REAL WORLD CASE 1

Allstate Insurance, Aviva Canada, and Others: Centralized Business Intelligence at Work

The most common approach to business intelligence is to assemble a team of developers to build a data warehouse or data mart for a specific project, buy a reporting tool to use with it, and disassemble the team upon the project's completion. However, some companies are taking a more strategic approach: standardizing on fewer business-intelligence tools and making them available throughout their organizations even before projects are planned. To execute these strategies, companies are creating dedicated groups, sometimes called competency centers or centers of excellence, to manage business-intelligence projects and provide technical and analytical expertise to other employees. Competency centers are usually staffed with people who have a variety of technical, business, and data-analysis expertise, and the centers become a repository of business-intelligence-related skills, best practices, and application standards.

About 10 percent of the 2,000 largest companies in the world have some form of business-intelligence competency center, Gartner Inc. analyst Howard Dresner says. Yet approaches vary. While most are centralized in one location, a few are virtual, with staff scattered throughout a company. Some are part of the IT department—or closely tied to it—while others are more independent, serving as a bridge between IT and business-unit managers and employees.

Allstate Insurance Co.'s Enterprise Business Intelligence Tools Team is responsible for setting business-intelligence technology strategy for the company's 40,000 employees and 12,900 independent agents, says Jim Young, the team's senior manager.

Based in Allstate's Northbrook, Illinois, headquarters, the center was created earlier this year by consolidating three groups built around separate business-intelligence products used in different parts of the company. The center serves as a central repository for business-intelligence expertise, providing services and training for Allstate employees, and is developing a set of standard best practices for building and using data warehouses and business-intelligence applications.

"That way, we can execute on a common strategy," Young says. The center maintains a common business-intelligence infrastructure and manages software vendors and service providers.

At Aviva Canada Inc., a property and casualty insurance company, the primary role of its Information Management Services department is to bridge the communications gap between business-intelligence-tool users and Aviva's IT department.

"Business intelligence isn't a technology issue. BI is a business issue," says Gerry Lee, information management services VP. Centralization is critical, because Aviva's goal is to grow by 50 percent over the next five years, partly through additional acquisitions, Lee says. The center also impacts the company's numerous customer relationship-management initiatives. "We couldn't get into CRM until we had solid data-management and business-intelligence capabilities," he says.

Cost reduction is often the driving factor for companies to create competency centers and consolidate business-intelligence systems. Standard technology and implementation practices can reduce the cost of some business-intelligence projects by up to 95 percent, says Chris Amos, reporting solutions manager at British Telecom. BT established a center of excellence around Actuate's reporting software three years ago and is developing business-intelligence systems for the telecommunications company's wholesale, retail, and global services operations.

Despite the potential savings, funding can be an issue for creating and running business-intelligence centers of excellence. Start-up costs for a business-intelligence competency center can be $1 million to $2 million, depending on a company's size, Gartner's Dresner says.

Many believe the payoffs are worth it. General Electric Co.'s energy products business formed its Business Data-Modeling Center of Excellence last year to improve data-management and business-intelligence practices for GE Energy's 8,000 employees. That has helped the business move beyond simple reporting of financial and supplier data to more advanced forecasting and predictive analysis.

"The data's become more actionable. The visibility of this data to the business has brought millions in savings," says Rich Richardson, manager of business data modeling and delivery, who manages the center. That's a business-intelligence competency center that's more than paid for itself.

Case Study Questions

1. What is business intelligence? Why are business-intelligence systems such a popular business application of IT?
2. What is the business value of the various BI applications discussed in the case?
3. Is a business-intelligence system an MIS or a DSS?

Source: Adapted from Rick Whiting, "Centralized Intelligence at Work," *InformationWeek*, April 19, 2004. Copyright © CMP Media LLC.

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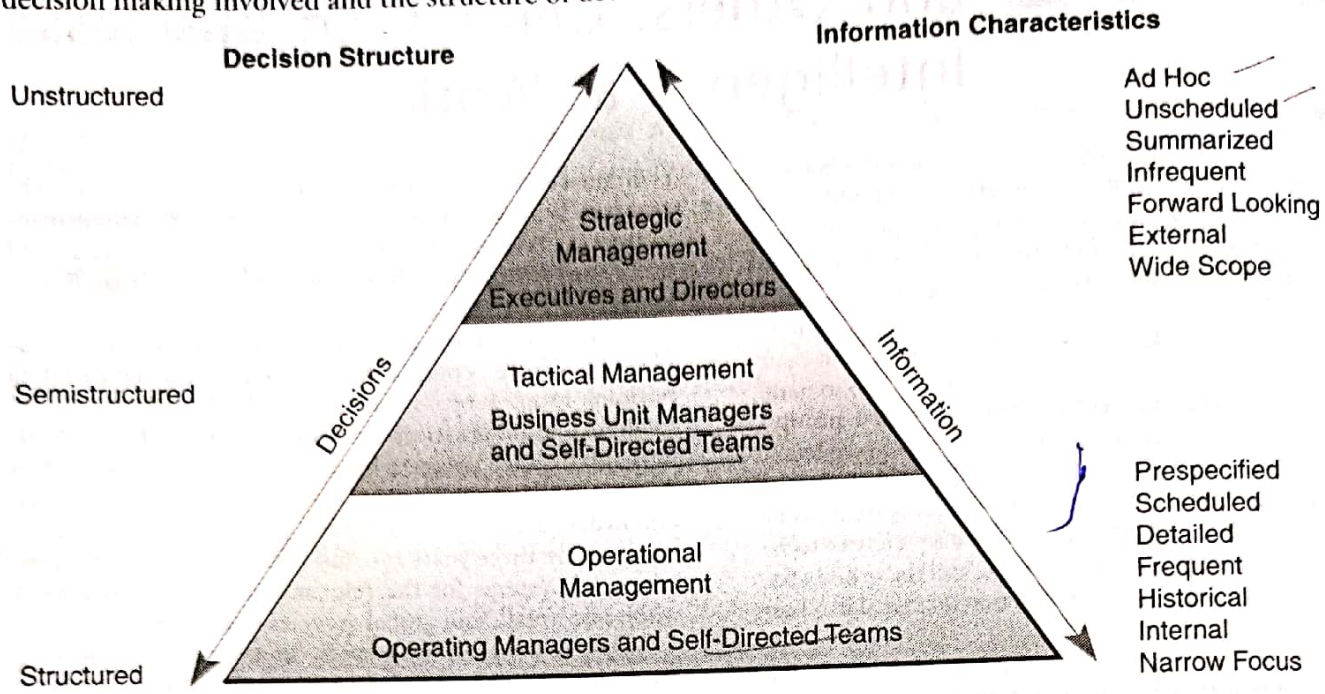
FIGURE 10.1 Information requirements of decision makers. The type of information required by directors, executives, managers, and members of self-directed teams is directly related to the level of management decision making involved and the structure of decision situations they face.



inaccurate, or hard to understand would not be very meaningful, useful, or valuable to you or other business professionals. People want 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 10.2 summarizes the important attributes of information quality and groups them into these three dimensions.

Decision Structure

Decisions made at the operational management level tend to be more *structured*, those at the tactical level more *semistructured*, and those at the strategic management level more *unstructured*. Structured decisions involve situations where the procedures to follow when a decision is needed can be specified in advance. The inventory reorder decisions faced by most businesses are a typical example. Unstructured decisions involve decision situations where 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 (i.e., "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. Figure 10.3 provides a variety of examples of business decisions by type of decision structure and level of management [22].

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, on the other hand, may depend on *management information systems* to supply more prespecified internal reports emphasizing detailed current and historical data comparisons that support their more structured

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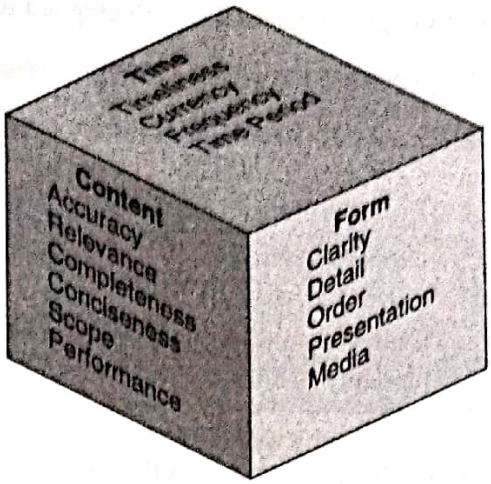
FIGURE 10.2
A summary of the attributes of information quality. This outlines the attributes that should be present in high-quality information products.



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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.

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responsibilities in day-to-day operations. Figure 10.4 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 [27].

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. However, during the 1990s, both academic researchers and business practitioners began reporting that the traditional managerial focus originating in classic management

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FIGURE 10.3 Examples of decisions by the type of decision structure and by level of management.

Decision Structure	Operational Management	Tactical Management	Strategic 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	

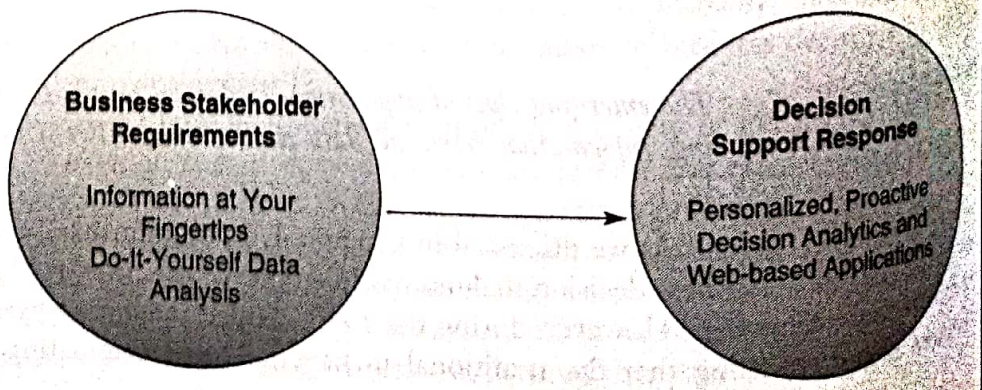
information systems (1960s), decision support systems (1970s), and executive information systems (1980s) was expanding. The fast pace of new information technologies like PC hardware and software suites, client/server networks, and networked PC versions of DSS/EIS software made decision support available to lower levels of management, as well as to nonmanagerial individuals and self-directed teams of business professionals [18, 40, 45].

This trend has accelerated with the dramatic growth of the Internet and intranets and extranets that internetwork 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 expectations of a company's employees, managers, customers, suppliers, and other business partners. Figure 10.5 illustrates that all business stakeholders expect easy and instant access to i-

FIGURE 10.4
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

FIGURE 10.5
A business must meet the information and data analysis requirements of their stakeholders with more personalized and proactive Web-based decision support.



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information and Web-enabled self-service data analysis [27]. 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, 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.

Figure 10.6 highlights several major information technologies which are being customized, personalized, and Web-enabled to provide key business information and analytical tools for managers, business professionals, and business stakeholders [25, 26, 33, 48]. We will highlight the trend toward such business intelligence applications in the various types of information and decision support systems that are discussed in this chapter.

Cisco Systems: MIS Dashboard

At Cisco (www.cisco.com), company executives say that ideally, everyone in the business should have access to real-time information. "The whole corporation is moving to real time," says Mike Zill, director of sales and finance IT at Cisco. "It's difficult to have applications stay in batch mode when the business architecture is message-based."

Channel account managers in the sales department use a Web-based "dashboard," or graphical user interface–based view, from OneChannel Inc. that gives them real-time views of their accounts' activities. When a business condition hits a predetermined threshold, the software triggers an alert, sending a message or warning to the user's dashboard. For example, if Cisco's sales department has a top-10 list of new products it wants sold through, say, Ingram Micro, the application will let the Cisco channel manager know the instant the distributor's sales fall outside target levels.

To achieve this, Cisco had to build deep hooks into its supply chain, which wasn't easy to develop. The firm has established agreements with its partners to receive point-of-sale data via the Internet or, in some cases, through electronic data interchange. However, most of the data are batched. Few partners will feed real-time point-of-sale data to the company, Zill says.

