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INTRODUCTION TO DECISION SUPPORT SYSTEMS

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INTRODUCTION

Virtually everyone makes hundreds of decisions each day. These decisions range from the inconsequential, such as what to eat for breakfast, to the significant, such as how best to get the economy out of a recession. All other things being equal, good outcomes from those decisions are better than bad outcomes. For example, all of us would like to have a tasty, nutritional breakfast (especially if it is fast and easy), and the country would like to have a stable, well-functioning economy again. Some individuals are "lucky" in their decision processes. They can muddle through the decision not really looking at all of the options or at useful data and still experience good consequences. We have all met people who instinctively put together foods to make good meals and have seen companies that seem to do things wrong but still make a good profit. For most of us, however, good outcomes in decision making are a result of making good decisions.

"Good decision making" means we are informed and have relevant and appropriate information on which to base our choices among alternatives. In some cases, we support decisions using existing, historical data, while other times we collect the information, especially for a particular choice process. The information comes in the form of facts, numbers, impressions, graphics, pictures, and sounds. It needs to be collected from various sources, joined together, and organized. The process of organizing and examining the information about the various options is the process of modeling. Models are created to help decision makers understand the ramifications of selecting an option. The models can range from quite informal representations to complex mathematical relationships.

For example, when deciding on what to eat for a meal, we might rely upon historical data, such as those available from tasting and eating the various meal options over time and

Decision Support Systems for Business Intelligence by Vicki L. Sauter

our degree of enjoyment of those options. We might also use specially collected data, such as cost or availability of the options. Our model in this case might be simple: Select the first available option that appeals to us. Or, we might approach it with a more complex approach: Use linear programming to solve the "diet problem" to find the cheapest combination of foods that will satisfy all the daily nutritional requirements of a person.[1]

In today's business world, we might use models to help refine our understanding of what and how our customers purchase from us to improve our customer relationship management. In that case we might collect information from point-of-sale systems for all of our customers for multiple years and use data-mining tools to determine profiles of our customers. Those profiles could in turn profile information about trends with which managers could change marketing campaigns and even target some marketing campaigns.

The quality of the decision depends on the adequacy of the available information, the quality of the information, the number of options, and the appropriateness of the modeling

DSS in Action
DSS in Business

Equifax provides DSS and supporting databases to many of America's Fortune 1000 companies which allow these businesses to make more effective and profitable business decisions. The system allows users access to more than 60 national databases, mapping software, and analysis tools so that users can define and analyze its opportunities in a geographic area.

The tool enables retailers, banks, and other businesses to display trade areas and then to analyze demographic attributes. In particular, this DSS integrates customer information with current demographic and locational data. For example, Consumer-Facts™, offers information about spending patterns of more than 400 products and services in more than 15 major categories, with regional spending patterns incorporated. Further, it provides five-year projections that reflect the impact of dynamic economic and demographic conditions, such as income, employment, population, and household changes, on consumer spending that can be integrated with a corporation's own customer information.

This coupling of data and analysis of reports, maps, and graphs allows decision makers to consider questions of customer segmentation and targeting; market and site evaluation; business-to-business marketing; product distribution strategies; and mergers, acquisitions, and competitive analysis. For example, the DSS facilitates consideration of crucial, yet difficult questions such as:

- Who are my best customers and where are they located?
- Which segments respond positively to my marketing campaign?
- How will the addition of a new site impact my existing locations?
- How can I analyze and define my market potential?
- How can I estimate demand for my products and services accurately?
- What impact will an acquisition have on my locations?
- How is the competition impacting my business?

[1]The diet problem was one of the first large-scale optimization problems solved using modern modeling techniques. The Army wished to find the cheapest way to provide the necessary nutrition to the field soldiers. The National Bureau of Standards solved the problem with the simplex method (which was new then) with 9 equations and 77 variables. To solve the problem, it took nine clerks using hand-operated calculators 120 days to find the optimal solution. For more information on the diet problem, including a demonstration of the software, check the NEOS page at http://www-neos.mcs.anl.gov/CaseStudies/dietpy/WebForms/index.html.

effort available at the time of the decision. While it is *not* true that more information (or even more analysis) is better, it is true that more of the appropriate type of information (and analysis) is better. In fact, one might say that to improve the choice process, we need to improve the information collection and analysis processes.

Increasingly corporations are attempting to make more informed decisions to improve their bottom lines. Some refer to these efforts to use better information and better models to improve decision making as business intelligence. Others refer to it as analytics. In either case, the goal is to bring together the right information and the right models to understand what is going on in the business and to consider problems from multiple perspectives so as to to provide the best guidance for the decision maker.

One way to accomplish the goal of bringing together the appropriate information and models for informed decision making is to use decision support systems (DSS). Decision support systems are computer-based systems that bring together information from a variety of sources, assist in the organization and analysis of information, and facilitate the evaluation of assumptions underlying the use of specific models. In other words, these systems allow decision makers to access relevant data across the organization as they need it to make choices among alternatives. The DSS allow decision makers to analyze data generated from transaction processing systems and other internal information sources *easily*. In addition, DSS allow access to information external from the organization. Finally, DSS allow the decision makers the ability to analyze the information in a manner that will be helpful to that particular decision and will provide that support interactively.

So, the availability of DSS provides the opportunity to improve the data collection and analyses processes associated with decision making. Taking the logic one step further, the availability of DSS provides the opportunity to improve the quality and responsiveness of decision making and hence the opportunity to improve the management of corporations. Said differently, the DSS provides decision makers the ability to explore business intelligence in an effective and timely fashion.

DSS in Action
DSS for Protecting the Environment

Biologists working at the university of Missouri-St. Louis and the Missouri Botanical Gardens have used a specialized kind of DSS called a geographic information system (GIS) to test hypotheses in phytogeographic studies. The GIS allows for greater sophistication in studies of spatial components, such as the movement patterns of fruit-eating birds. For example, the Loiselle Lab at UM-St. Louis considered the Atlantic forests of Brazil and bird migration using a GIS. They modeled the historic distributions of birds in this region using a GIS and digitalized environmental layers from the National Atlas of Brazil. These historic distributions were compared to the present forest coverage to estimate the impact of the vast deforestation of this area. This allowed Loiselle to estimate the original habitat and the implications of its reduction. This, in turn, allowed the researchers to consider a wide range of options that impacted biodiversity conservation decisions of these forests.

