DECISIONS AND DECISION MAKERS

Learning Objectives

◆ Understand the elements and framework of the decision-making process
◆ Be familiar with the classification of decision makers
◆ Based on decision makers’ cognitive complexity and value orientation, understand the classification of decision styles and the three related factors: problem context, perception, and personal values
◆ Understand the interactions between problem context and decision styles in order to design systems that provide appropriate support
◆ Comprehend the definition of a good decision and the forces acting upon the decision makers during the decision process
◆ Learn the common types of support that can be provided by decision support systems
◆ Understand the difficulties of decision making from different angles such as problem structure, cognitive limitations, uncertainty of decision outcomes, and alternatives and multiple objectives
◆ Learn the classification of decisions and understand the role of these typologies in the design of decision support systems
◆ Understand Simon’s model of problem solving
◆ Learn the theory of rational decision making
◆ Gain an understanding of Simon’s “satisficing” strategy and bounded rationality
◆ Clarify the difference between a symptom and a problem
◆ Become familiar with the process of choice
◆ Understand the decision maker’s cognitive process and its effects on decision making
◆ Learn four of the most common heuristic biases and their effects on decision making
◆ Distinguish between effectiveness and efficiency
Experts in cockpit resource management study the worst tragedy in aviation history for its many lessons. After a bomb rocked the Las Palmas airport, located in the Canary Islands’ capital, early in the afternoon of March 27, 1977, inbound traffic was diverted to Los Rodeos on the island of Tenerife. The airport on Tenerife did not have the capacity of Las Palmas, so aircraft were squeezed in on its ramp. Among those diverted to Los Rodeos that day were Pan Am Flight 1736 and KLM (Royal Dutch Airlines) Flight 4805, both Boeing 747s laden with passengers. Arriving after the KLM flight, the Pan Am jet was parked behind it on the apron, just short of the departure end of runway 12.

On the flight deck of the KLM aircraft, Captain Jacob van Zanten, a highly regarded training captain, was anxious to get back in the air because the duty hours for his crew were running low. When the tower radioed that Las Palmas had reopened, van Zanten decided that, instead of refueling at Las Palmas, which would undoubtedly be busy with the reopening, he would refuel while waiting on the ramp at Los Rodeos. It was now Pan Am 1736’s turn to depart, but the only way to reach the departure end of the active runway, runway 30, was to enter runway 12 and backtrack. Unfortunately, KLM 4805 had only just begun refueling, leaving no way for the Pan Am airliner to taxi around it with the limited space at Los Rodeos. Pan Am’s First Officer Bragg called the KLM crew, asking how long it would take to refuel, to which they replied, “About 30 minutes.” The crew of flight 1736 could do nothing but wait. While flight 4805 was refueling, fog moved in at the airport, and by the time the refueling was completed, visibility had decreased to as little as 900 feet in some areas. The KLM crew finally started their engines and prepared to take off. As they taxied to the beginning of runway 12, the tower instructed flight 4805 to “taxi straight ahead . . . ah . . . for the runway . . . make . . . ah . . . backtrack.” At this point, Pan Am 1736 had also started its engines and was holding short of the runway. The visibility now prevented the tower from seeing either the runway or the two aircraft. Bragg then called the tower for instructions and flight 1736 was told to “taxi into the runway and . . . ah . . . leave the runway third . . . third to your left.”

Apparently the pronunciation was unclear to Pan Am’s Captain Grubbs who said, “I think he said first,” to which Bragg replied, “I’ll ask him again.” Meanwhile the tower called flight 4805, instructing the crew, “at the end of the runway make one eighty and report . . . ah . . . ready for ATC clearance.” After this communication, Bragg called back and said, “Would . . . you confirm that you want us to turn left at the third intersection?” The tower replied, “The third one, sir . . . one two three . . . third one.” The crew of flight 1736 was still having difficulty sorting out the taxiways as they rolled down the runway. At this point, flight 4805 had reached the end of the runway and was making its 180-degree turn. As the aircraft finished the turn, van Zanten opened the throttle and the plane began to move forward. First Officer Meurs said, “Wait a minute . . . we don’t have an ATC clearance,” to which Bragg replied, “No, I know that. Go ahead and ask,” as he held the brakes. Meurs called for the clearance and as he was reading it back, van Zanten again opened the throttles, saying, “Let’s go, check thrust.” After repeating the clearance, Meurs, in an attempt to let the controller know what was happening, said, “We are now at takeoff.” The tower controller apparently took this to mean they were ready for takeoff, saying, “OK . . . stand by for takeoff . . . I will call you.” On the flight deck of the Pan Am aircraft, the crew was obviously anxious about the implications of the transmission from flight 4805, Bragg saying, “We are still taxiing down the runway!” to which the tower replied, “Roger, Pan Am 1736, report the runway clear.” Unfortunately, this first transmission blocked the tower’s transmission to flight 4805 so all the KLM crew heard