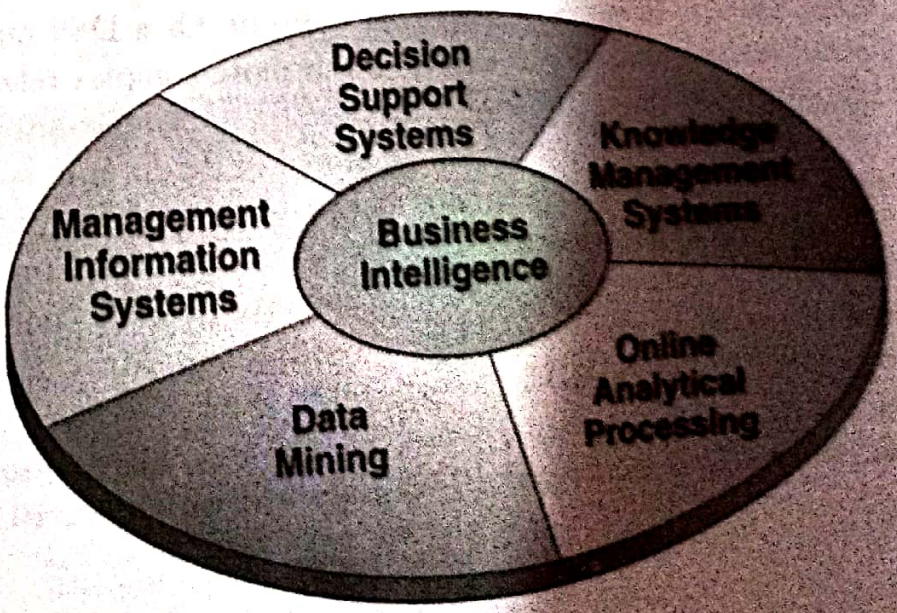

FIGURE 10.6
Business intelligence applications are based on personalized and Web-enabled information analysis, knowledge management, and decision support technologies.

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Once it receives the data, Cisco couples it with real-time Web-based inventory information and processes it using analytics software from Hyperion Solutions Corp. Channel managers can then query the Hyperion software in detail through the OneChannel dashboard to find the underlying causes of any distribution problem. "The response time is fast enough so you're not waiting," Zill says. And that's the essence of real time for any user [23].

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 the making of 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, on the other hand, would also interactively show a sales manager the effects on sales performance of changes in a variety of factors (such as promotion expense and salesperson compensation). The DSS could then use several criteria (such as expected gross margin and market share) to evaluate and rank several alternative combinations of sales performance factors.

Therefore, DSS systems 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 directly support 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 − Expenses = Profit. Or a DSS model base could 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 [28]. See Figure 10.7.

DSS software packages can combine model components to create integrated models that support specific types of decisions [13]. 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. See Figure 10.8.

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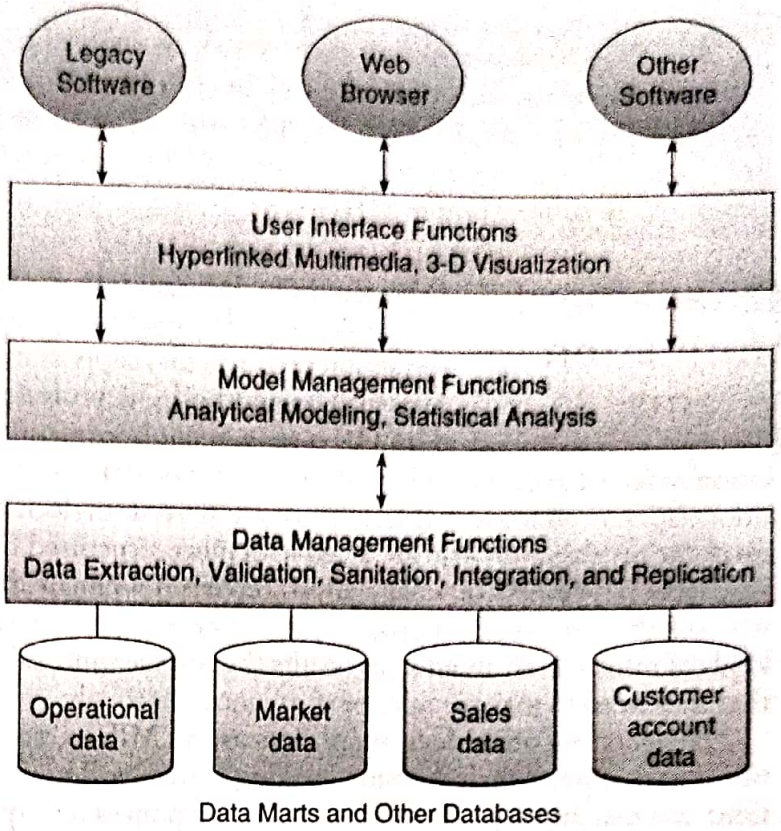
FIGURE 10.7
Components of a Web-enabled marketing decision support system. Note the hardware, software, model, data, and network resources involved.



Web-Enabled DSS at PepsiCo

PepsiCo and Sedgwick James Inc., the world's second largest insurance broker, developed a risk management DSS to help minimize PepsiCo's losses from accidents, theft, and other causes. Every week, Sedgwick loads the latest casualty claims data from the nation's leading insurance carriers into a DSS database resident on IBM RS/6000 servers in the PepsiCo intranet. The database is then accessed by managers and analysts using desktop PCs and remote laptops equipped with the INFORM risk management system. Both the RS/6000 servers and local PCs use Information Builders' middleware to provide PepsiCo managers and business analysts with transparent data access from a variety of hardware/software configurations.

FIGURE 10.8
Examples of special-purpose DSS packages.

DSS Packages
• **Retail:** Information Advantage and Unisys offer the Category Management Solution Suite, an OLAP decision support system and industry-specific data model.
• **Insurance:** Computer Associates offers RiskAdvisor, an insurance risk decision support system whose data model stores information in insurance industry specific tables designed for optimal query performance.
• **Telecom:** NCR and SABRE Decision Technologies have joined forces to create the NCR Customer Retention program for the communications industry including data marts for telephone companies to use for decision support in managing customer loyalty, quality of service, network management, fraud, and marketing.

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The INFORM risk management system combines the analytical power of FOCUS decision support modeling with the graphical analysis capabilities of FOCUS/EIS for Windows. As a result, PepsiCo managers and business analysts at all levels can pinpoint critical trends, drill down for detailed backup information, identify potential problems, and plan ways to minimize risks and maximize profits [33].

Management Information Systems

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 exceed 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 and DBMS query languages and report generators enable managers at PC workstations to get immediate responses or 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 selectively broadcast reports and other information to the networked PCs of managers and specialists over their corporate intranets. See Figure 10.9.

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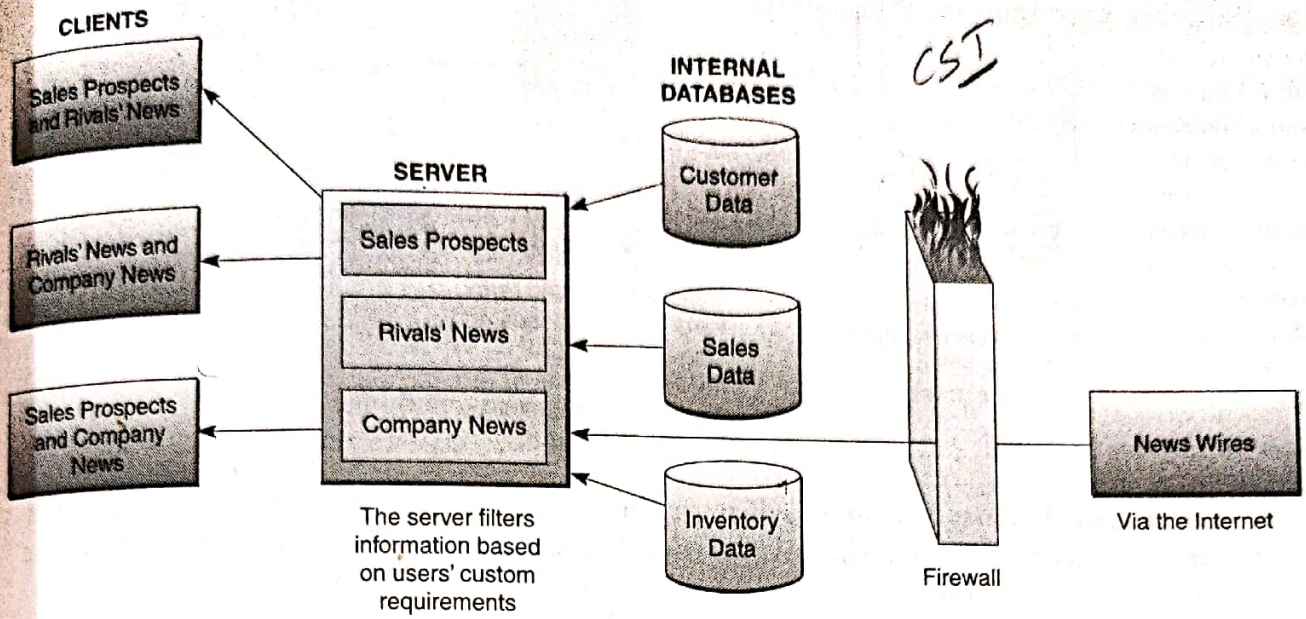
FIGURE 10.9 An example of the components in a marketing intelligence system that uses the Internet and a corporate intranet system to "push" information to employees.



Online Analytical Processing

At a recent stockholder meeting, the 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" [49].

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 their analytical or decision-making process is undisturbed. See Figure 10.10.

Online analytical processing involves several basic analytical operations, including consolidation, "drill-down," and "slicing and dicing." See Figure 10.11.

- **Consolidation.** Consolidation involves the aggregation of data. This can involve simple roll-ups or complex groupings involving interrelated data. For example, sales offices can be rolled up to districts and districts rolled up to regions.
- **Drill-Down.** OLAP can go in the reverse direction and automatically display detail data that comprise consolidated data. This 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.

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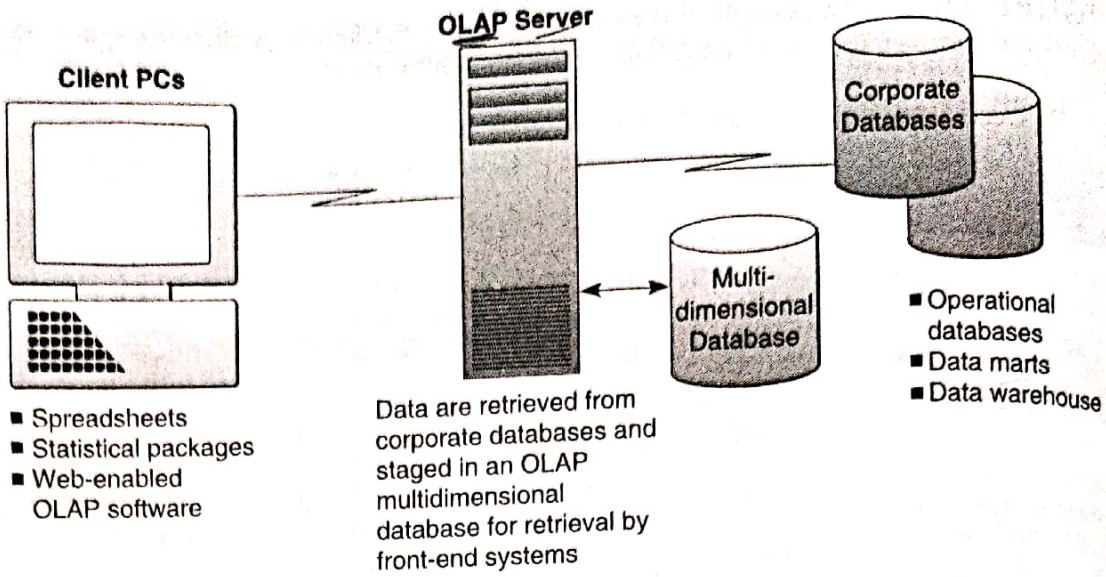

FIGURE 10.10 Online analytical processing may involve the use of specialized servers and multidimensional databases. OLAP provides fast answers to complex queries posed by managers and analysts using traditional and Web-enabled OLAP software.

- **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 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 in order to analyze trends and find time-based patterns in the data.

The GAP: Using OLAP to Analyze Key Measures in a Retail Environment

GAP Inc., headquartered in San Francisco, is a leading international specialty retailer with over 3,000 stores worldwide offering clothing, accessories, and personal care products for men, women, children, and babies under the GAP, Banana Republic, and Old Navy brand names. Customers can shop at GAP stores in every state in the United States, as well as the United Kingdom, Canada, France, Japan, and Germany.