To see how DSS can change the way in which decisions are made, consider the following example of a Manhattan court. Consider the problem. New York spends in excess of $3 billion each year on criminal justice and the number of jail beds has increased by over 110% in 20 years. In Manhattan, in particular, developers have spent billions of dollars refurbishing neighborhoods and providing good-quality living, business, and entertainment areas. Yet people continue not to feel safe in them, and minor crimes depreciate the quality

of life for residents. Furthermore, the likelihood of repeat offenses is high; over 40% of the defendants seen in a year already have three or more convictions.

While clearly there is a problem, those facts (that crime exists, that enormous amounts of money are spent, and that people do not feel safe) are examples of bad *outcomes*, not necessarily bad decisions. However, three facts do suggest the quality of the decision could be improved:

- Criminal justice workers know very little about the hundreds of thousands of people who go through the New York court systems.
- There has been little creative thinking about the sanctions judges can use over time.
- Most defendants get the same punishment in the same fashion.

Specifically, they suggest with more information, more modeling capabilities, and better alternative generation tools that better decisions, which could result in superior outcomes, might be achieved.

In this case, citizens, court officials, and criminal justice researchers noted the problem of information availability and have developed a process to address it for "quality-of-life" crimes, such as shoplifting and street hustling. Specifically, the city, landlords, and federal funding jointly created a new court and located the judge in the same building as city health workers, drug counselors, teachers, and nontraditional community service outlets to increase the likelihood of the court working with these providers to address the crime problem innovatively. The centerpiece of this effort is a DSS that provides judges with more and better information *as well as* a better way for processing that information so as to make an impact on the crime in Manhattan.

This example does illustrate some of the important characteristics of a DSS. A DSS must access data from a variety of sources. In this court example, the system accesses the arresting officer's report, including the complaint against the offender and the court date. In addition, the DSS provides access to the defendant's criminal record through connections with the New York Division of Criminal Justice. These police records are supplemented with information gained by an independent interviewer either at the police precinct or at the courthouse. These interviewers query the defendant regarding their lifestyle, such as access to housing, employment status, health conditions, and drug dependencies. Finally, an intermediary between the court and the services available, called a court resource coordinator, scans the person's history, makes suggestions for treatment, and enters the information into the system.

A second characteristic of a DSS is that it facilitates the development and evaluation of a model of the choice process. That is, the DSS must allow users to transform the enormous amount of "data" into "information" which helps them make a good decision. The models may be simple summarization or may be sophisticated mathematical models. In this case, the modeling takes on a variety of forms. The simple ability to summarize arrest records allows judges to estimate recidivism if no intervention occurs. Further, the summarization of lifestyle information encourages the development of a treatment model. In addition, with the DSS, the judge can track community service programs and sites to determine which is likely to be most effective for what kinds of offenses. Hence, the judge can model the expected impact of the sanctions on a defendant with particular characteristics. In other words, it can facilitate the evaluation of programs to determine if there is a way to have greater impact on particular defendants or on a greater number of defendants.

The design team is in the process of adding additional modeling capabilities. Soon, they hope to integrate mapping technology that will plot a defendant's prior arrest record. The judge can evaluate this map to determine (a) if there is a pattern in offenses that can be addressed or (b) where to assign community service sentence to optimize the payback to society.

The third characteristic that is demonstrated by this DSS is that they must provide a good user interface through which users can easily navigate and interact. There are enormous amounts of raw data in this system—equivalent to a 3-in. file folder on most individuals. Providing access to the raw data and the summarized information in some sort of meaningful fashion is challenging. In this case, the designers used a windowing environment and summarized all information into a four-window, single-screen format. As shown in Figure 1.1, the current incident is shown on the main (left-to-right) diagonal. The system locates the complaint in the top left quadrant and leaves the bottom left quadrant for the judge's decision. At the top right, the DSS provides a summary of the historical offenses for the defendant. The bottom left quadrant summarizes the lifestyle questions and the interviewer's recommendations for changes.

While the summary information provides an overview of the information about the defendant, the judge can drill down any of the quadrants to obtain more detailed information. For example, the lifestyle summary screen displays the education level, housing status, and drug dependency problems. However, the judge can drill down in this screen to find precisely what drugs the person uses and for how long or with whom the defendant lives and where.

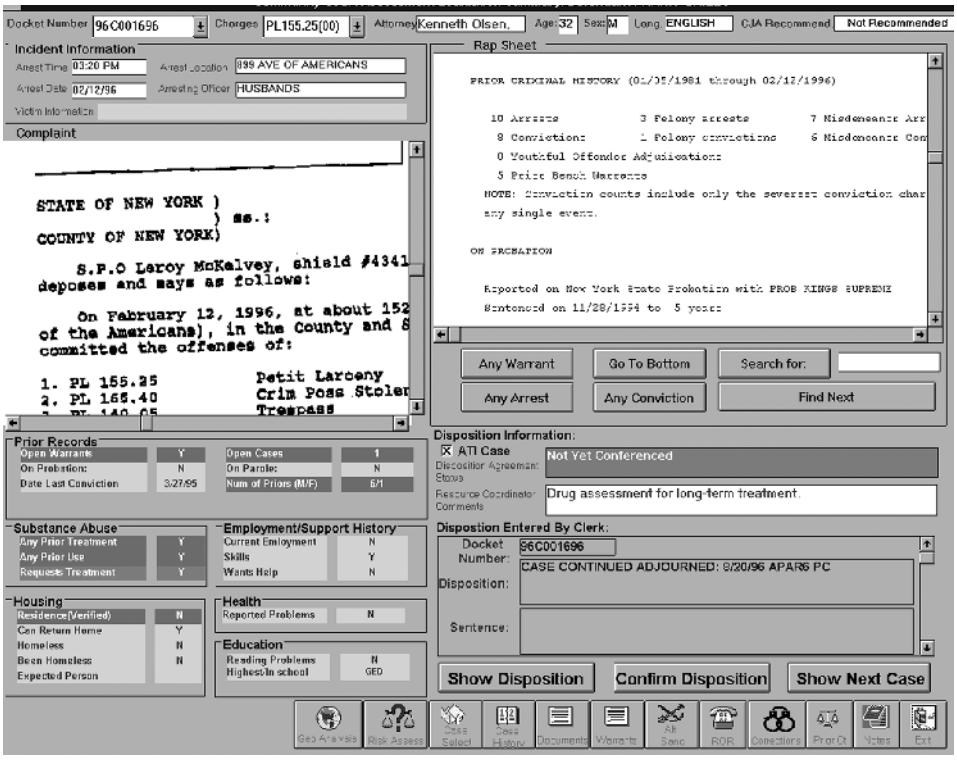

Figure 1.1. Manhattan Court DSS—defendant overview screen. The image is reprinted with permission of the Center for Court Innovation.