Note: The text continues on the next page.
was “OK.” The transmission from flight 1736 troubled flight 4805’s Flight Engineer Schreuder, prompting him to say, “Did he not clear the runway then?” Van Zanten, now focusing on the takeoff, replied with only “What did you say?” Schreuder repeated himself, saying, “Did he not clear the runway then, that Pan American?” to which both van Zanten and Meurs replied, “Yes, he did.” Flight 1736 was still creeping down the runway, trying to find the proper turnoff, but obviously now concerned about KLM 4805’s transmissions. Grubbs said, “Let’s get the hell right out of here,” to which Bragg replied, “Yeah . . . he’s anxious, isn’t he?” A few seconds later, Grubbs spotted the lights of flight 4805 coming at them through the fog and said, “There he is . . . look at him! Goddamn . . . that son-of-a-bitch is coming!” He opened all four throttles in an attempt to swing the aircraft off the runway as Bragg yelled, “Get off! Get off! Get off!” Van Zanten saw flight 1736 still in the runway and pulled back, attempting to climb off the runway before impacting the aircraft. The nose gear managed to clear flight 1736, but the rest of the aircraft slammed into the Pan Am plane’s starboard side. Flight 4805 remained airborne for a few more seconds before slamming into the ground and exploding. Pan Am 1736 was crushed and quickly caught fire as well. Everyone on board KLM 4805 was killed. The flight crew of Pan Am 1736 all survived uninjured, having just missed being hit by flight 4805’s engine. Amazingly, 66 others survived from the Pan Am aircraft. Unfortunately, 583 people died that day on Tenerife in what is still today the worst aviation accident in history.

The biggest question on the minds of investigators was why van Zanten, a highly experienced training captain, would make the decision to begin a takeoff without a takeoff clearance from the tower. Meurs was still copying the en route clearance when van Zanten began advancing the throttles. It seems clear that van Zanten was aware that the clearance hadn’t been received when Meurs checked him and he replied, “No, I know that. Go ahead and ask.” It is likely that van Zanten was in a rush to get to Las Palmas because of the delay on the ground and his crew’s lack of extra duty hours. However, even after the en route clearance was given, the tower instructed KLM 4805 to “stand by for takeoff,” which the crew failed to hear as well as the clear indications that Pan Am 1763 was still on the runway. In addition, Meurs did nothing to enlighten van Zanten that they were not cleared for takeoff after his initial comment. It is possible that Meurs was not comfortable challenging van Zanten due to his experience level. To exacerbate the situation further, the efforts of the crew of flight 1736 were hampered by the low visibility. They had only a small diagram of the airport and the third taxiway led backwards from their intended taxi direction—a turn of 135 degrees, which would be extremely challenging in a 747. They apparently believed that the fourth taxiway, which was at a 45-degree angle in the proper direction, was the one the tower intended for them to use, so they proceeded past taxiway 3. None of the taxiways at Los Rodeos were marked. A final consideration was the difficulty with English of the tower controller and the KLM (Dutch) crew. With the weather as bad as it was, relying solely on radio communications was already a dangerous practice, but the nonstandard communications of both parties led to a breakdown of situational awareness. The Dutch investigation team placed the blame firmly on the controllers at Los Rodeos, while the American investigation team found the actions of Captain van Zanten to be the primary cause of the accident.

Can you decide?
2-1: DECISION MAKERS: WHO ARE THEY?