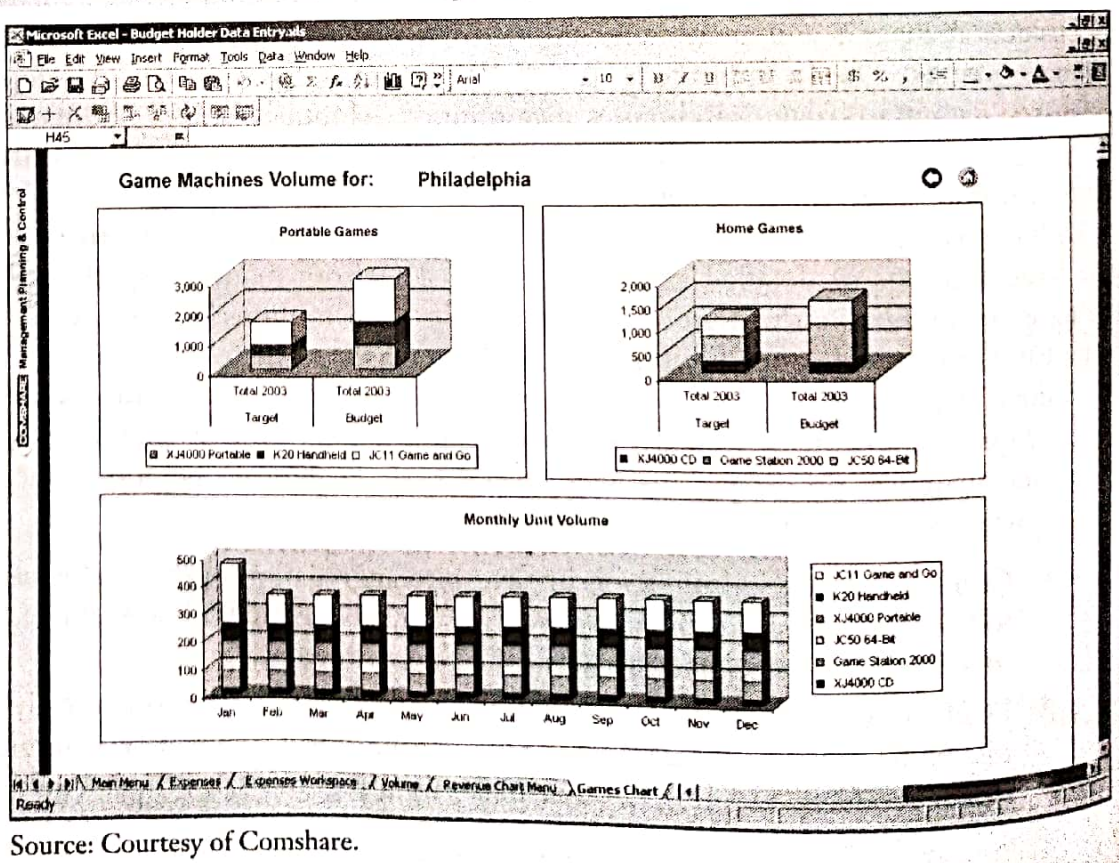

FIGURE 10.11 Comshare's Management Planning and Control software enables business professionals to use Microsoft Excel as their user interface for Web-enabled online analytical processing.

Source: Courtesy of Comshare.

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Along with their global successes come global-size problems. To maintain competitive pricing in all their product lines, GAP Inc. needs to constantly look for ways to improve the profitability of individual stores, improve inventory management by store and brand, and track and understand seasonality trends by brand.

GAP managers know in order to improve profitability they need to accurately and efficiently report and analyze a set of key business measures. This, in turn, will allow them to better match their inventory levels to individual store sales, thereby improving inventory turnover. While these are important issues in any industry, they are particularly critical in retail.

To fulfill these requirements, GAP business managers must track these metrics down to and including the level of every combination of store, product, style, and color by week—a breakdown that yields over three billion combinations!

To make the job somewhat easier, GAP analysts have determined that tracking two of GAP's major store chains, GAP stores and Old Navy, provides a sufficient level of accuracy to make decisions for the entire company. Nonetheless, each store chain needs to track approximately 200 measures, 100 time elements, 200 season members, and a dozen fiscal and price information points. Further, Old Navy must keep track of 1,500 store locations and 150,000 products. GAP stores must track 3,000 store locations and 350,000 products. In addition, both store chains need to track currency for foreign exchange transactions. In total, their tracking system supports over 1,000 users accessing the information.

It is easy to imagine the complexity of such a decision support system, but things get even more complex when you consider the fact that GAP Inc. needed to design such a system to support the use of MS Excel as the primary reporting tool, because most managers were already trained in its use. Finally, the system response time has to be fast, regardless of the volume of data and the number of users.

So, how is this all accomplished?—OLAP, of course!

Data is loaded weekly into a multidimensional system that contains approximately 750+ GB of data. The business managers use MS Excel as the primary reporting and analysis tool and retrieval times are as fast as three seconds. The secret to the success of this system centers on an Essbase model spanning 15 physical Essbase databases, linked to form four "virtual" cubes. Each virtual cube represents a single store chain. Together, they represent a single view or solution to GAP's reporting and analysis needs. GAP business managers have at their disposal the information they need to make better and faster decisions that enable them to monitor and improve profitability to a finite level [3, 19].

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 and 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 10.12.

Data visualization systems represent complex data using interactive three-dimensional graphical forms such as charts, graphs, and maps. DVS tools help users to interactively sort, subdivide, combine, and organize data while it is in its graphical form. This helps users discover patterns, links, and

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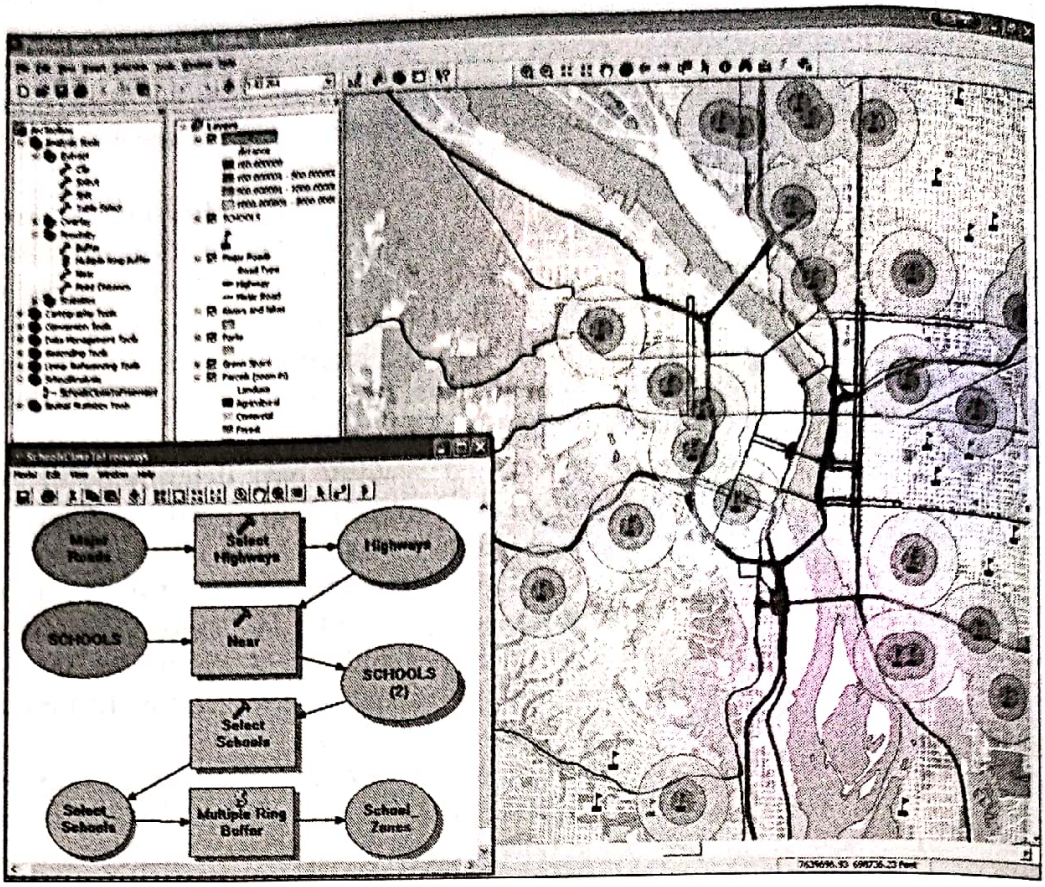

FIGURE 10.12
Geographic information systems facilitate the mining and visualization of data associated with a geo-physical location.

Source: Courtesy of ESRI.

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 its meaning for business decision making [14, 24]. Figure 10.13 is an example of website activity data displayed by a data visualization system.

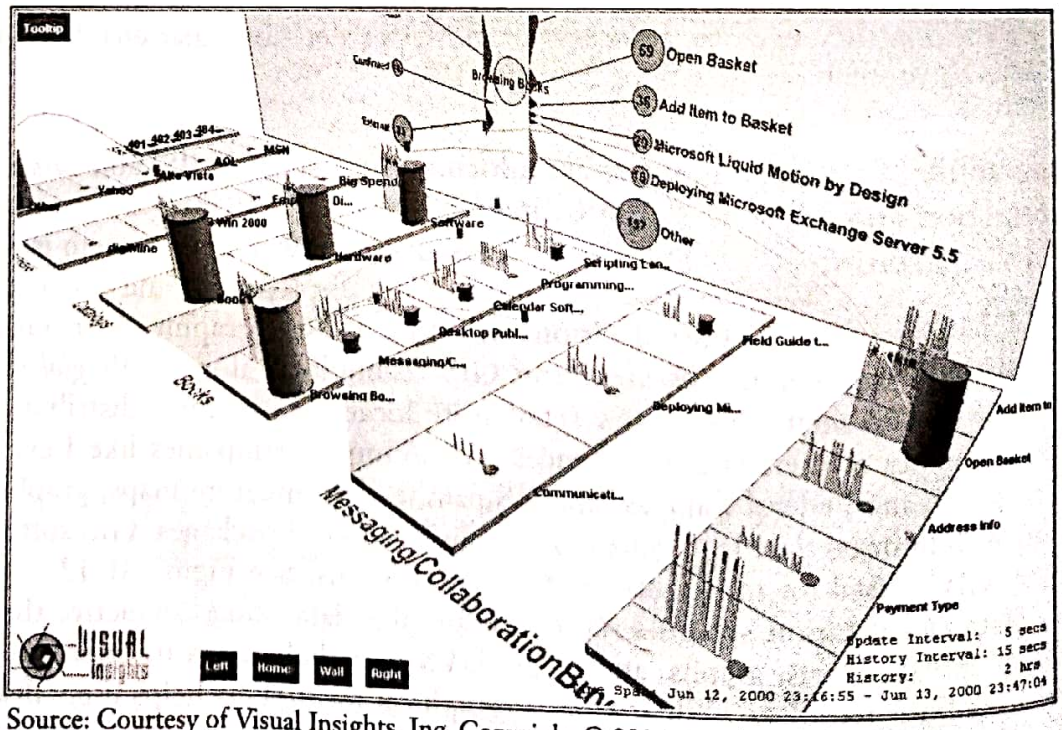

FIGURE 10.13
Using a data visualization system to analyze user activity on an e-commerce website.

Source: Courtesy of Visual Insights, Inc. Copyright © 2004 visualinsights.com.

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Eli Lilly: Data Visualization for Decision Support

A new idea in software is beginning to help companies reduce the time and money they spend searching for patterns and meaning in their data oceans. It's an approach that started as a doctoral thesis by Christopher Ahlberg, the 32-year-old Swedish-born founder of software company Spotfire, in Somerville, Massachusetts.

Spotfire's software is the first to combine both "data visualization" and a powerful database querying flexibility. Known as DecisionSite, the data visualization system (DVS) software isn't cheap—installations start at $100,000. That hasn't stopped customers in a wide range of industries from buying more than 16,000 licenses.

The magic in Spotfire's software is that it lets users easily do what-if queries and comparisons of data from different sources by moving sliders on a computer screen with a mouse. The results appear as brightly colored bar graphs, pie charts, scatter plots, and even maps.

When Spotfire rolled out its software in 1997, it aimed first at the drug industry, where the data explosion has been immense. An early adopter was Sheldon Ort, Eli Lilly's information officer for manufacturing and supply services. Ort now has some 1,500 company scientists around the world hooked up to Spotfire's software. "We primarily use it to facilitate decision making," Ort says. "With its ability to represent multiple sources of information and interactively change your view, it's helpful for homing in on specific molecules and deciding whether we should be doing further testing on them."

Using Spotfire, researchers avoid having to construct multiple queries in perfect syntax. Dragging the sliders to and fro, the user is actually launching a sequence of queries in rapid succession and seeing the outcomes expressed graphically onscreen. Lilly uses the software to conduct meetings among researchers at multiple sites who are linked on a computer network. As the person making a presentation moves the sliders on his or her screen, everyone can see the families, clusters, outliers, gaps, anomalies, and other statistical nuggets that database users fish for. Ideas can be tried out collaboratively in real time [10].

4 basic

Using Decision Support Systems

Using 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, since 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. That is the essence of the decision support system concept.

Using a decision support system involves four basic types of analytical modeling activities: (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 10.14.

What-If Analysis

In **what-if analysis,** an end 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 instantly recalculate all affected variables in the spreadsheet. A managerial user would be very interested in observing and evaluating 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

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FIGURE 10.14
Activities and examples of the major types of analytical modeling.