In addition, the system highlights problematic answers in red so the judge can locate them immediately. This further allows the judge to establish how many problems the defendant has by the amount of red displayed on the screen: The more red on the screen, the greater the number of problematic lifestyle choices the person has made. This drill-down screen evidence is shown in Figure 1.2. Demonstration of the flexibility in analyzing the data is shown in Figure 1.3.

In this case, it is too early to determine if better decisions will result in better outcomes. However, early evidence is promising. For example, to date, it is known that only 40% of defendants in the standard Manhattan courts complete their community service sentence, while 80% of the defendants going through this system complete their sentences. Further,

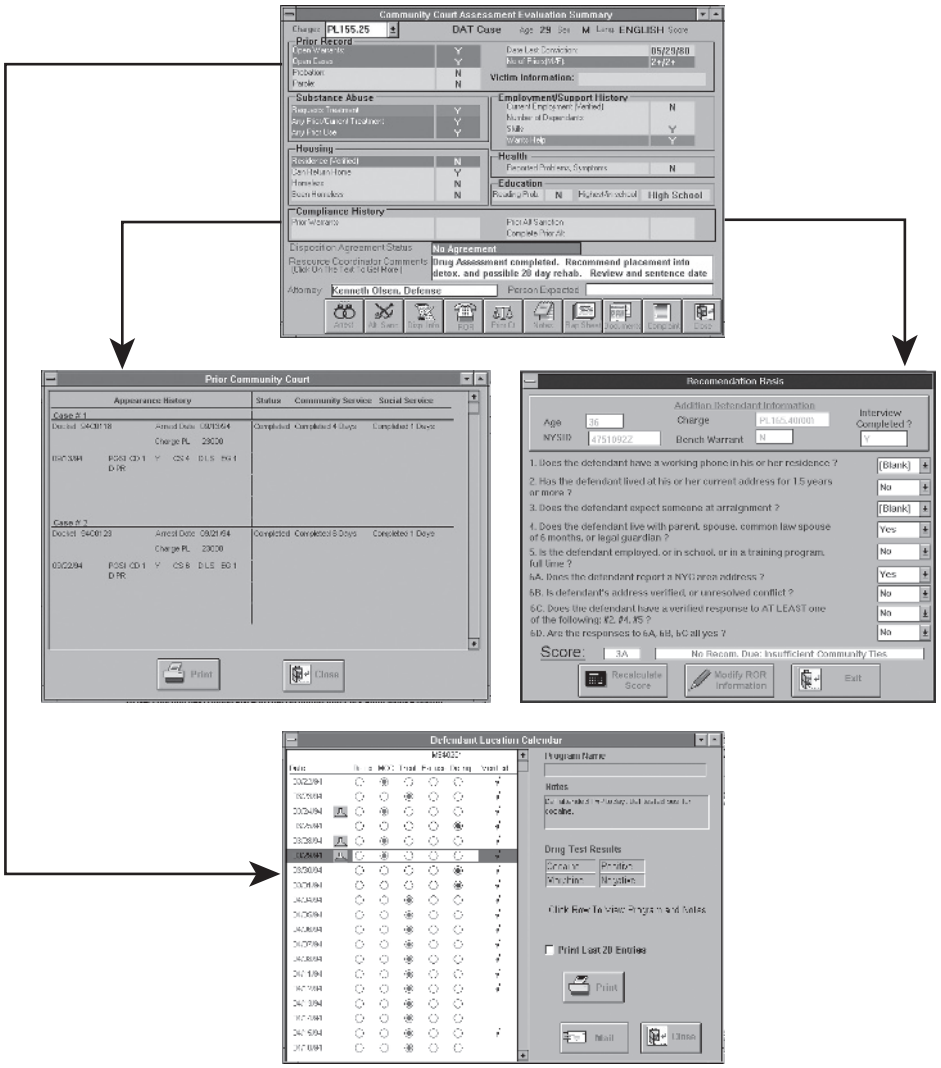

Figure 1.2. Manhattan Court DSS—drill-down screens. The image is reprinted with permission of the Center for Court Innovation.

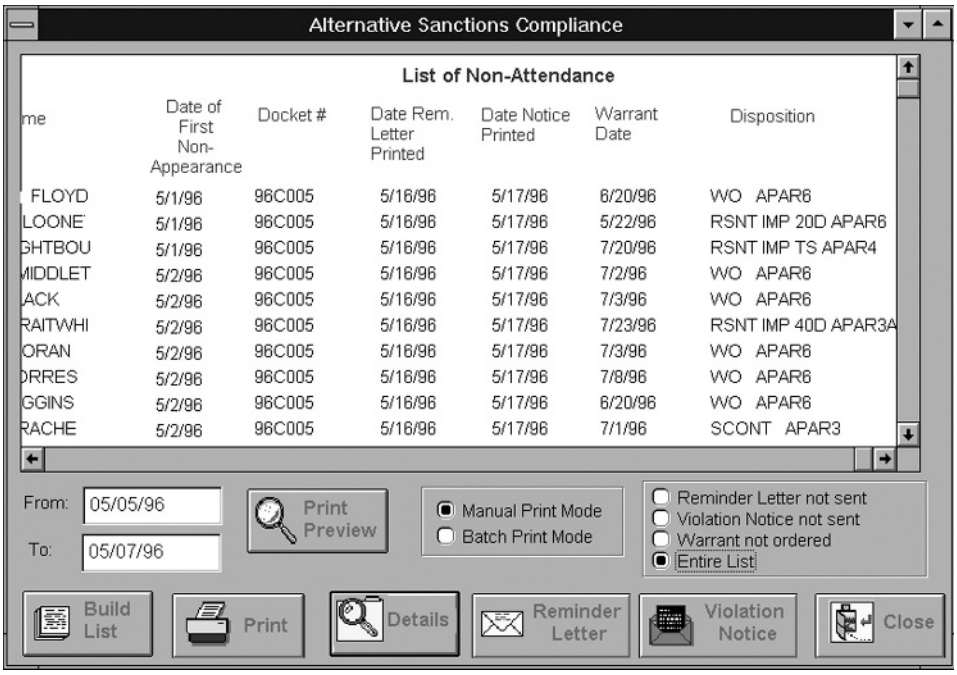

Figure 1.3. Manhattan Court DSS—flexibility in data analysis. The image is reprinted here with the permission of the Center for Court Innovation.

almost 20% of the defendants sentenced to community-based sanctions[2] *voluntarily* take advantage of the social services. Finally, the system was awarded the National Association of Court Management's Justice Achievement Award.