In Chapter 1, we explored the component parts and essential elements of a DSS from the inside out. We began with the DBMS, MBMS, and knowledge base and proceeded to weave our way out of the mechanical insides of the system to the user interface, and finally to the user. The purpose of that inside-out investigation was to lay the groundwork for understanding what a DSS is and what it is not. This discussion of what a DSS is and is not will begin with you—the decision maker.

The objective, or purpose, regarding the design and use of a DSS is really quite simple: We know we need to make decisions but we don’t know exactly how to make them. In this context, “how” does not always mean procedure or method, although a DSS can be extremely valuable in that part of the decision-making realm. Rather, we are referring to the “how” part of decision making that deals with processing large volumes of seemingly disparate data and managing a myriad of models of reality that “predict” certain key outcomes. This chapter begins by focusing on the reason why we have decision support systems at all: the decision maker. Were it not for the needs of human problem solvers to be supported in certain phases of the often lengthy and complex process of semistructured decision making, we would not have DSSs and, as such, we would not need to talk about them. Happily, for us at least, decision makers need support and a DSS is just the ticket. We begin, therefore, by exploring just who these decision makers are and what makes each of them unique.

PROFILE OF A DECISION

One last point of order remains before focusing directly on the decision maker. We need a working model of what the decision maker, in the generic sense at least, is trying to accomplish during the making of a decision.

The literature on the subject contains many theories about how decisions are made, the steps within the decision-making process, the motivations for making the decision, the steps within the steps, and on and on and on. All of this attention is not bad, but it is too much for a manager to absorb and understand. Here we focus on one or two theoretical frameworks for the decision process and use them to guide our investigation of both the process and the people involved in it.

Figure 2-1 profiles one of the many ways that a decision is made. Describing the process in this way takes into account that in the real world of decision making, a decision is rarely, if ever, made in exactly the order suggested by the model or even by using all of the steps contained in the model. Moreover, the process depicted offers only a static representation of a distinctly dynamic operation. The specific conditions and circumstances of the problem to be solved will ultimately dictate the way in which the decision is made. Nonetheless, we can use the model in Figure 2-1 as a basis for understanding what should be going on in a typical decision context.

The decision maker plays a somewhat schizophrenic role in the process of making a decision. Not only is he or she considered an element, or step, in the process (as shown in Figure 2-1), but the decision maker is also a participant, in varying degrees, in all of the steps in the process. In Chapter 3, we examine how this dual role complicates the process of decision making and further adds complexity to the management of the
process. For now, however, let’s simply look at each element in the process and see how they all fit together.

**Stimulus**
The first step in the process occurs when the presence of some externality or force causes the decision maker to perceive that one or more problems exist that require one or more decisions to be made. A problem is defined simply as the perception of a difference between the current state of affairs and a desired state of affairs. A variety of stimuli can cause this perception of a problem context. These stimuli may take many forms and can be perceived differently by different decision makers. In other words, what is perceived by one decision maker as a problem may not be viewed as a problem by another member of the same organization. This disparity of perception may occur because a problem really does not exist and the decision maker is misinterpreting existing facts or information or because a problem really does exist and one or more members of the organization fail to recognize it.

The forms the stimuli take can affect the perception of a problem. Often, a problem doesn’t manifest itself as a problem per se. It manifests itself as a series of symptoms that indicate the presence of an underlying problem. Either way, the situation triggers the decision-making process.

**The Decision Maker**
The example in Figure 2-1 shows the decision maker as one part of the process. Throughout our discussion, however, the decision maker functions as a participant in the process. We will focus on the participant role in the next few chapters. Here
the decision maker is defined as simply the next step or event following the onset of a stimulus.

The decision maker is truly a “black box” in every sense of the word. We don’t know nearly as much as we want to about the DSS user, but perhaps this area of research will contribute significant advances for the manager of tomorrow.

**Problem Definition**
As already stated, problems often manifest themselves as a series of symptoms that all relate to the real problem or are the results of it. In either situation, however, the problem solver must define the problem before any effective investigation of alternative solutions can be conducted. This phase is crucial to the successful outcome of the decision-making process. If the right problem definition is formulated, then the right problem will be solved. If, however, the problem definition is flawed by an incorrect assessment of the true nature of the problem at hand, then a potentially great solution to the wrong problem may be offered. Worse yet, it may also be implemented. Hopefully, the DSS will guide potential problem identification and result in the definition of the correct one.