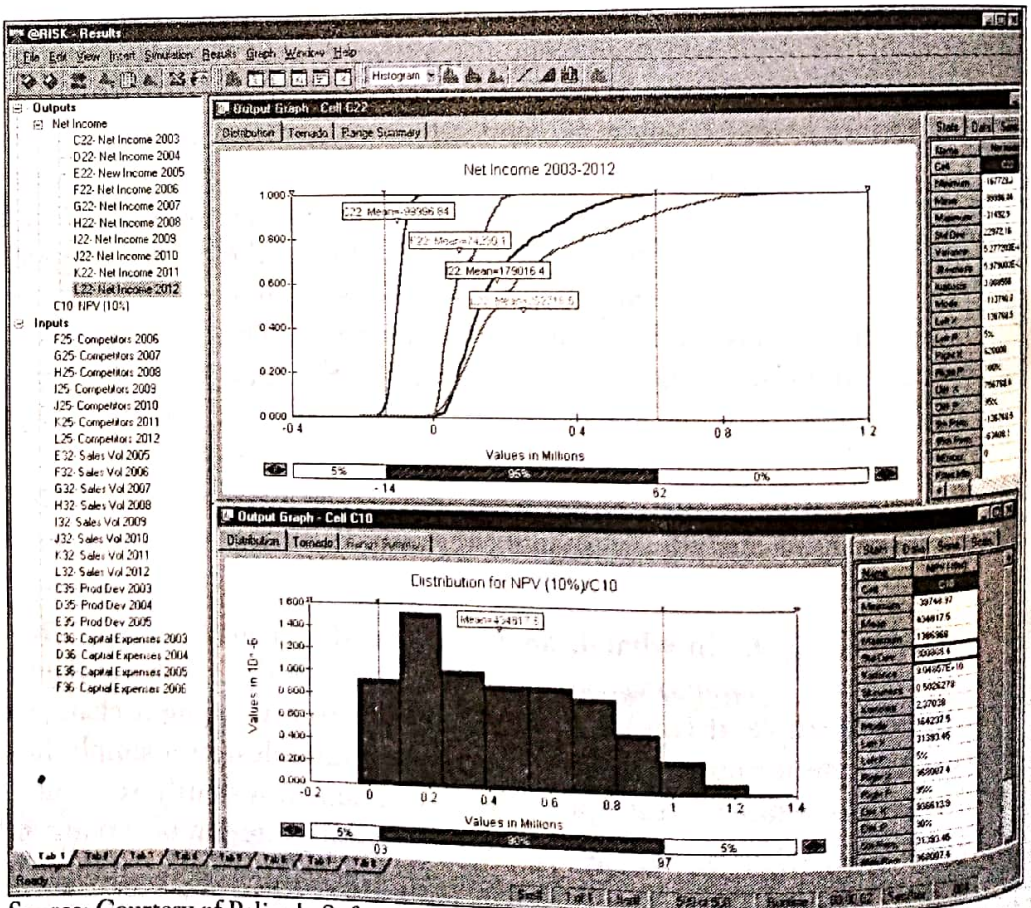
Type of Analytical Modeling	Activities and Examples
What-if analysis	Observing how changes to selected variables affect other variables. *Example:* What if we cut advertising by 10 percent? What would happen to sales?
Sensitivity analysis	Observing how repeated changes to a single variable affect other 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 $1million.
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?

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 10.16 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. So sensitivity analysis is really a case of what-if analysis involving repeated

FIGURE 10.15
This what-if analysis 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: Courtesy of Palisade Software.

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changes to only one variable at a time. Some DSS packages automatically make repeated small changes to a variable when asked to perform sensitivity analysis. Typically, sensitivity analysis is used when decision makers 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 would help a manager understand the impact of various revenue levels on other factors involved in decisions being considered.

Goal-Seeking Analysis

Goal-seeking analysis reverses the direction of the analysis done in what-if and sensitivity analysis. Instead of observing how changes in a variable affect other variables, goal-seeking analysis (also called *how can* analysis) sets a target value (a 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 for net profit after taxes for a business venture. Then you could repeatedly change the value of revenue or expenses in a spreadsheet model until a result of $2 million is achieved. Thus, you would discover what amount of revenue or level of expenses the business venture needs to achieve in order 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?" Thus, 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 the best values for the target variables are discovered. 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.

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 sometimes called *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 10.16. 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 to discover better ways to display products in a store, design a better e-commerce website, reach untapped profitable customers, or recognize customers or products that are unprofitable or marginal [16].

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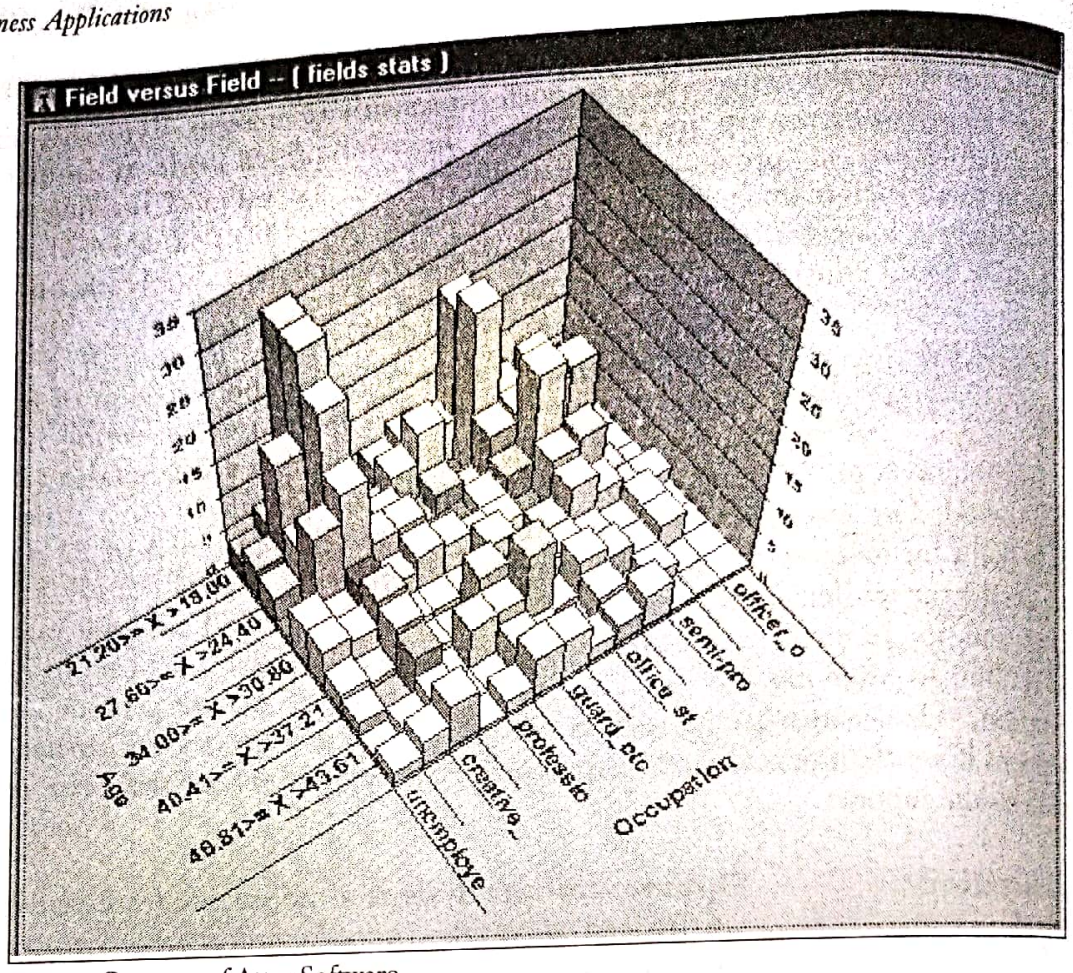

FIGURE 10.16
Data mining software helps discover patterns in business data like this analysis of customer demographic information.

Source: Courtesy of Attar Software.

Market Basket Analysis (MBA) is one of the most common and useful types of data mining for marketing. The purpose of market basket analysis is to determine what products customers purchase together with other products. MBA takes its name from the concept of customers throwing all their purchases into a shopping cart (a market basket) during grocery shopping. Knowing what products people purchase as a group can be very helpful to a retailer or to any other company. A store could use this information to place products frequently sold together into the same area, while 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 what new products to offer their prior customers.

In some cases, the fact that items sell together is obvious—every fast-food restaurant asks their customers "Would you like fries with that?" whenever a customer orders a sandwich. However, sometimes the fact that certain items would sell well 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. While the result makes some sense—couples stocking 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: By using computer data mining tools, it's not necessary for a person to think of what products consumers would logically buy together—instead, the customers' sales data is allowed to speak for itself. This is a good example of data-driven 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 to 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

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likely 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.

National Basketball Association: Playing "Mine" Games

The job of coach in the National Basketball Association (NBA) is an exciting job to be sure. It is also a job where winning is expected, and too much losing is simply not tolerated. So what can an NBA coach do to help bring his team to victory? Naturally, there are the full-court press, the pick and roll, the fast break, the low post, and of course, multimillion-dollar players. But to help develop the strategy necessary to win on any given day, NBA coaches also have a different kind of weapon in their arsenal: data mining. About 20 NBA teams have been using Advanced Scout, a data mining application developed by IBM, to hone their game plans.

Advanced Scout is a data analysis tool that coaches use on laptops both at home and on road trips to mine data housed on the NBA's central server. The events of each game are categorized statistically—by points, assists and fouls, etc.—and time-stamped, allowing coaches to easily search NBA game videos to give meaning to statistical findings. So, for instance, if a coach finds via Advanced Scout that a star opposing player has trouble scoring against certain players on his team, he can pinpoint the times on the game tapes when the opposing star goes head-to-head with those players and devise a defensive strategy.

The results from Advanced Scout are presented to the coach in one of two forms—a text description or a graph. Automatically generated text describes the patterns found for the situation under analysis. An example report might look something like this:

When Price was point-guard, J. Williams missed 0 percent (0) of his jump field-goal attempts and made 100 percent (4) of his jump field-goal attempts. The total number of such field-goal attempts was 4. This is a different pattern than the norm which shows that: Cavaliers' players missed 50.70 percent of their total field-goal attempts. Cavaliers' players scored 49.30 percent of their total field-goal attempts.

By formatting the results in a natural language form, the results can be more easily understood by the coach. The text presentation also offers a suggestion as to why the particular pattern is interesting—explicitly pointing out the ways that this particular pattern deviates from an expected norm—in essence presenting an initial argument and easily interpretable justification of the relative importance of this finding. Advanced Scout also allows for "what-if" analysis to investigate different combinations of players to improve a given situation. For example, if plays designed for Pistons power forward Ben Wallace are less successful when Chauncey Billups plays point guard, coach Larry Brown can issue a query for the identical circumstances, except with Lindsey Hunter or Rip Hamilton as point guard. Data mining takes the excitement of the NBA to a higher level by allowing coaches to play the best against the best [20, 44].

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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.

However, executive information systems are becoming so widely used by managers, analysts, and other knowledge workers 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, electronic 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 [18, 45].

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 stress the use of a graphical user interface and graphics displays that can be customized to 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 quickly retrieve displays of related information at lower levels of detail, is another important capability.

Figure 10.17 shows one of the displays provided by the Web-enabled Hyperion executive information system. Notice how simple and brief this display is. Also 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. Beside the drill-down capability, the Hyperion EIS also stresses trend analysis and exception reporting. Thus, a business user can quickly discover the direction 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.

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 [40].

We mentioned earlier in this chapter that major changes and expansion 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.

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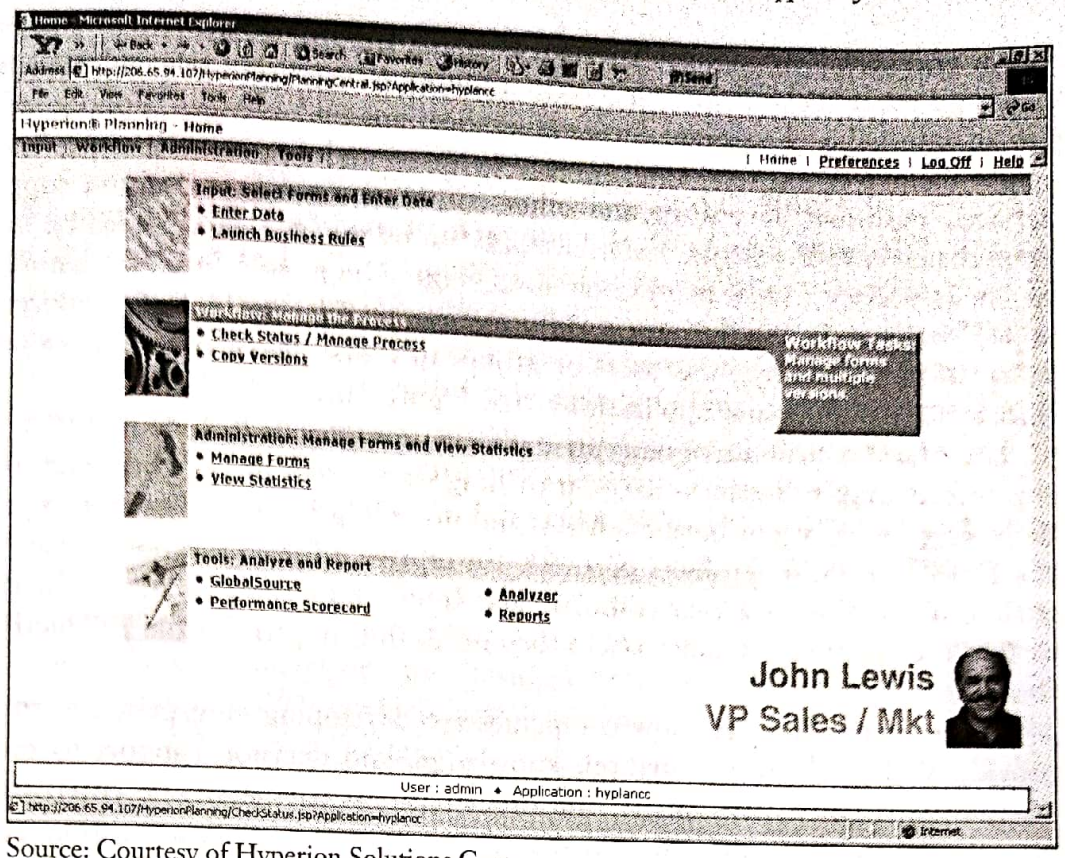

FIGURE 10.17 This Web-based executive information system provides managers and business professionals with a variety of personalized information and analytical tools for decision support.