In this example, the decision makers are using data and analyses to drive their processes. Many other companies, from sports teams such as the Oakland A's to greeting card companies such as Hallmark, are finding that through better analyses of their data they can exploit niches to improve their business processes, decision making, and profits. There are many different levels at which the analyses can help decision makers consider the business, as illustrated in Figure 1.4. The analyses can help decision makers understand what is happening in their organization, why problems or trends occur, what trends are likely to continue, what actions are best, and how to take advantage of situations in the future.

According to their research of more than 40 C-level executives and directors at 25 globally competitive organizations, Davenport and Harris (2007) indicate that *competitive* organizations will increasingly rely upon data integrated from a variety of sources to drive their mainstream decisions. Howson (2008), in her survey of companies, found that 43% of large companies (with annual revenues greater than a billion U.S. dollars), 30% of medium companies, and 27% of small companies already rely upon business intelligence in their companies. Of these applications, over 80% are reported to improve company performance, and over 30% of that improvement is considered "significant." Further, an Accenture (2009)

[2]Community-based sanctions include projects such as sweeping streets, removing graffiti, cleaning bus lots, maintaining street trees, painting affordable housing units, and cleaning and painting subway stations. All work is done under the supervision of the appropriate metropolitan agency.

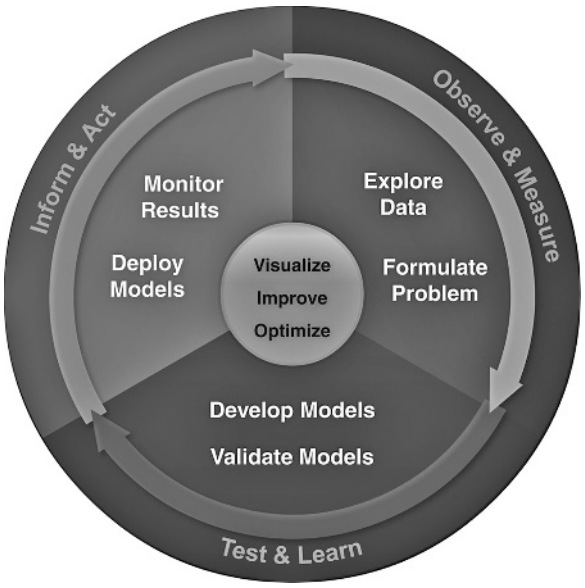

Figure 1.4. Uses of DSS throughout the Business. (*Source*: Istvan Szeman, *Business Intelligence: Past, Present and Future*, SAS Institute, 2006. Available: http://www.sas.com/search/cs.html?url=http%3A//www.sas.com/offices/europe/bulgaria/downloads/saga_conf_sas.ppt&charset=iso-8859-1&ql=degree+of+intelligence+competitive+advantage+%2Bgraphic&col=exisas&n=1&la=en, viewed January 29, 2009.)

study notes that improvement in systems that provide business intelligence will be a high priority for 2009 and beyond.

Design Insights
Too Much Information

Nobel laureate economist Herbert Simon points out: "What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate that attention efficiently among the overabundance of information sources that might consume it" (*Scientific American,* September 1995, p. 201). Hence, as the amount of information increases, so does the need for filtering processes which help decision makers find that which is most important and meaningful.

Not only will business-intelligence-based systems help upper level managers, but they will be used throughout the organization to help with the variety of choices. The ability to manage information in this way is enabled by DSS which bring together the data with the models and other tools to help the decision maker use the results more wisely.

Said differently, the need for business intelligence and thus DSS will only increase in the future of solid companies. The obvious question is, "why?" People have been making decisions for thousands of years without DSS. In fact, business managers have been making good decisions with good outcomes for many hundreds of years. Why should DSS technology *now* be important to the choice process?

Figure 1.5 illustrates the factors that are pushing organizations to adopt DSS. As you can see, the pressures range from enabling tools that allow them to get more and

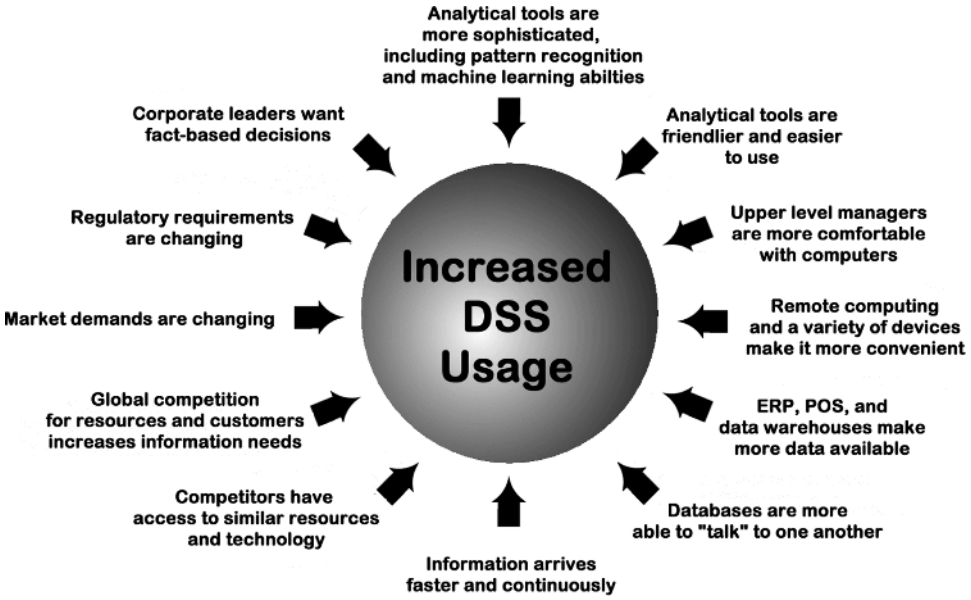

Figure 1.5. Pressures to business to use DSS.

better information to compelling pressures that others will get the benefits first. First and foremost is the argument that the analytical tools are better now and so the kinds of business intelligence that we need are possible in a way it was not before. The tools generally are more sophisticated, but the relatively recent availability of tools such as pattern recognition and machine learning provide an insight into customers' suppliers and other corporate influences that was not possible before.