**Alternative Selection**
At the heart of the decision-making process, and where a DSS is often most useful, lies the task of selecting an effective solution from a set of feasible alternatives. It is the essence of decision making—the decision itself. The DSS can be used to provide quantitative approaches to the analysis of the set of feasible alternatives and to assist the manager in choosing the best available solution to the problem at hand. We will see later in this chapter, however, that this selection process is the part we are least naturally equipped to perform and, thus, the one for which we must rely most heavily on the DSS to assist us.

**Implementation**
Once the user settles on the most effective solution from the set of alternatives the work has really just begun. The decision process triggers actions and events within the organization that are focused on implementing the solution and, thus, solving the problem. These actions include creating consensus and acceptance, negotiation, strategizing, politicking, and intense planning. The greatest solution in the world is worthless if it is not effectively implemented. A DSS can be of limited support in assisting with decisions directly related to issues of implementation; at this phase, the decision maker him- or herself becomes the most important player. The success or failure of implementing a solution ultimately rests with the decision maker. We will explore this aspect of the process in greater detail in Chapter 4.

**CLASSES OF DECISION MAKERS**
Now that we have a model of the decision process to help us understand what is going on, we need to focus our attention on the decision maker. Many different types of decision makers must be supported in the many different types of problem contexts, which is why so many different types of DSSs exist. Figure 2-2 provides a model of the different decision-maker classifications.
Individual Decision Makers

The individual decision maker, as the name implies, stands alone in the final decision process. This class of users essentially works alone during the decision process in the sense that the analysis of information and the ultimate generation of a final decision rests solely in their hands. Because an individual decision maker is, by definition, an individual, his or her unique characteristics with regard to knowledge, skill set, experience, personality, cognitive style, and individual biases come to bear in the decision-making process. Each of these traits both directly and interactively affects how the decision maker ultimately decides and what types of support are needed during the process. This factor, among others, also contributes to the complexity of many DSS designs. To be truly effective, a DSS intended for use by an individual problem solver must be designed to account for his or her unique characteristics and needs. If more than one individual decision maker is to use the DSS, then the design must reflect the unique characteristics and support needs of each of the intended users. The combinatorial nature of this problem should be readily apparent. Designing a DSS for individual use is a complex and difficult activity. We will see just how these complexities and difficulties manifest themselves and how they are addressed in Chapters 13 and 14.

Multiple Decision Makers

This class of decision makers consists of multiple individuals interacting to reach a decision. We differentiate between multiple decision makers and group or team decision makers in the next section. Here, the multiple decision makers involved have a stake in a particular decision outcome and thus are motivated to reach eventual agreement and common commitment to a course of action. Each member of this class may come with unique motivations or goals and may approach the decision process from a different angle. Furthermore, each may use a common DSS or a variety of systems as
support for his or her contribution to the decision-making process. Finally, multiple decision makers seldom possess equal authority to make a particular decision, nor do any of them possess enough authority to make the decision alone. In these problem contexts, multiple decision makers do not necessarily meet in a formalized manner or conduct open forums or discussions as a unit. Instead, the institutionalized patterns of communication—and the various levels of authority within the organization—structure the interaction among the participants in such a way that eventually a “decision” is reached and implementation begins. The best way to conceptualize this class of users is as a dynamic union of users who act individually to bring a decision or solution to a particular problem context and to the point it can be implemented.

**Group Decision Makers**

In contrast to multiple decision makers, a group decision maker is characterized by membership in a more formal structure where members of the group share a similar vested interest in the decision outcome and an equal say in its formation. Group decision makers generally work in a formal environment that consists of regular meetings devoted to working through the decision process, formal schedules and agendas focusing on specific portions of the process, and often deadlines by which the decision must be finalized and implemented. Common examples of group decision makers are those who make up organizational committees and juries. Each participant is involved in the making of a decision based on consensus of the group, but none possesses any more input or authority to make the decision than any other. The formalization of the decision process differentiates the group decision maker from the multiple decision maker. Therefore, the unique nature of the group process must be understood if support is to be provided by a DSS. We explore these issues in depth in Chapters 6 and 7.

