elevators designed for the robots' use. Three Windows servers linked to the network maintain a database of robot jobs and traffic patterns. OSUMC is the first hospital in the United States to implement an infrared-guided automated system for transporting materials.

Hospital staff use a touch-screen computer connected to a server to call a robot when, for example a linen cart needs to go to the laundry room. To get from point A to point B, the robots rely on a digital map of the medical center programmed into their memory; they also track their movements against the number of times their wheels rotate in a full circle. So if it takes a robot 1,000 wheel revolutions to get from a building's kitchen to the sixth floor, and its wheels have moved in 500 revolutions, the robot knows it is halfway there. If a robot loses network contact, it shuts down.

The $18 million system is expected to save the hospital approximately $1 million a year over the next 25 years. Since it went live in 2004, OSUMC has saved $27,375 annually on linen delivery alone. OSUMC's CIO Detlev Smaltz says the system improves patient care by freeing up personnel: "If we can take mundane jobs like taking out the trash off of our employees and give them more time to do the things they came into the health-care profession to do, then that's an added benefit of the system."

Monsanto's IT department created software to identify genes that indicate a plant's resistance to drought, herbicides, and pests; those genetic traits are used to predict which plants breeders should reproduce to yield the healthiest, most bountiful crops.

The software crunches data from breeders worldwide and presents them in a colorful, easy-to-comprehend fashion. By pinpointing the best breeding stock, it increases breeders' odds of finding a commercially viable combination of genetic traits from one in a trillion to one in five. Monsanto's global breeding organization drove the project.

When the patent expired for Roundup, Monsanto's signature weed killer, the St. Louis company invested in growing its business involving seeds and genetic traits, which comprises more than half of its $6.3 billion revenue and $255 million profits in 2005. Monsanto believes it can sell more corn, soybean, and cotton seeds if farmers know its seeds will produce heartier crops and require fewer sprays of insecticide and herbicide, thus reducing costs.

Monsanto's scientists use the software to engineer seeds that effectively resist drought and pests and to produce plants that are healthier for humans and animals to eat. They do it by implanting those seeds with the genetic material that makes a plant resist insects or produce more protein. What would Gregor Mendel, the father of genetics, think of this? "This is really different from the way breeders bred their crops," says Monsanto CIO Mark Showers. "They didn't have this level of molecular detail to determine and select plants they wanted to move forward from year to year."

Monsanto reaps the benefit of its software but wouldn't reveal development costs. Earnings per share (EPS) on an ongoing basis grew from $1.59 to $2.08, or 30 percent, from 2004 to 2005. Its EPS is expected to grow by 20 percent more in 2006. "In the last four or five years, we've had a marked improvement in taking market share from our competition. We've grown our share at a couple of points per year," says Showers.

Source: Adapted from Meridith Levinson, "IT Innovation: Robots, Supercomputers, AI and More," *CIO Magazine*, August 15, 2006.

CASE STUDY QUESTIONS

1. Consider the outcomes of the projects discussed in the case. In all of them, the payoffs are both larger and achieved more rapidly than in more traditional system implementations. Why do you think this is the case? How are these projects different from others you have come across in the past? What are those differences? Provide several examples.
2. How do these technologies create business value for the implementing organizations? In which ways are these implementations similar in how they accomplish this, and how are they different? Use examples from the case to support your answer.
3. In all of these examples, companies had an urgent need that prompted them to investigate these radical, new technologies. Do you think the story would have been different had the companies been performing well already? Why or why not? To what extent are these innovations dependent on the presence of a problem or crisis?

REAL WORLD ACTIVITIES

1. Choose one of the companies introduced in the case and search the Internet to update the current status of their project. Also take a look at their competitors, and discover how they have responded to the introduction of the developments mentioned in the case. Have they attempted to imitate them?
2. As these technologies go beyond the capacity and abilities of human beings, what is the role of people in the processes they affect? Do you think these technologies empower us by allowing us to overcome our limitations and expand our range of possibilities? Instead, do they relegate people to the role of uncritically accepting the outcomes of these processes? Break into small groups to discuss these issues, and note which arguments that support one or the other position arise as a result.