Source: Courtesy of Hyperion Solutions Corp.

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 [39].

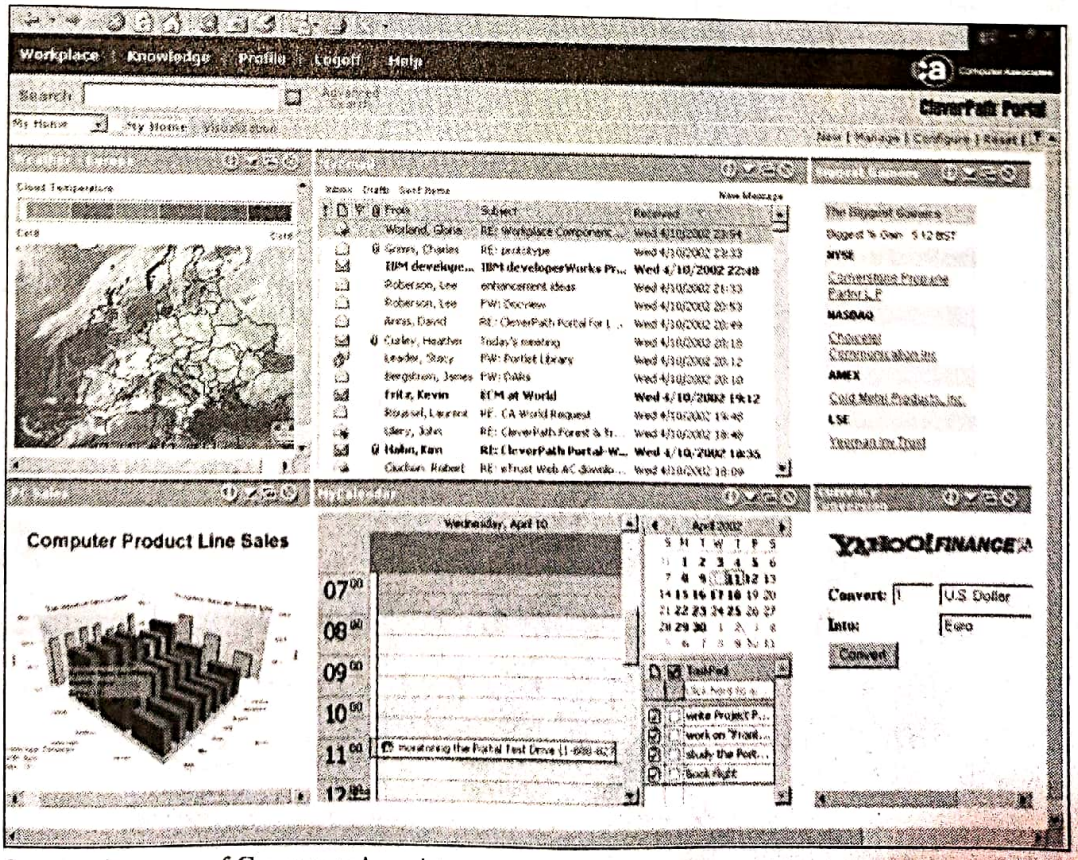

FIGURE 10.18 An enterprise information portal can provide a business professional with a personalized workplace of information sources, administrative and analytical tools, and relevant business applications.

Source: Courtesy of Computer Associates.

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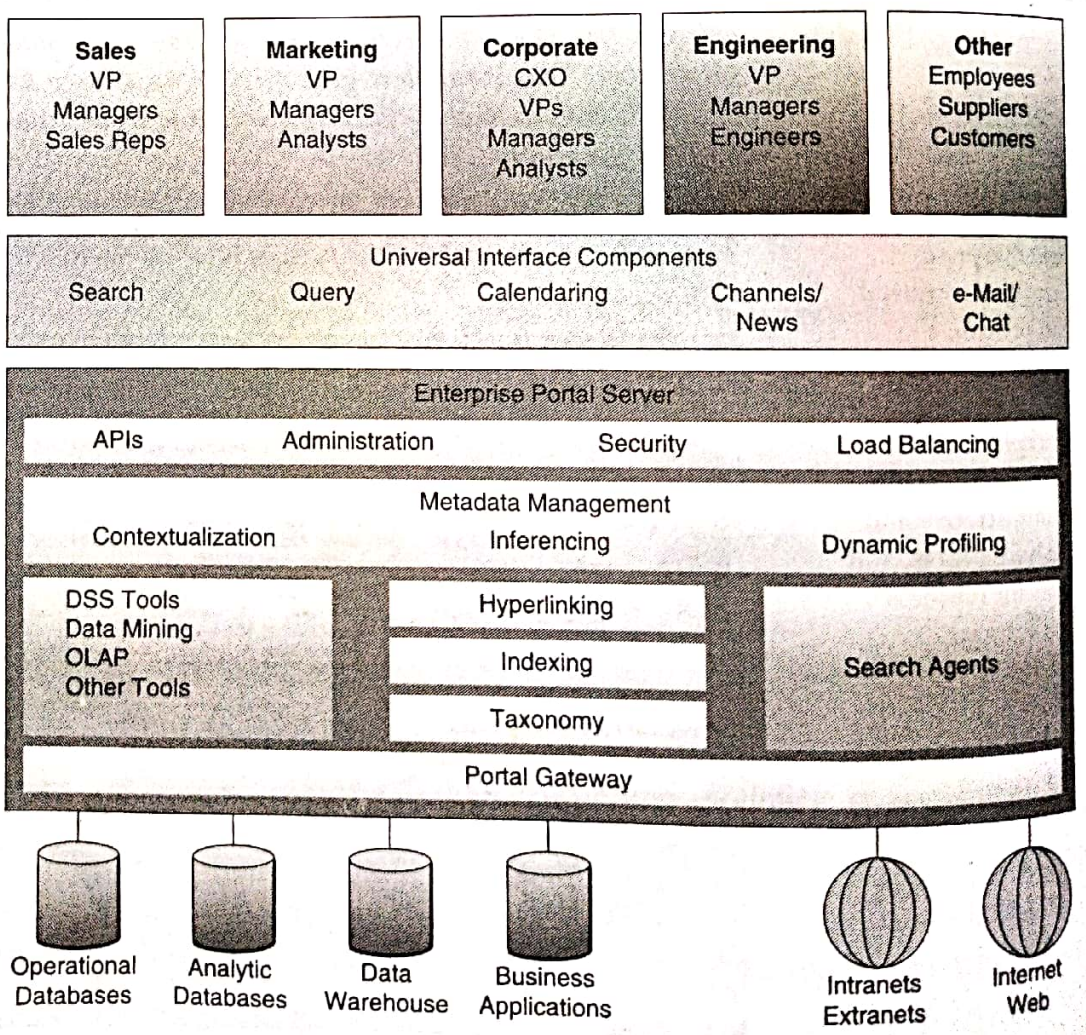
An **enterprise information portal** (EIP) is a Web-based interface and integration of MIS, DSS, EIS, and other technologies that gives all intranet users and selected extranet users access to a variety of internal and external business applications and services. For example, internal applications might include access to e-mail, project websites, 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 websites. 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 10.18.

The business benefits of enterprise information portals include providing more specific and selective information to business users, providing easy access to key corporate intranet website 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 and Internet websites 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 [40].

Figure 10.19 illustrates how companies are developing enterprise information portals as a way to provide Web-enabled information, knowledge, and decision 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

FIGURE 10.19
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.



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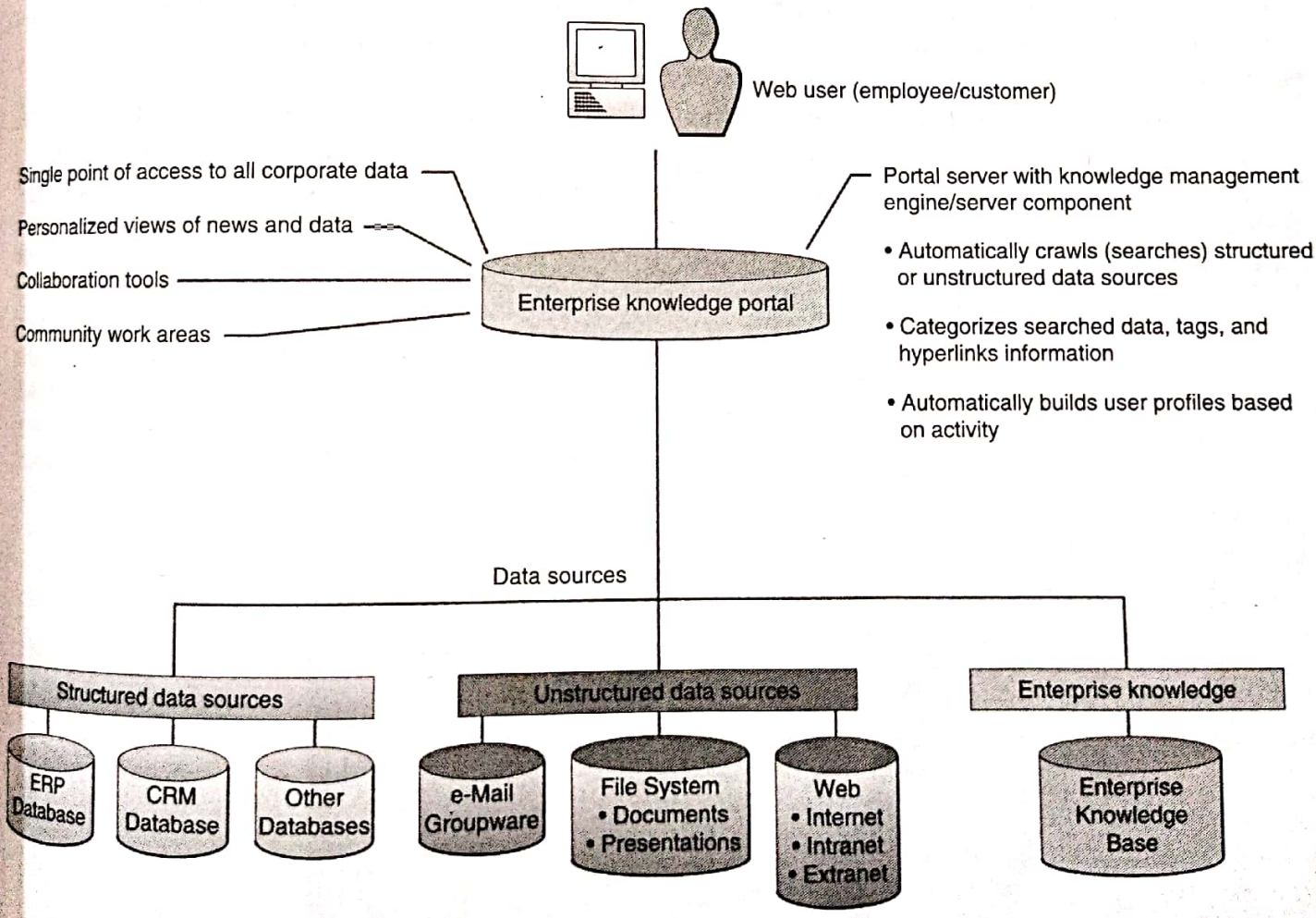
access to a variety of internal and external business applications, databases, and services. For example, the EIP in Figure 10.19 might give a qualified user secure access to DSS, data mining, and OLAP tools, the Internet and the Web, the corporate intranet, supplier or customer extranets, operational and analytical databases, a data warehouse, and a variety of business applications [36, 39, 40].