**Team Decision Makers**

Yet another class of decision maker is called the team decision maker. This class can be thought of as a combination of the individual and group classes. Often, an organization’s structure is such that even though the authority to make a particular decision rests with an individual manager, he or she is supported by several assistants working toward the same goal(s). In the team context, decision support may come from several individuals empowered by the key individual decision maker to collect information and/or make certain determinations regarding a portion of the intended decision outcome. Also, support may come from one or more DSSs being used by any combination of team members. In this context, the team produces or “manufactures” the final decision, but the formalization of that decision and authority to make it rest with the individual decision maker. Figure 2-3 illustrates the differences between the individual, multiple, group, and team classes of decision makers.

One unique difference between decisions made by a group and those made by a team is the type of decisions made. In the group class, decision outcomes are often negotiated outcomes. Generally, external forces determine the need for the formation of a group in the first place and, in such scenarios, the choices facing the group are often controversial. The group decision makers, therefore, tend to seek alternatives that permit the attainment of the group’s original objectives while serving as a compromise among the concerned parties. In the team class, however, decisions are normally unilateral in nature. Only one decision maker has the authority and responsibility to make
a unilateral decision, even though many people can be said to have influenced that decision's final form. This type of decision is the most basic and generally possesses many characteristics similar to those decisions made by the individual decision-making class.

**Organizational and Metaorganizational Decision Makers**

More than 50 years ago, Chester Barnard, a noted expert on management as a science, offered a definition of an organization as “a system of consciously coordinated activities of two or more persons” (Barnard, 1938, p. 73). Although a lot has changed since Barnard’s definition was first printed, it remains viable today. The glue holding the organization together is the purposes and goals shared by its members. Using this definition, we can easily conceive of organizations within organizations: groups and teams that consciously coordinate their activities for the purpose of reaching a commonly held objective or goal. Decision makers at the organizational level are those who are empowered with the authority and charged with the responsibility of making decisions on behalf of the entire organization. The characteristics of those decisions and the processes used in arriving at them, by definition, bear strong similarities to those made by individual, team, and group class decision makers. If their purposes are so similar, why do we need to identify a unique class of decision makers at the organizational level?

One reason is the breadth and depth of information needed by the organizational decision maker. This class of users is embodied by the most senior level of manage-
ment: the CEO. As we will see in Chapters 6 and 7, a special type of DSS has been developed for use at this level. We call these special DSSs executive information systems (EIS).

Another reason why we differentiate between the team or group classes and the organizational class is that the decisions made by this class of users generally require support from the entire organization for successful implementation. A classic example of this type of decision making is found in most Japanese organizations. The concept, called nemawashi, uses a central decision maker following a prescribed set of consensus-building conventions at all levels of the organization until a global agreement is reached concerning what the final decision should be. Organizational decision makers generally do not have the resources to implement large-scale decision outcomes without support from the vast majority of their subordinates. As such, the special support needs of these decision makers differ from those at the individual, group, or team levels and are appropriately categorized separately.

Yet another class of decision maker exists beyond the organizational level. All of the world’s organizations together make up the system of enterprise. Decisions made by users operating at this level tend to be oriented toward social welfare, quality of life, allocation of controlled or limited resources, social order, or civil justice. In other words, decision makers in this class are not principally oriented by economics as are the decision makers within the system of enterprise. They are, rather, focused on decisions that affect the establishment of social order. Because organizations exist within the overall socioeconomic system, all decision makers and their respective decisions must account for the decisions made at the metaorganizational level. More importantly, as with all other classes of decision makers, metaorganizational decision makers require special support and, thus, special systems of support.

2-2: DECISION STYLES

To further our understanding of the decision maker, we need to better understand those things that directly affect his or her behavior. One such area of focus is decision style. Decision style is a term used to describe the manner in which a manager makes decisions. The manager’s design style is reflected in the way he or she reacts to a given decision-making context—what is believed to be of value or importance, how the information is interpreted, how the externalities and forces are dealt with. The ultimate effect of a particular individual’s decision style on a decision outcome depends on factors such as problem context, the perceptions of the decision maker, and the personal set of values that he or she brings to the situation. The mechanisms used to measure and categorize decision styles and the results obtained from these measures provide the input for the design and implementation of a DSS.