REAL WORLD CASE 4

Hillman Group, Avnet, and Quaker Chemical: Process Transformation through Business Intelligence Deployments

Jim Honerkamp, CIO of Hillman Group, is proud of his new business intelligence (BI) system. Why not? It's much better than what came before. In the bad old days, executives looking for sales information, for example, had to ask one of Honerkamp's programmers to make a manual database query to pull the numbers from the company's legacy systems. The lag time made the charts "stale the minute they came out," according to Honerkamp, whose company is a $380 million manufacturer and distributor of engraving technologies and hardware, such as keys and signs.

With Hillman Group's new BI system, curious business executives can query the system themselves and get instant answers about such critical questions as the number of unfilled customer orders, which is tracked by the system in real time. There's just one problem: The new system hasn't made the business better—at least not yet—only better informed.

That's generally the problem with BI, the umbrella term that refers to a variety of software applications used to analyze an organization's raw data (e.g., sales transactions) and extract useful insights from them. Most CIOs still think of it as a reporting and decision support tool. Although the tools haven't changed much recently, there is a small revolution going on in the ways BI tools are being deployed by some CIOs. Done right, BI projects can transform business processes—and the businesses that depend on those processes—into lean, mean machines.

It isn't easy to take BI to the next level; it requires a change in thinking about the value of information inside organizations from the CEO down. Information is power, and some people don't like to share it. Yet sharing is vital to this new vision of BI because everyone involved in the process must have full access to information to be able to change the ways that they work.

The other major impediment to using BI to transform business processes is that most companies don't understand their business processes well enough to determine how to improve them. Companies also need to be careful about the processes they choose. If the process does not have a direct impact on revenue, or the business isn't behind standardizing the process across the company, the entire BI effort could disintegrate. Companies need to understand all the activities that make up a particular business process, how information and data flow across various processes, how data are passed between business users, and how people use it to execute their particular part of the process. They need to understand all this before they start a BI project—if they hope to improve how people do their jobs.

The new, greater scope of these BI projects gives CIOs a strong justification for working with the business to study processes and determine how these tools and the insights they provide can support and improve them. Companies that use BI to uncover flawed business processes are in a much better position to successfully compete than those companies that use BI merely to monitor what's happening. Indeed, CIOs who don't use BI to transform business operations put their companies at a disadvantage. For CIOs who have carried out this difficult strategy successfully, there is no looking back.

Avnet, a computer systems, component, and embedded subsystems manufacturer, took the new process-oriented BI strategy directly to the processes that matter most: selling and serving customers. The company has put together a system from three BI vendors—Informatica, Business Objects, and InfoBurst—to generate reports on orders, shipment schedules, and dates by which Avnet will no longer manufacture certain products. Reports, however, were just the beginning. To transform the sales and customer service processes, CIO Steve Phillips rolled out the system to 2,000 salespeople so that they could actively incorporate that information into their day-to-day workflows and interactions with customers.

Employees use the information to modify their individual and teamwork practices, which leads to improved performance among the sales teams. When sales executives see a big difference in performance from one team to another, they work to bring the laggard teams up to the level of the leaders. "We try to identify, using our reporting tools, where best practices exist inside our work teams and then extend those best practices across the company," says Phillips.

One of those best practices is to alert customers if a product they have purchased in the past is about to be discontinued. Salespeople can ensure that customers have ordered enough for all of their future needs or identify a new component to replace the one that's being phased out. Those kinds of conversations boost sales and convince customers that Avnet's salespeople are looking out for their needs and interests.

It helps that Avnet's sales team is flexible and willing to adapt to the information. "Because our sales team is so flexible, they'll take this information from BI reports and change processes when they see a benefit to it," says Phillips.

Sometimes, they don't even realize they are changing the ways they work—a kind of organic reengineering. Indeed, salespeople benefit so directly from better information and have such a big impact on revenue that they can be the best advocates for transformative BI in the company.

Yet this kind of effortless link between information and processes doesn't happen by magic. Phillips says his company has been able to use BI effectively because IT and business users have worked closely and steadily. "We needed to know how things really happen day to day, over and above the documented processes so that we could anticipate some of the business's information needs as we built out the warehouse," says Phillips.