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 websites 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 [35, 36]. See Figure 10.20. Now let's look at an example of a Web-enabled knowledge management system in business.

FIGURE 10.20 This example of the capabilities and components of an enterprise knowledge portal emphasizes its use as a Web-based knowledge management system.



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Qwest Communications: Web Knowledge Management System

At Qwest Communications, knowledge management (KM) was the only way to be sure that call center representatives had the information they needed, when they needed it. Relying on print documentation or a supervisor's directive did not ensure cross-company accuracy or even that the information was delivered to all who needed it. Knowledge management was the only way to ensure that support would be available for every conceivable situation, and that the information was accurate and complete. Qwest has had an online procedures database for quite some time, but it was just online documentation. Each document looked different. Design was in the hands of the individual author, and there were lots of authors. Compounding the problem, authors had their own view about the content and the appropriate level of detail. Generally speaking, they wrote what *they* thought the representative needed to know, not necessarily what the representative *actually* needed to know.

In 1999 the old system was replaced by *InfoBuddy*, Qwest's Web-based knowledge management system. It supports a wide variety of job functions in addition to customer service representatives, including technical repair, installation and maintenance, etc. InfoBuddy uses a methods and procedures database with intelligent KM capabilities, such as searching, tagging, and customizable interface. It can reorder the information presentation based on who the user is.

When users identify themselves and their job function or role, the InfoBuddy intranet portal knows how to configure its user interface to provide information of most value to each person. In addition, users have the ability to personalize their portal through the "MyBuddy" feature, enabling representatives to place bookmarks on their home pages to the information they feel is most important. Over time, as users "learn" from the system, they can replace learned material with new, usually more advanced information.

In addition, the InfoBuddy system "pushes" information to specific users based on their needs. For example, if a new promotion were initiated, specific information—products, pricing, etc.—would appear on the "desktop" of those representatives who are involved in the marketing initiative [42].

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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 10.21. 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 [50].

Read the Real World Case on the next page. We can learn a lot about the business value of artificial intelligence technologies 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 10.22.

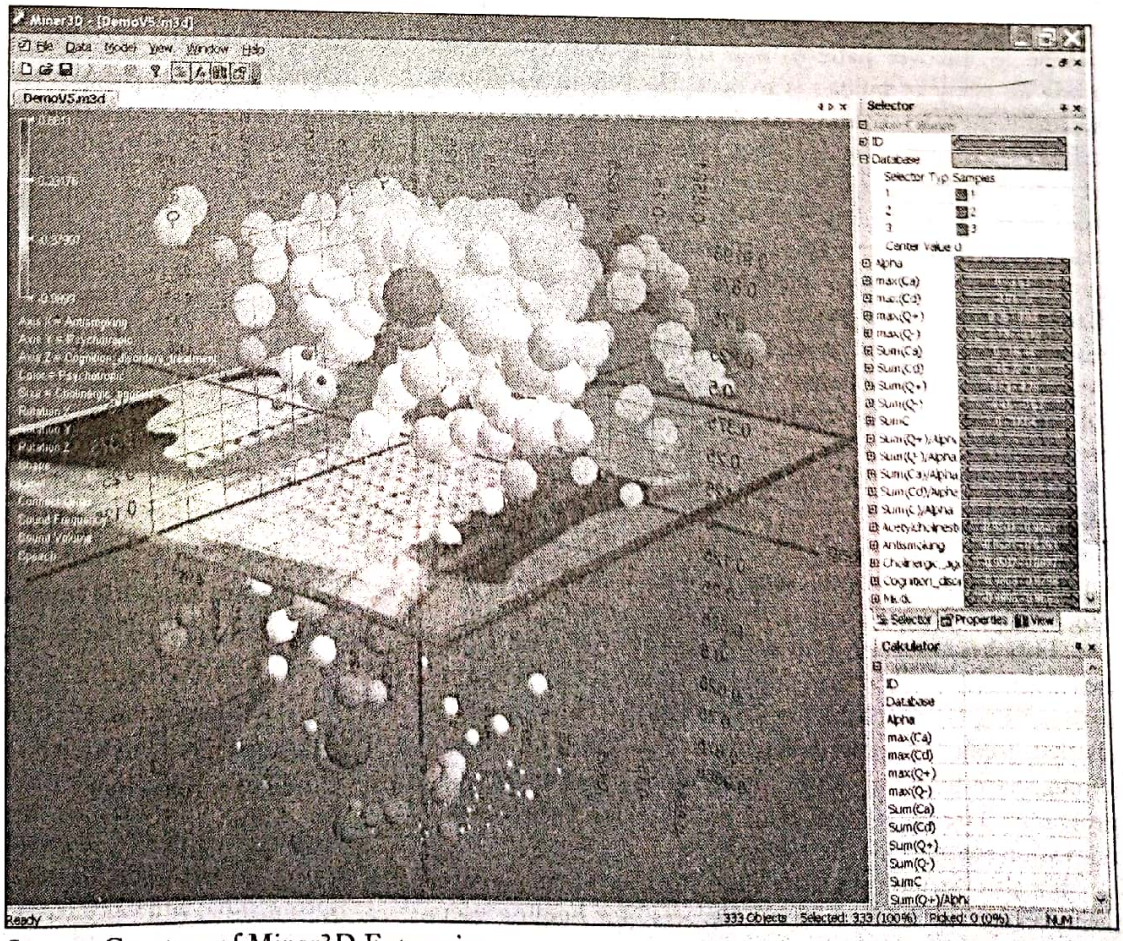

FIGURE 10.21
Data mining and artificial intelligence software applications can find valuable relationships in the data that result in new products, services, and strategies.

Source: Courtesy of Miner3D Enterprise.

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REAL WORLD CASE 2 Wal-Mart, BankFinancial, and HP: The Business Value of AI

Some managers still think that artificial intelligence—the decades-long effort to create computer systems with humanlike smarts—has been a big flop. But executives at many companies know better. Artificial intelligence (AI) is often a crucial ingredient in their stellar performance. In fact, AI is now a part of the technology of many industries. AI software helps engineers create better jet engines. In factories, it boosts productivity by monitoring equipment and signaling when preventive maintenance is needed. And in the pharmaceutical sector, it is used to gain new insights into the tremendous amount of data on the human genome.

The finance industry is a real veteran in such technology. Banks, brokerages, and insurance companies have been relying on various AI tools for two decades. One variety, called a neural network, has become the standard for detecting credit-card fraud. Since 1992, neural nets have slashed such incidents by 70 percent or more for the likes of U.S. Bancorp and Wachovia Bank. Now, even small credit unions are required to use the software in order to qualify for debit-card insurance from Credit Union National Association.

Wal-Mart. Like banks, retailers collect huge amounts of data. Wal-Mart Stores Inc. (www.walmart.com), for instance, harnesses AI to transform that raw data into useful information. Wal-Mart consolidates point-of-sale details from its 3,000 stores. Data-mining systems sift instantly through the deluge to uncover patterns and relationships that would elude an army of human searchers. Data-mining software typically includes neural nets, statistical analysis, and so-called expert systems with if-then rules that mimic the logic of human experts. The results enable Wal-Mart to predict sales of every product at each store with uncanny accuracy, translating into huge savings in inventories and maximum payoff from promotional spending.

BankFinancial. The potential for mining cost-saving and revenue-boosting ideas from data is increasing as companies build bigger data warehouses, computers grow more powerful, and vendors of analytic software introduce products that are easier to use. But while many of the products that can answer those questions use esoteric techniques such as neural networks, logistic regression, and support-vector machines, they don't require a PhD in math, users say. Indeed, the biggest stumbling block to using "predictive analytics" is getting the data, not analyzing it, they say.

That has been the case so far at BankFinancial Corp. (www.bankfinancial.com) in Chicago. It uses the Clementine data-mining "workbench" from SPSS Inc., to develop models that predict customer behavior so the bank can, for example, more accurately target promotions to customers and prospects. The bank uses Clementine's neural network and regression routines for these models.

It's also beginning to use PredictiveMarketing, SPSS's new package of "best-practice templates" for helping users set up predictive models. PredictiveMarketing will reduce the time it takes the bank to develop a model by 50 percent to 75 percent, says William Connerty, assistant vice president of market research. The first major application is a model to predict customer "churn," the rate at which customers come and go. It will be used to identify the customers most likely to leave the bank during the coming month. The problem is, the model has access only to account information prepared from weekly and monthly summaries, not to the daily customer activity that would make it more timely.

"The biggest obstacle is getting transaction data and dealing with disparate data sources," Connerty says. The data that BankFinancial needs in order to assess customer loyalty comes from several bank systems and unintegrated customer survey databases. A lot of systems integration and interface work needs to be done before the bank will see the full fruits of its modeling tools, Connerty says.

HP Enterprise Systems. Hewlett-Packard (www.hp.com) has an Enterprise Systems Group that pulls together people with diverse backgrounds and strong analytical skills for its group that does predictive modeling of customer behavior. The group is part of "CRM operations" under a vice president for sales, says Randy Collica, a senior business/data mining analyst.

HP uses software from SAS Institute Inc. in Cary, North Carolina, to mine its database of customers and prospects, using AI techniques to predict customer churn, loyalty, and where to target promotions. HP also mines its huge stores of unformatted text data from its call centers, including e-mails from customers and prospects and text typed in during voice calls with SAS predictive analytics for text. The techniques use "lead ratings" of call center personnel's assessments of a caller's readiness to buy—coded as "hot," "warm," or "suspect"—to predict the customer-led rating of noncoded text sources with 85 percent accuracy, Collica says.

Case Study Questions

1. What is the business value of AI technologies in business today? Use several examples from the case to illustrate your answer.
2. What are some of the benefits and limitations of data mining for business intelligence? Use BankFinancial's experience to illustrate your answer.
3. Why have banks and other financial institutions been leading users of AI technologies like neural networks? What are the benefits and limitations of this technology?

Sources: Adapted from Otis Port, Michael Arndt, and John Carey, "Smart Tools," *BusinessWeek*, The BusinessWeek 50, Spring 2003; and Gary Anthes, "The Forecast Is Clear," *Computerworld*, April 14, 2003, pp. 31–32.

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FIGURE 10.22
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.

Debate has raged around artificial intelligence since serious work in the field began in the 1950s. Not only technological, but moral and philosophical questions abound about the possibility of intelligent, thinking machines. For example, British AI pioneer Alan Turing in 1950 proposed a test for determining if 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 [30, 45].

Though 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 developing intelligence to impart true humanlike capabilities to computers is simply not possible. But progress continues, and only time will tell if the ambitious goals of artificial intelligence will be achieved and equal the popular images found in science fiction.

List and explain

The Domains of Artificial Intelligence

Figure 10.23 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 each other, 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

FIGURE 10.23
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.

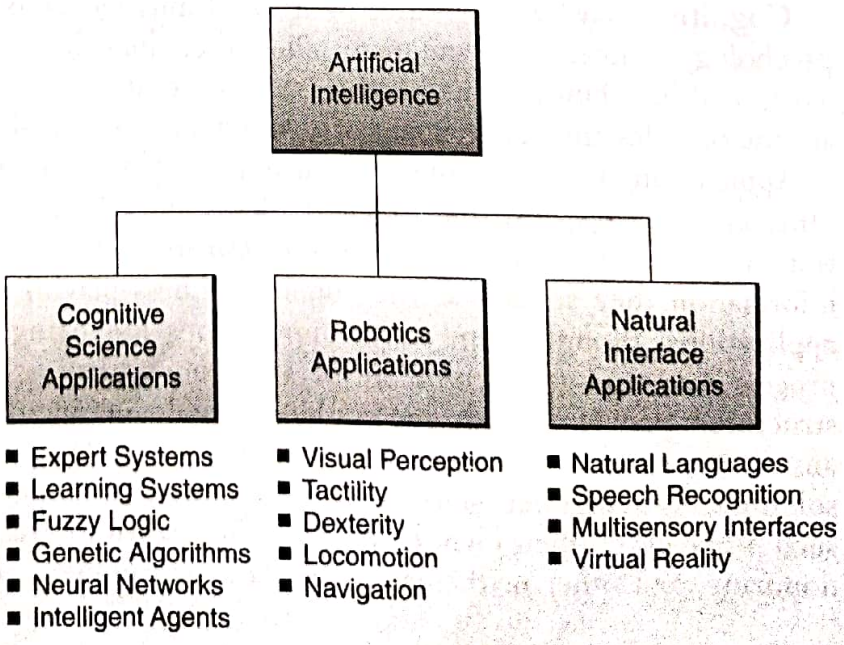

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FIGURE 10.24
Examples of some of the latest commercial applications of AI.

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 intra- 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-raylike vision enabled by enhanced-reality visualization that allows brain surgeons to "see through" intervening tissue to operate, monitor, and evaluate disease progression • Automated animation and haptic interfaces that allow users to interact with virtual objects via touch (i.e., 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 micro robots and hands and legs to cognitive robotic and trainable modular vision systems

their current technologies. Figure 10.24 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 based on 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 semi-structured 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 to simulate evolutionary processes that can generate

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increasingly better solutions to problems. And *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 properly find one's way to a destination [30].