CONTEXT, PERCEPTION, AND VALUES

The three interwoven factors of context, perception, and values contribute to decision style. The problem context involves factors relating to the forces acting on the decision maker in the course of making the decision. Organizational and environmental forces such as government regulation, new technologies, market competition, and internal power struggles all affect the problem context. Forces of a more individual nature such...
as skill set, energy, motivation, and perceived abilities, among others, can also shape the problem context. The decision maker must balance and manage the totality of these forces during the problem-solving process.

Another factor affecting decision style is perception. Decision makers bring personal biases into the problem context, which often serve to “convert” the facts so that they better match their own reality. Various studies demonstrate that managers tend to perceive a problem situation and its potential solutions in relation to their personal goals rather than a strict set of realities. As a result, perceptual biases interact with the problem context to determine a particular decision maker’s approach to solving a problem and whether that approach is effective. We focus in depth on the effects of individual biases on decision outcomes in the next chapter.

Last, but not least, the personal values of the decision maker are important in determining his or her decision style. Values consist of those world views or global beliefs that guide individual actions, judgments, and desired outcomes. An individual’s values are not tied to any particular object or situation and can be generalized across all modes of conduct. Moreover, values are acquired at an early age and tend to remain strong throughout a person’s lifetime. An individual’s values, therefore, form a permanent framework that influences a person’s behavior and the manner in which he or she makes decisions.

The complexity with which these three factors intertwine in the formation of decision style is significant. Established measures of decision style provide a basis on which to build a classification scheme for decision styles to use when designing DSSs intended for specific problem contexts and users possessing certain decision style characteristics. Let’s begin by looking at the basic classes of decision style and their associated characteristics.

Figure 2-4 shows a decision style classification scheme derived from the work of noted psychiatrist Carl Jung. The classification scheme provides the basis for many measures of decision style including the popular Myers-Briggs Type Indicator test (Myers 1962) and the Decision Style Inventory developed by Alan Rowe. As can be seen in the figure, decision style is classified using two component parts: cognitive complexity and value orientation. These two dimensions can be used further to identify four distinct categories of decision style.

DIRECTIVE

The directive decision style combines a high need for structure in the problem context with a relatively low tolerance for context ambiguity. Decision makers possessing these characteristics tend to focus on decisions of a technical nature and often do not require large amounts of information or consider multiple alternatives. They are generally considered efficient managers but require visible levels of both security and status. Finally, directive-style decision makers tend to function best when they communicate verbally rather than through writing or other multichannel media.

ANALYTICAL

This style demonstrates a much greater tolerance for context ambiguity and tends toward the need for greater volumes of information and the consideration of large sets of alternatives. Analytical-style decision makers are best at coping with new, often
unexpected, situations and problem contexts. They simply enjoy solving problems. In contrast to the directive style, analyticals prefer written communication and are not quick to reach a decision or solution. Their orientation toward detail often results in protracted investigations of the problem context before a final decision is made.

CONCEPTUAL

Much like the analytical decision maker, the conceptual manager demonstrates a high tolerance for ambiguity but tends to be much more of a “people person.” Conceptuals display an openness with their subordinates and tend to be driven by an idealistic emphasis on values and ethics. This type of decision maker is a long-term thinker and generally strongly committed to the organization. In addition, conceptual decision makers tend to be achievement oriented and value accolades and organizational recognition. Their management style commonly focuses on participation and exhibits loose control. As implied by their name, conceptuals are thinkers rather than doers.
BEHAVIORAL

The fourth category of decision style falls low on the cognitive complexity scale. Nonetheless, behavioral types display a deep commitment to the organization as well as an employee orientation. This style requires a relatively low amount of data input and, as such, generally demonstrates a relatively short-range vision. Behaviorals are conflict-averse by nature and tend to rely on meetings and consensus for communicating to and organizing subordinates.

DECISION STYLE IN DSS DESIGN

The four classifications of decision style in the Rowe typology provide us with a method of categorizing decision makers according to the characteristics of their particular style, but we need a method of incorporating this knowledge into the design process for a DSS. Effectively using these classifications in DSS design requires that a few key points be addressed.