At the same time that analytical tools have become more powerful, these tools have become friendlier and easier for managers to use. Unlike in the early days of DSS, when one needed to know specialized languages and commands (such as "Job Control Language") just to be able to access data on a computer, few of today's packages require much specialized knowledge to use. One can access the package and begin looking a trends, graphs, and interrelationships just by using a menu and/or point-and-click technology. Software written for a special purpose also tends to be easier to use, with greater reliance upon online help options and context-sensitive help. As the software is used more frequently, decision makers gain familiarity and expertise with the tool.

This coincides with increasing numbers of upper level managers becoming more comfortable using computers and technology in general for a variety of tasks. A generation ago, managers were fixed to their desks if they wanted to rely upon a computer; they could not have the information where they wanted it when they wanted it. These earlier generations of managers would have found it impossible to imagine a U.S. president who felt passionately about using a Blackberry to keep information and analytics available at all times!

With increases in tools and aptitude come increasing amounts of data. The use of Enterprise Resource Planning (ERP) systems, point of service (POS) systems, and data warehouses has made data about suppliers, processes, and customers more available than ever before. Rather than guessing what customers do, they *know* what customers have purchased, how often, and with what. These databases are more flexible in their design so that their data are more easily combined with data from other databases. The result is a more complete vision of what is happening in organizations. Of course, the data come in

faster than ever before too. Without a tool made to process the data with the managers in mind, the data could not have been understood fast enough to respond to it properly.

DSS in Action
DSS in Grocery Stores

Today's analytics provide more than just the profit level or sales quantity of a store. With new data mining tools managers can now get insights into *why* sales hit specific levels as well as *what* is likely to happen next month, thus giving them factors that can be manipulated to improve performance. By analyzing vast quantities of data, managers better understand what drives different categories of shoppers. This, in turn, stimulates decisions such as how to rearrange store layouts, stock shelves and price items. Once shopping behaviors and preferences are understood, store then can tailor offerings accordingly to differentiate themselves from competitors. Britain's Tesco relies on mined data for most decisions, including the development of house brands. Kroeger (U.S.) uses mined data to profile customer buying behavior so they can better target coupons to make the store more appealing. The ability to predict customer response to changes in business rules provides a powerful competitive advantage for the store.

Executives have turned to the analytics provided by DSS because they need something that will give them the competitive edge over their competitors. Companies are finding that it is increasingly difficult to differentiate themselves based upon the product they manufacture or the way they use technology because other companies are doing the same thing. Competitors have access to the same resources and the same technology to use within their own corporations. At the same time, companies are no longer competing with just others in their own city, state, or nation: Global competition for resources, employees, and customers is typical.

Market conditions continue to change as well, and managers need to be able to respond to those changes quickly. Ten years ago, the annual increase in demand for automobiles in China was about 6%, while today it is about 15% and still growing. Such increases in demand require managers to change their production to respond. Similarly, when demand for products and services decreases rapidly, such as what has been seen in the recession of 2008, managers need to respond rapidly to change their product mix to stay profitable. Understanding market conditions and being able to predict changes in market conditions in the global environment require good business intelligence.

Regulations have changed too, requiring executives to understand more about their business and its practices. The Public Company Accounting Reform and Investor Protection Act of 2002 (more commonly known as Sarbanes Oxley, or SOX) mandates that senior executives take individual responsibility for the accuracy and completeness of corporate financial reports. Said differently, the law requires corporate executives to understand what is happening in their business and to be responsible for it. Even in small organizations, this becomes difficult without good analytics.

The final pressure noted in Figure 1.5 is that increasingly managers want fact-based decisions. Industry analysts indicate that managers are frustrated by efforts to computerize corporations and yet cannot get one "version" of what is happening. Accenture (2009) reports that 40% and Lock (2008) reports that 35% of business decisions are judgmental. These reports also note that managers want to replace them with fact-based decisions. The most critical problem they report is not having systems that provide the facts needed to make the decisions.

While these factors clearly contribute to the acceptance of technology, there is another factor that is pushing the use of DSS technology. That is, decision makers are using DSS because the cost of *not* using the technology is too high. The complexity of organizations and the competition mean that other corporations will need to use analytics to get an advantage. Hence, not using DSS tools will mean losing an advantage to competitors.

For example, today's banks are competing fiercely for customers, and analytics help them do it better. Combining the bank's main corporate database with departmental databases, branch managers can use the tools in the DSS to determine the most profitable customers who should receive preferential treatment and which customers would be most responsive to cross-selling of new products. The availability of these rich databases and analytical tools not only saves time but also increases the quality of analyses considered. The personalization of the customer care makes these banks more attractive to customers than their competitors.

Similarly, today's hospitals are under significant pressure to control costs, but those costs are driven by physicians. The DSS tools can allow physicians to compare their treatment protocols with others in the same specialty for patients of similar age and disease to evaluate the efficacy of their treatment protocols when compared to others. These analyses help the doctor determine if he or she is providing the best possible care for the patient as well as helping the doctor determine if there are reasonable ways to reduce the cost of that care. In other words, they help reduce the hospital's costs without impacting the quality of patient care.

DSS in Action
DSS in Health Care

Jewish Hospital Healthcare Services uses various DSS applications in the areas of productivity, cost accounting, case mix, and nursing staff scheduling. The systems include modeling, forecasting, planning, communications, database management systems, and graphics. Furthermore, all of the data are drawn from key clinical and financial systems so there is not inconsistency in the data used by different decision makers. This allows decision makers to consider problems *and opportunities* from more dimensions with better support than ever before. For example, the DSS includes a "nursing acuity system" for classifying patients by the severity and nursing needs associated with their illnesses. These calculations can be used by the nurse-staffing scheduling system to estimate the demand for nurses on a daily basis. Not only does this system help nurse managers to plan schedules, the DSS helps them to evaluate heuristics they might employ in developing the schedule. For example, they can compare the estimated nurse-staffing needs to the actual levels to determine if there are better ways of managing their staffs. In this era of managed care, such analyses help the hospitals use scarce resources more effectively.