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 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. This 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.

BAE Systems: Using AI for Knowledge Management

It's one of those blue-sky goals to which many big companies only aspire: capturing the seemingly infinite amount of intellectual capital that's carried by tens of thousands of employees around the world and using it to achieve competitive advantage. But it's a flight that's well under way at London-based BAE Systems PLC (www.baesystems.com), formerly British Aerospace, which is getting solid returns on a knowledge management intranet-based system. Thousands of BAE engineers scattered across five continents in 100 offices are using the system to search for information that may be vital to big initiatives and to identify and eliminate redundant project work.

Like other far-flung multinationals, the $20 billion-plus aerospace and engineering giant suspected that its engineers and other workers might be wasting a lot of time searching for information scattered across the enterprise. So BAE Systems invested roughly $150,000 to study its global operations to see whether "we had the right information to support decision-making processes and if people had the right learning systems to help them support their day-to-day jobs," says Richard West, BAE's organizational and e-learning manager in Farnborough, England.

The results, says West, "were certainly eye-opening." BAE Systems discovered that nearly two-thirds of its top 120 decision makers didn't have the right information at key stages. The company also found that 80 percent of employees were "wasting" an average of 30 minutes each day trying to find the information they needed to do their jobs. Another 60 percent were spending an hour or more duplicating the work of others.

One of the problems BAE Systems officials discovered through the study was information overload on its intranets. The information itself was often unstructured, and the search engines were inadequate for conducting keyword searches to find information, says West. The company

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decided to test two or three of the top intranet search engines over three months and compare their ability to find information, says West.

One of the search engines BAE Systems tested was from San Francisco–based Autonomy Corp. The Autonomy search engine uses advanced pattern matching, intelligent agents, and other artificial intelligence (AI) technologies whose "ability to retrieve information was second to none," says West. What sold BAE Systems on Autonomy's AI-based technology was its ability to flag whether other people in the organization are searching against similar information and, perhaps, working on common problems.

That kind of matching identification helped the Autonomy system pay for itself just seven months after it was installed. One of the system's first big payoffs came when two disparate groups of engineers in the U.K. were working on wing construction issues for the company's Harrier 2 military aircraft. After using the Autonomy system to search for wing specification information across the company's intranet, one of the engineering groups discovered that the other group was working on the same problem. Catching the redundancy early in the cycle helped save the company millions, says West. And a year into using the Autonomy search engine, BAE Systems evaluated its performance and determined that it was able to reduce the time needed to retrieve information from its intranet by 90 percent [25].

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 [30].

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 10.25 illustrates the interrelated components of an expert system. Note the following components:

- **Knowledge Base.** The knowledge base of an expert system contains (1) facts about a specific subject area (for example, *John is an analyst*) and (2) heuristics (rules of thumb) that express the reasoning procedures of an expert on the subject (for example: 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 10.26.
- **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

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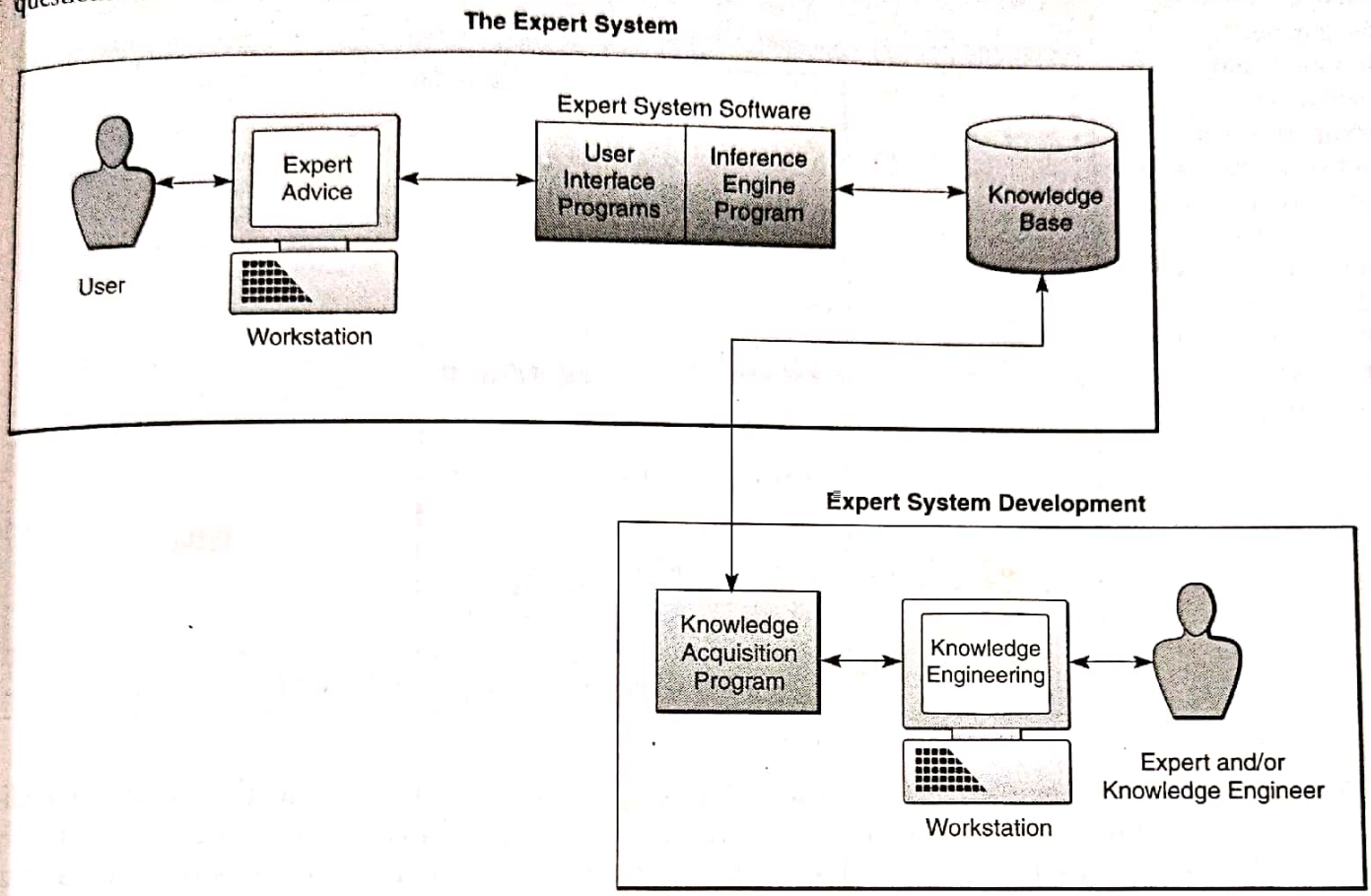
FIGURE 10.25 Components of an expert system. The software modules perform inferences on a knowledge base built by an expert and/or knowledge engineer. This provides expert answers to an end user's questions in an interactive process.



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 10.27 illustrates an expert system application.

FIGURE 10.26 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).

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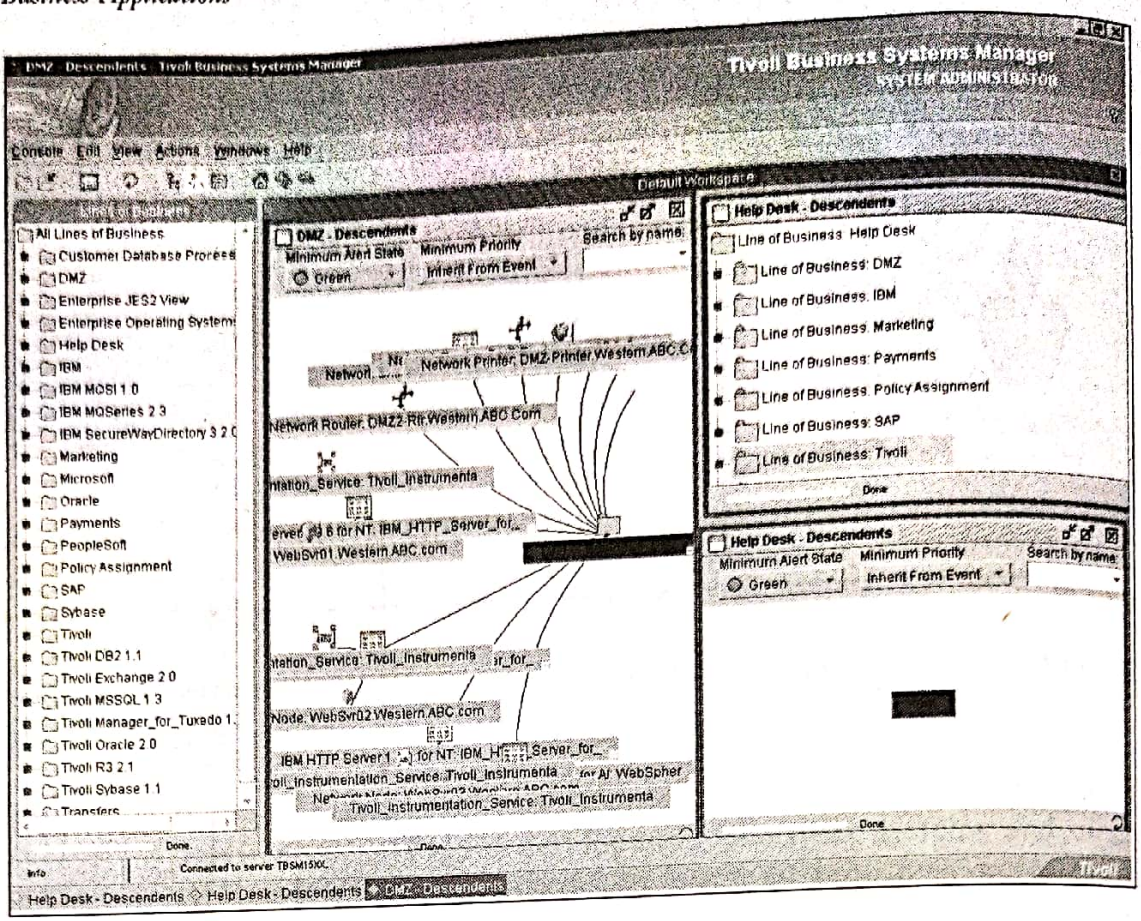

FIGURE 10.27
Tivoli Systems Manager by IBM automatically monitors and manages the computers in a network with proactive expert system software components based on IBM's extensive mainframe systems management expertise.

Source: Courtesy of IBM Corporation.

Expert systems are being used for many different types of applications, and the variety of applications is expected to continue to increase. However, you should realize that expert systems typically accomplish one or more generic uses. Figure 10.28 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 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 properly. The costs of knowledge engineers, lost expert time, and hardware and software resources may be too high to

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FIGURE 10.28
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

D³SP

offset the benefits expected from some applications. Also, expert systems can't maintain themselves. That is, they can't learn from experience but must be taught new knowledge and modified as new expertise is needed to match developments in their subject areas.

Developing Expert Systems

What types of problems are most suitable to expert system solutions? One way to answer this is to look at examples of the applications of current expert systems, including the generic tasks they can accomplish, as were summarized in Figure 10.28. Another way is to identify criteria that make a problem situation suitable for an expert system. Figure 10.29 outlines some important criteria.

Figure 10.29 should emphasize 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 [45].

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

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is, its knowledge base. This leaves a *shell* of software (the inference engine and user interface programs) with generic inferencing and user interface capabilities. Other development tools (such as rule editors and user interface generators) are added in making the shell a powerful expert system development tool.

FIGURE 10.29
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.

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.

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.