Now that the BI system matches up with the way the company conducts its business, improving those processes

and sharing the improvements are that much easier. "This is not just about reporting," says Phillips. "It's about using BI to make us smarter."

Quaker Chemical used its BI system to change completely the way it manages accounts receivable. In the past, the process of keeping track of whether customers paid their bills, and if they paid them on time, was primarily the purview of employees in the accounting department. Collection managers used the company's accounting system to identify which accounts were overdue, but they had limited information about the details of overdue balances. As a result, they had visibility only into glaring payment problems—customers who hadn't paid their bills at all in 60 days or more—and couldn't proactively identify which customers were at risk for not paying in full. Occasionally, they asked a sales manager to get involved, but the whole process for identifying which customers weren't paying and why they weren't paying and putting salespeople on the case was ad hoc.

To improve accounts receivable, Quaker Chemical decided in early 2005 that salespeople needed to play a larger, more formal role in the collections process. After all, they were the ones who had the primary relationship with the customers and had opportunities to speak with them more often, more proactively, and more sympathetically about their outstanding payments.

To get the salespeople involved, the IT department created a data mart that extracted accounts receivable information from transaction systems: It analyzed historical payments and historical balances by customer and by transaction and then loaded it into the data warehouse. By using its BI tools from SAS to analyze factors such as the amount of time it took Quaker Chemical to collect payment from a customer on a given invoice, as well as the number of times a customer paid part, but not all, of what he or she owed, the company was able to identify which customers were consistently paying late and which customers weren't paying at all. The IT department programmed the data warehouse to run reports automatically on which customers still owed money to Quaker Chemical. The system would then send those reports directly to the sales manager in charge of those accounts several times a month so that they could follow up with those customers. Collections managers no longer have to keep tabs on this information manually.

Quaker CIO Irving Tyler says this business process change was successful in part because IT was careful to deliver only the most specific, relevant information in these reports to salespeople. "If you don't focus the information and deliver it intelligently, people won't understand how to incorporate it into their workflows," says Tyler. This kind of dramatic change in process needs to be linked to the overall business strategy, according to Tyler. "Information doesn't necessarily change anything. You have to have a strategy to drive any change," he says.

Avnet and Quaker Chemical demonstrate that BI is about more than decision support. As a result of improvements in the technology and the way CIOs are implementing it, BI now has the potential to transform organizations. CIOs like Avnet's Phillips and Quaker Chemical's Tyler who successfully use BI to improve business processes contribute to their organizations in more far-reaching ways than by implementing basic reporting tools. "Our BI system provides information that helps us seek out greater efficiency," says Avnet's Phillips.

Source: Adapted from Meridith Levinson, "Business Intelligence: Not Just for Bosses Anymore," *CIO Magazine*, January 15, 2006; and Diann Daniel, "Five Ways to Get Your Employees Better Information More Quickly," *CIO Magazine*, January 10, 2008.

CASE STUDY QUESTIONS

1. What are the business benefits of BI deployments such as those implemented by Avnet and Quaker Chemical? What roles do data and business processes play in achieving those benefits?
2. What are the main challenges to the change of mindset required to extend BI tools beyond mere reporting? What can companies do to overcome them? Use examples from the case to illustrate your answer.
3. Both Avnet and Quaker Chemical implemented systems and processes that affect the practices of their salespeople. In which ways did the latter benefit from these new implementations? How important was their buy-in to the success of these projects? Discuss alternative strategies for companies to foster adoption of new systems like these.

REAL WORLD ACTIVITIES

1. Search the Internet for other examples of both "mere reporting" and transformational implementations of business intelligence tools. In which ways are these similar to the ones discussed in the case? In which ways are these different? What seems to be the main distinction between reporting and process-transformation BI rollouts? Prepare a report to summarize your findings.
2. How do you think the possession or access to certain information shapes the political dynamics of organizations? Do you believe companies should be open about widespread access to information, or will they be better off by restricting it? Why? Break into small groups with your classmates to discuss these issues, and take turns advocating the two alternative positions.