WHAT IS A DSS?

As stated previously, a DSS is a computer-based system that supports choice by assisting the decision maker in the organization of information and modeling of outcomes. Consider Figure 1.6 which illustrates a continuum of information system products available. In this diagram, the conventional management information system (MIS) or transaction processing system (TPS) is shown at the far left. The MIS is intended for routine, structural, and anticipated decisions. In those cases, the system might retrieve or extract data, integrate it, and produce a report. These systems are not analysis oriented and tend to be slow, batch processing systems. As such, they are not good for supporting decisions.

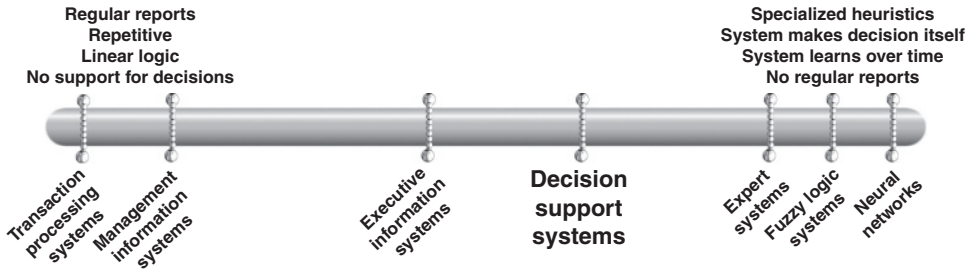

Figure 1.6. Continuum of information system products.

The far right of this diagram illustrates expert systems (ES). These systems are intended to reproduce the logic of a human who is considered an expert for the purposes of a particular decision. The systems generally process a series of heuristics that are believed to mimic that logic. They are good at supporting decisions, but only those decisions it has been programmed to process.

In between those two is the area of DSS and executive information systems (EIS). These two types of systems are intended to help decision makers identify and access information they believe will be useful in processing poorly structured, underspecified problems. They provide *flexible* mechanisms for retrieving data, *flexible* mechanisms for analyzing data, and tools which help understand the problems, opportunities, and possible solutions. They allow the decision maker to select what they want in both *substance* and *format*.

For example, an MIS might provide a report of profit by item on a monthly basis, typically in a written form. A DSS, on the other hand, would store the profit by item for later analysis. The system would allow the decision makers to decide whether said analyses were for individual products, groups of related products, products in a particular region, and so on. In addition, it might flash a notice to the manager (at the first availability of the data) when a product had a profit that was outside its typical range—either high or low. Decision makers can then decide for themselves whether or not the shift represented a need for corrective action for a problem or the possibility of an opportunity. In this way, it makes it easier to collect information, easier to put it in a form that allows analysis, and easier to have it available when it is needed.

Similarly, the MIS provides no help in generating alternatives. If it does provide some sort of model, it provides only the results. Typically there is no provision for "what if?" analyses to determine how sensitive the answer is to the assumptions made. The DSS would typically provide access to these sensitivity analyses. In addition, a DSS might prompt users to consider sensitivity analyses or provide suggestions on how to improve the analyses.

To achieve this decision support, there are three components which comprise a DSS, as shown in Figure 1.7.

We will discuss these components briefly here, and each of these components will be discussed in depth later in this book. The database management system (DBMS) provides access to data as well as all of the control programs necessary to get those data in the form appropriate for the analysis under consideration without the user programming the effort. The data include facts about internal operations, trends, market research and/or intelligence, and generally available information. The DBMS should be sophisticated enough to give users access to the data even when they do not know where the data are located physically. In addition, the DBMS facilitates the merger of data from different sources. Again, the

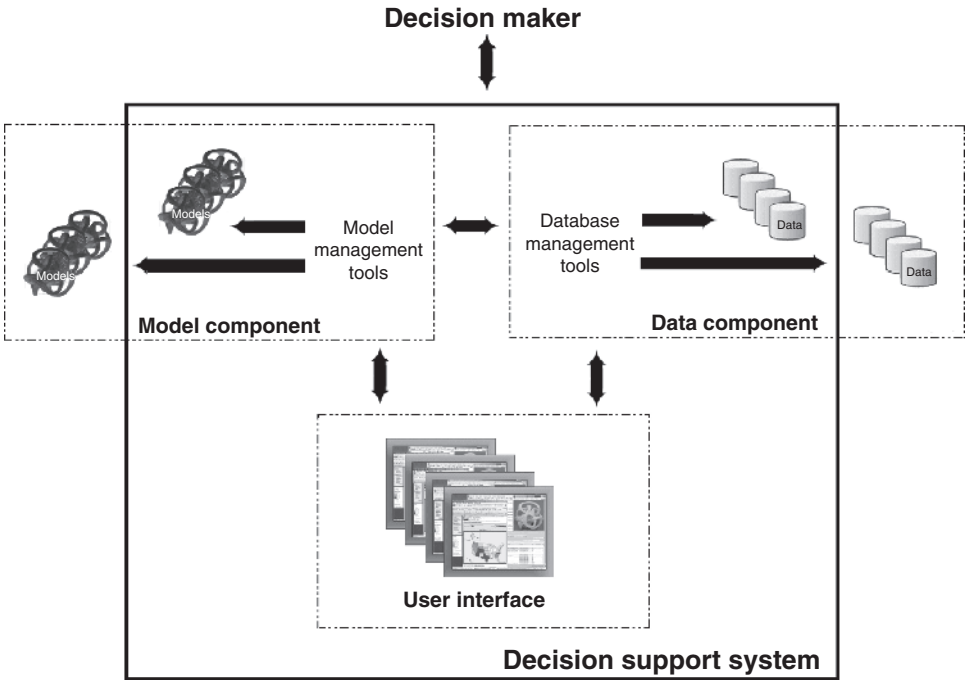

Figure 1.7. Components of a DSS.

DBMS should be sufficiently sophisticated to merge the data without explicit instructions from the user regarding how one accomplishes that task.