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. Or experts skilled in the use of expert system shells could 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, 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 over 100 billion neuron brain cells!). However, like the brain, the interconnected processors in a neural network operate in parallel and interact dynamically with each other. This enables the network to "learn" from data it processes. That is,

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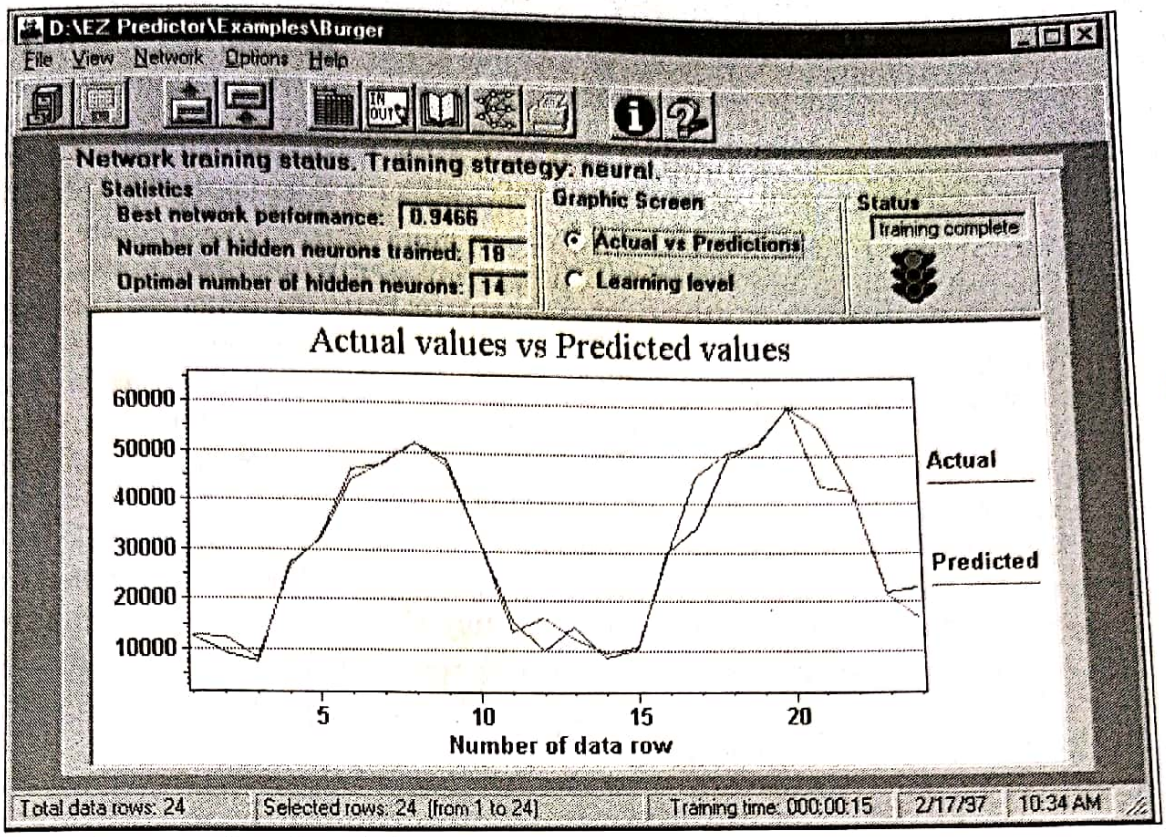

FIGURE 10.30 Evaluating the training status of a neural network application.

Source: Courtesy of Trading Solutions.

it learns to recognize patterns and relationships in this 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 [8, 45]. See Figure 10.30.

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, and 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.

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 tumors of the brain. 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 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.

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A new technique, which is a combination of hardware and software, has been developed which 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 which 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 stopped 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 [6, 37].

Fuzzy Logic Systems

In spite of the 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 since 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 10.31 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.

FIGURE 10.31 An example of fuzzy logic rules and a fuzzy logic SQL query in a credit risk analysis application.

Fuzzy Logic Rules

```
Risk should be acceptable
If debt-equity is very high
  then risk is positively increased
If income is increasing
  then risk is somewhat decreased
If cash reserves are low to very low
  then risk is very increased
If PE ratio is good
  then risk is generally decreased
```

Fuzzy Logic SQL Query

```
Select companies
  from financials
    where revenues are very large
      and pe_ratio is acceptable
      and profits are high to very high
      and (income/employee_tot) is reasonable
```

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Notice how fuzzy logic uses terminology that is deliberately imprecise, such as *very high*, *increasing*, *somewhat decreased*, *reasonable*, and *very low*. This 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 10.31, promise to improve the extraction of data from business databases [12, 26].

Fuzzy Logic in Business

Examples of applications of fuzzy logic are numerous in Japan, but rare in the United States. The United States has tended to prefer using 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, but includes autofocus cameras, autostabilizing camcorders, energy-efficient air conditioners, self-adjusting washing machines, and automatic transmissions [34].

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. Now genetic algorithm software is being used to model a variety of scientific, technical, and business processes [4, 21].

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 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)* in order to generate increasingly better solutions. Figure 10.32 illustrates a business use of genetic algorithm software.

GE's Engeneous

General Electric's design of a more efficient jet engine for the Boeing 777 is a classic example of a genetic algorithm application in business. A major engineering challenge was to develop more efficient fan blades for the engine. GE's engineers estimated that it would take billions of years, even with a supercomputer, to mathematically evaluate the astronomical number of performance and cost factors and combinations involved. Instead, GE used a hybrid genetic algorithm/expert system, called Engeneous, that produced an optimal solution in less than a week [4].

Virtual Reality

Virtual reality (VR) is a 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

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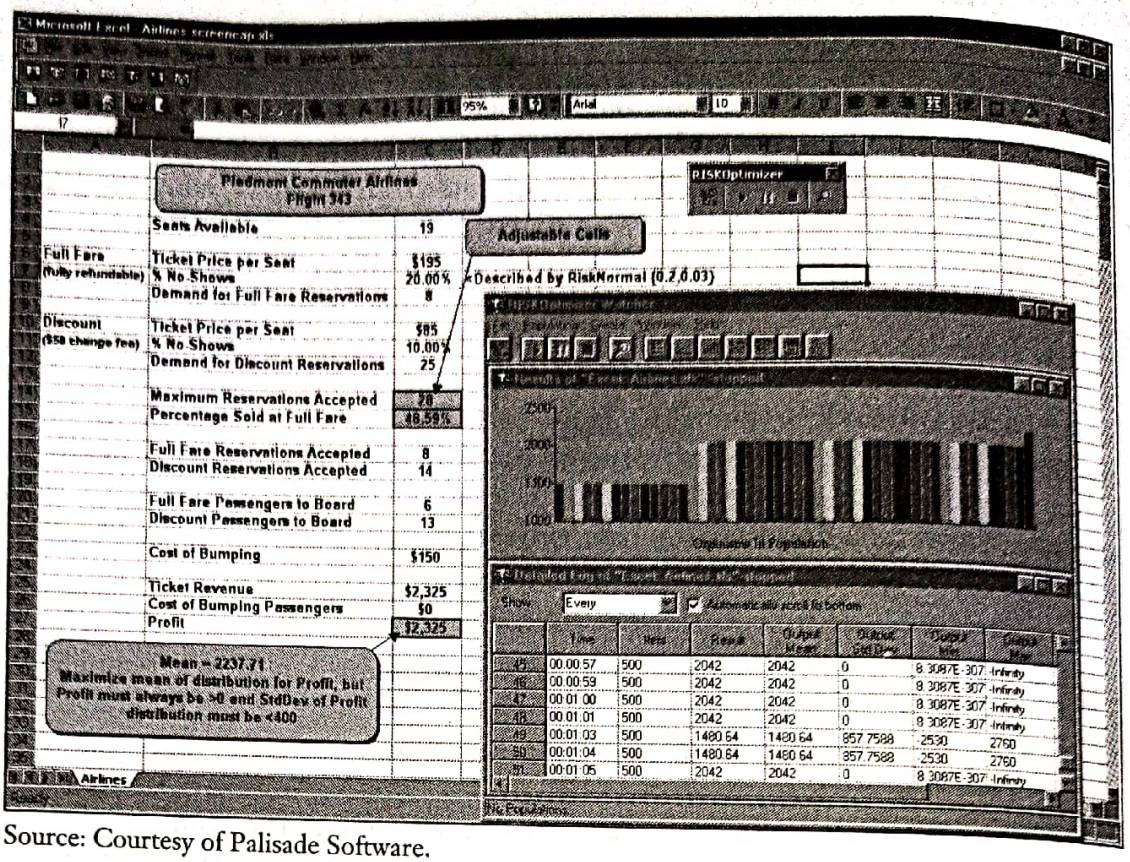

FIGURE 10.32 Risk Optimizer software combines genetic algorithms with a risk simulation function in this airline yield optimization application.

Source: Courtesy of Palisade Software.

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. Thus, 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 [2, 41].

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.

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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 importantly, 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 12 to 14 meters wide, but with in-place reserves of approximately 2.2 billion barrels. The oil is produced by horizontal wells located 0.5 to 1.5 meters above the point where the oil and seawater make contact.

During one particular 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 250 meters 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 or not 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 [38, 43].

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 10.33 summarizes major types of intelligent agents [32].

One of the most well-known uses of intelligent agents is the wizards found in Microsoft Office and other software suites. These wizards are built-in capabilities 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 10.34.

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FIGURE 10.33
Examples of different types of intelligent agents

Types of Intelligent Agents

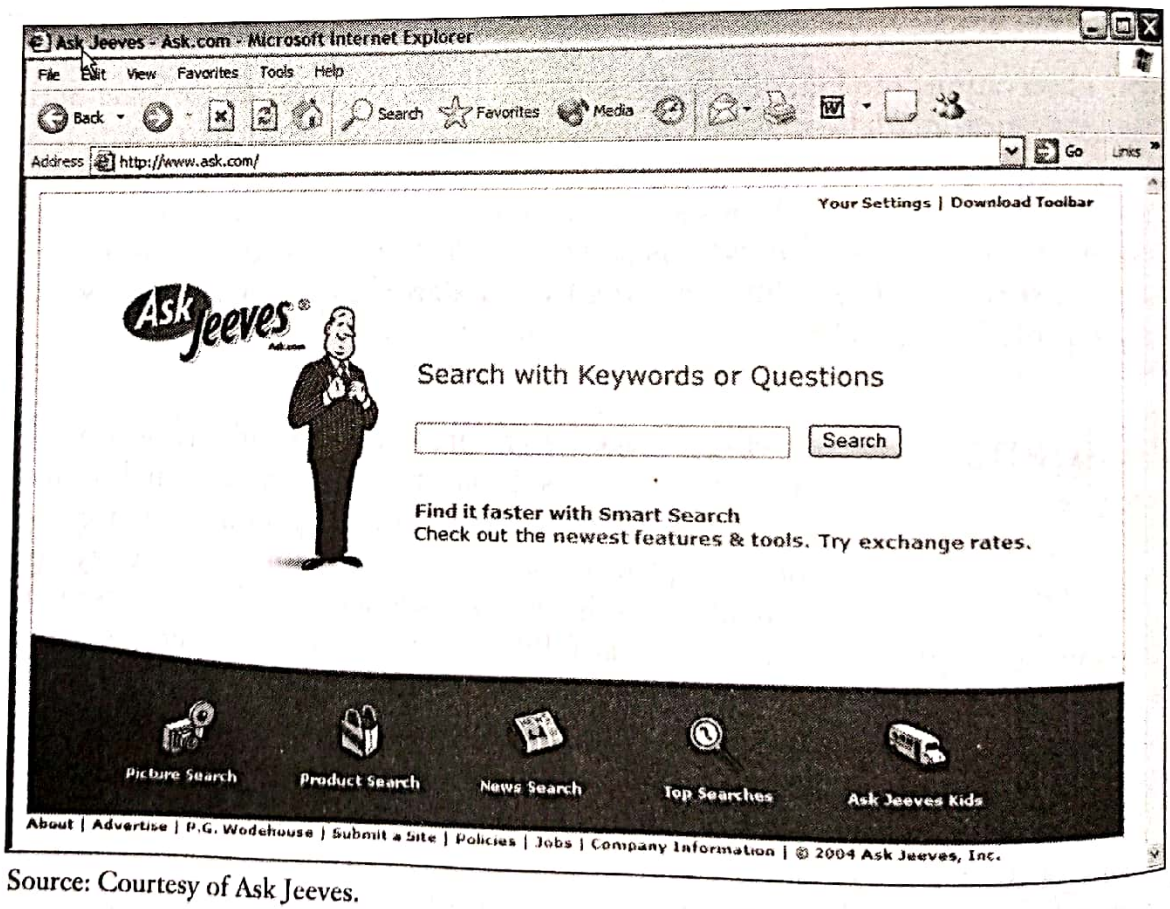
User Interface Agents

- **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.

FIGURE 10.34
Intelligent agents help you find information in a variety of categories from many online sources.



Source: Courtesy of Ask Jeeves.

The use of intelligent agents is growing rapidly as a way to simplify software use, search websites 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

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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.

Dow Jones & Co.: Intelligent Web Agents

Websites such as Amazon.com's Shop the Web, Excite's Jango.com, and MySimon's MySimon.com use intelligent agent technology to help users compare prices for fragrances, book titles, or other items on multiple sites. Other types of agents can answer e-mail, conduct intelligent searches, or help users find news reports and useful sites based on stated preferences.

For example, dozens of sites can show you the news, but Dow Jones & Co.'s Dow Jones Interactive (www.djinteractive.com) is different. Nearly 600,000 customers pay to search through stories from its 6,000 licensed and internal publications. That's a huge amount of data to filter and the company has applied intelligent agent and other artificial intelligence (AI) technologies to manage the task.

One of the site's most important features is Custom Clips, which allows users to create folders based on predefined topics—such as agribusiness or IBM—or to build their own using custom key words. When the site IS agent retrieves relevant articles, it can post them to a database-generated Web page or send the stories to the user's e-mail address [31, 32].

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