DSS in Action
DSS for Greeting Cards

Hallmark, the 100-year-old greeting card company, has used data mining to improve the effectiveness of direct-marketing campaigns for its best customers. The company collects point-of-sale data, information about loyalty card holders, and information obtained from the customers themselves to understand how and to what the customers respond. The analysis, which utilizes three years of data at the UPC (product) level for individual customers, provides profiles that help Hallmark understand what products to market and at what time to market to individual customers. Further, these analyses help Hallmark understand which of its marketing campaigns are successful (or not) and where increased marketing would bring additional revenues.

The model base management system (MBMS) performs a similar task for the models in the DSS. In that way, it keeps track of all of the possible models that might be run during the analysis as well as controls for running the models. This might include the syntax necessary to run the jobs, the format in which the data need to be put prior to running the model (and to put the data in such a format), and the format the data will be in after running the job. The MBMS also links between models so that the output of one model can be the input into another model. Further, the MBMS provides mechanisms for sensitivity analyses of the model after it is run. Finally, the MBMS provides context-sensitive and model-sensitive assistance to help the user question the assumptions of the models to determine if they are appropriate for the decision under consideration.

DSS in Action
DSS in Sports

Data have begun to transform the management of professional sports. Managers who intelligently use data and analytics can improve asset acquisition and management, talent management, and operational performance. Billy Beane showed the world that his ideas about using analytics could produce a low-cost baseball team that was competitive with those teams having a much higher payroll. Manager Billy, aided by assistant Paul DePodesta, first with the aid of a decision support system (AVM Systems) and then on their own, broke down activities to predict a player's ability to score runs and used that knowledge to decide how to build and manage the lowest cost winning team in professional baseball. This effort was so amazing that when the Major League Players Association created the Commissioner's Blue Ribbon Panel on Baseball Economics in 1999, they found Beane's Oakland A's to be an anomaly in their analysis. In fact, it was sufficiently troubling that the commission asked Mr. Beane to appear to explain how he managed to be competitive. Some in baseball claimed he was just lucky. However, Mr. Beane knows that it is to the effective use of analytics in his organization. In fact, this use of analytical tools is chronicled in Michael Lewis's (2003) best selling book *Moneyball: The Art of Winning an Unfair Game.*

As the name suggests, the user interface represents all of the mechanisms whereby information is input to the system and output from the system. It includes all of the input screens by which users request data and models. In addition, it includes all of the output screens through which users obtain the results. Many users think of the user interface as the *real* DSS because that is the part of the system they see.

Decision support system use is *not programming* and *not data entry*. That is, decision makers do not write computer code to analyze data when using a DSS. Rather the DSS provides a framework through which decision makers can obtain necessary assistance for decision making through an easy-to-use menu or command system. Generally, a DSS will provide help in formulating alternatives, accessing data, developing models, and interpreting their results, selecting options or analyzing the impacts of a selection. In other words, the DSS provides a vehicle for accessing resources external to the decision-making process for use in that choice process.

Similarly, decision makers generally do not enter data in their use of a DSS but rather avail themselves of corporate and public databases already available. From time to time, decision makers will want to enter some of their own data in a private database, but it is kept at a minimum. Neither is a DSS simply the use of a spreadsheet package or modeling package. Spreadsheets and modeling packages simply provide the tools to do analysis. They do not provide a mechanism for accessing data unless one already knows where it is and how it should be accessed. Further, these tools do not provide assistance in the wide range of decision support generally associated with a DSS.

We can differentiate among *types* of DSS by looking at their major purpose. Holsapple and Whinston (1996) identified six types of DSS: text-oriented DSS, database-oriented DSS, spreadsheet-oriented DSS, solver-oriented DSS, rule-oriented DSS, and compound DSS. For example, text-oriented systems catalog books, periodicals, reports, memos, and other written documents so that their contents can be made available to decision makers. Each document, or a portion of that document, provides some information or even knowledge that could be important to a decision maker when making choices. The system allows you to categorize, consolidate, and merge documents as well as to write comments about the contents and the value thereof. By allowing users to focus on *portions* of documents, the system helps decision makers save time when they need to refer to the document. In addition, intelligent systems can perform content analyses of the texts and recommend sections (and

thus information) the decision maker might not otherwise consider. A variation on the text-oriented DSS is the hypertext-oriented DSS. The hypertext-oriented DSS provides the same basic functions that text-oriented systems do, but the documents are logically related and linked. This allows the decision makers to follow specific subjects *among documents* when making choices. No longer do they need to go through documents in a linear fashion to find the important information. They can instead transverse the information in all of the various sources, thereby supplementing his or her abilities to associate relevant portions of the text. Of course, since we now are accustomed to such links because of Web surfing, we generally take such abilities for granted in our online documents.

Database-oriented DSS are similar to the text systems in that they provide descriptive information that is of relevance to a choice under consideration. Instead of providing text, though, these systems focus on discrete data that are stored in a database. The system controlling these databases allow for manipulating and joining the data and presenting those data in ways that will benefit decision makers. Generally such systems use Structured Query Language (SQL) through which to identify and manipulate the data. Some minimal summaries of the data can be provided through the use of these SQL commands.

Spreadsheet-oriented DSS, as the name suggests, use the tools available in a spreadsheet to summarize and analyze the data. Instead of just providing access to data, these DSS allow the decision maker to create some basic models and to evaluate those models in a quick and efficient manner. Similarly, solver-oriented DSS provide some kind of modeling package as the basis of the DSS. These systems allow decision makers to identify more varied and sophisticated relationships among the data. The modeling package may be integrated into the DSS or simply used by the DSS depending on the architecture of the system.

A rule-oriented DSS or intelligent DSS provides advisory support to decision makers. Early examples were rule based of the form

IF <some premise is true>
THEN <some condition is true>
ELSE <some other condition is true>

By linking the rules together, these systems could provide some cognitive functions and prove something to be true (or sometimes false) or reason as far as the data allowed toward a conclusion. Improvements in artificial intelligence technologies have allowed these systems to demonstrate more sophisticated reasoning and even some learning.

The compound DSS are hybrid combinations of the individual types of DSS. Such systems have mixed capabilities, such as a solver–database combination or a spreadsheet–database–intelligence combination. The different components exist equally within the system and allow complete flexibility in their use. As you might expect, such hybrid designs are the most common form of DSS today. It will be this form that we generally assume in the discussion in the remainder of the book.

USES OF A DECISION SUPPORT SYSTEM

Throughout this chapter, there are examples of DSS in operation today. The applications range from strategic planning to operations management and exist in the public sector as well as the private sector, including both the for-profit and not-for-profit branches. So, if there is not a particular application area, how does one know when it would be appropriate to use a system?

Decision support systems are most useful when it is *not* obvious what information needs to be provided, what models need to be used or even what criteria are most appropriate. Said differently, they are useful when it is not obvious a priori how the choice should be made. Furthermore, since DSS proceed with requests from decision makers in the order and manner selected by the user (and not necessarily linear in their application), they tend to be associated with situations where users proceed differently with each problem. However, that does not mean a DSS cannot be useful for a more structured problem.

LaPlante (1993) notes that DSS are most useful when (a) managers and their staffs spend significant time locating and analyzing data that are already stored electronically, (b) management meetings stall because people challenge the validity of the data, (c) management is frequently surprised by the data when end-of-month-type reports are generated, and (d) decisions are too frequently made based upon anecdotal evidence instead of appropriate data even when data might be collected regularly. In short, she notes that if the data are collected electronically but are not used to their full potential, a DSS is warranted.

DSS in Action
DSS in Political Campaigns

The Obama Presidential campaign of 2008 used a DSS that they called *Neighbor to Neighbor*. The campaign leveraged election board data with data collected on websites, rallies, or through telephone polls. The system included names and addresses of voters whom they believed were undecided in the campaign. It also included issues of interest to the specific voter, data about issues of interest in a particular region, and past voting records. Using this tool, staff members could more effectively identify scripts and pitches to use with particular voters to convince them to vote for Obama. In addition, they could customize fliers and other campaign materials to get their point to the voters more effectively. Near real-time data and sophisticated analytics helped volunteers use valuable campaign time more effectively.

Hogue and Watson (1983) note that DSS might be developed for other reasons. Although their study noted that the number one reason for using a DSS is to obtain accurate information, many users develop such a system to obtain *timely* information or because *new* information is needed. Other corporations develop DSS because they are viewed as an "organizational winner" or because management has mandated the use of a system. In these cases, managers believe that their image of using the DSS affects their client's view of their product. In very few cases the DSS is used because it reduces cost.

The industrial revolution provided machinery to make one's job easier. The information revolution is supposed to provide the same level of help to the knowledge worker. Just like the automobile did not replace the human, the DSS does not replace the human. Similarly, the availability of automobiles did not solve all of the transportation and transshipment problems—just the problem of how to get one or more people with one or more items somewhere else faster, more comfortably, and using less energy. That is, a DSS will not solve all of the problems of any given organization. However, it does solve some problems well. Generally, it is accepted that DSS technology is warranted if the goal is to help decision makers:

- Look at more facets of a decision
- Generate better alternatives
- Respond to situations quickly
- Solve complex problems

- Consider more options for solving a problem
- Brainstorm solutions
- Utilize multiple analyses in solving a problem
- Have new insights into problems and eliminate "tunnel vision" associated with premature evaluation of options
- Implement a variety of decision styles and strategies
- Use more appropriate data
- Better utilize models
- Consider "what if?" analyses

The software facilitates one's own processes. One should remember, however, that a badly designed DSS can make one's life difficult—just as a lemon of an automobile can make one's transportation difficult.

THE BOOK

As the DSS develops in this book, we will use a liberal definition of the term so as to allow a wide variety of technologies to be included. This allows exploration of the greatest range of opportunities available for DSS. The possibilities will be pursued in terms of the three components defined earlier. In the next few chapters, we will discuss each of these components in depth. Following that will be further discussion on special features in some systems and guidelines for development and implementation.

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QUESTIONS

1. What factors inhibit the growth of DSS in today's business?
2. Define DSS. How are they different from transactional process systems?
3. List the major benefits of DSS.
4. What conditions suggest the need for a DSS?
5. Consider popular descriptions of computerized systems you have encountered over the last several months. Are any of these systems DSS? Why or why not?
6. Find an application of a DSS in an area of interest to you. What are the good aspects of the DSS? In a real DSS, some of the technical niceties are generally sacrificed for the realities of the situation. What technical niceties were sacrificed in your system? Were they reasonable sacrifices?
7. The literature often separates "expert systems" applications from "decision support systems" applications. Discuss why they should be considered separately.
8. Discuss examples of when one would want "expertise" integrated into a DSS.
9. Why must a corporation have good transactional processing systems before implementing a DSS?
10. Consider the system developed for the Manhattan court system at the beginning of this chapter. What attributes of the system make it a DSS? How do you know it is not a transaction processing system or an expert system?
11. What is the difference between a good decision and a good outcome? What does a DSS help?
12. Does your university use DSS? If so, how do they help the decision making of the university? If not, why are they not used?
13. What kind of DSS might help you in planning your studies and/or career?
14. Identify a newspaper or news magazine that describes a decision. Discuss the decision(s) being considered, the model and/or data used to consider the decision, the model and/or data that should used to consider the decision, and how a DSS might help.
15. Is an ERP system a DSS? Why or why not?

ON THE WEB

On the Web for this chapter provides additional information to introduce you to the area of decision support systems. Links can provide access to demonstration packages, general overview information, applications, software providers, tutorials, and more. Further, you can see some DSSs available on the Web and use them to help increase confidence in your general understanding of this kind of computer system. Additional discussion questions and new applications will also be added as they become available.

- *Links provide additional information*. For example, one link provides a brief history of the DSS and its relationship with other related disciplines. Similarly, another link provides a glossary of DSS terms. Finally, there are links to bibliographies about DSS available on the Web.
- *Links provide access to DSS examples in business, government, and research*. Some links provide access to papers on the Web describing DSS applications and their uses. Others describe the process used to develop the application.
- *Links provide access to information about DSS providers and software tools*. Many software companies have Web pages that describe their tools and the application of those tools.
- *Links provide summaries of applications in particular industries*. For example, summaries of how the use of DSS can help solve business problems related to manufacturing and marketing are available on the Web.

You can access material for this chapter from the general Web page for the book or directly at http://www.umsl.edu/∼sauterv/DSS4BI/intro.html.