To begin with, one must recognize that human beings are complex and no simple method of classification, such as the Decision Style Inventory, will reflect completely this complexity. Therefore, we cannot expect managers to fit neatly into a single category. Typically, a manager’s responses indicate the presence of a dominant decision style with one or possibly two backup styles. Thus it is better for us to think of a manager’s decision style in terms of style patterns rather than a distinct and highly predictable set of rigid behaviors. Knowing an individual’s dominant and backup decision patterns can yield a great deal of information useful in the design of interfaces and levels of procedurality or directiveness.

CONTEXT/DECISION STYLE INTERACTION

Table 2-1 lists a number of style-situation comparisons and behavior outcomes regarding the four classifications that can serve to inform the design of a DSS for a particular type of decision maker.

The key issues in our focus on decision style as it relates to DSS design and use are the decision maker’s specific reactions to stress and the method in which problems are generally solved. If we use our knowledge of these characteristics in the design of a DSS intended for use by a known decision style we may be able to provide support compatible with the user’s preferred approach. Conversely, if we ignore decision style

<table>
<thead>
<tr>
<th>Basic Style</th>
<th>Behavior under Stress</th>
<th>Motivations</th>
<th>Problem-Solving Strategy</th>
<th>Nature of Thought</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directive</td>
<td>Explosive, volatile</td>
<td>Power and status</td>
<td>Policies and procedures</td>
<td>Focused</td>
</tr>
<tr>
<td>Analytical</td>
<td>Focuses on rules</td>
<td>Challenge</td>
<td>Analysis and insight</td>
<td>Logical</td>
</tr>
<tr>
<td>Conceptual</td>
<td>Erratic, unpredictable</td>
<td>Recognition</td>
<td>Intuition and judgment</td>
<td>Creative</td>
</tr>
<tr>
<td>Behavioral</td>
<td>Avoidance</td>
<td>Peer acceptance</td>
<td>Feelings and instincts</td>
<td>Emotional</td>
</tr>
</tbody>
</table>

Source: Adapted from Rowe, A. J. and Boulgarides, J. D., (1994), Managerial Decision Making, Upper Saddle River, NJ: Prentice Hall. Used by permission, © 1985, all rights reserved.
or fail to provide appropriate support for a particular style, the DSS may actually inhibit the success of the process and reinforce certain biases or weaknesses in the decision maker’s approach to solving the problem. Some simple examples may better illustrate this point.

Let’s say we know the primary user of a proposed DSS possesses a dominant decision style in the analytical category. We know this style displays a high tolerance for ambiguity, uses considerable data in reaching a conclusion, strives toward optimization of the solution, is creative, and prefers a structured, rule-oriented environment. This type of user would be able to function effectively in a procedural DSS environment and would require access to a wide variety of data sources and models during the course of using the DSS. Systems that are designed to allow for innovative and counterintuitive analyses and model combining would be most useful to the analytical-style manager.

Consider, on the other hand, a system that is highly procedural and directive being used by a manager whose dominant decision style is highly directive. The directive type has a low tolerance for ambiguity and is not good at coping with stressful situations. The user’s need for control and power would require an interface that allows for such control to be exercised in the operation of the system. The tedious nature of constructing an exact and semantically accurate query or command to the DSS would soon wear thin on a directive decision maker. Also, recall that the directive type is primarily a verbal communicator, which would suggest that output requiring visual analysis for interpretation would not be utilized as well by a directive as would a simple, concise table or narrative response from the DSS. In sum, designing the system to complement the user’s decision style can provide additional support to the decision-making process and failing to do so can inhibit the success of the process.

### 2-3: DECISION EFFECTIVENESS

**WHAT MAKES A GOOD DECISION A GOOD DECISION?**

An old adage in the used car business says that a “good deal” is the deal you just agreed to. This approach makes the assumption that the buyer would never knowingly agree to a “bad deal” and therefore, if he or she agreed to it, it must be good. We can think of agreement to a deal as a decision and can assume that the decision to agree is viewed by the buyer as a good decision. But how do we really know whether a decision is a good one?

Given the fact that decision making is at the heart of managerial activities and that good decisions are significantly related to the long-term success of an organization, one would expect to find a wealth of knowledge regarding the profile of a good decision and the determinants of successful decision outcomes. Unfortunately, such knowledge remains elusive. Even though a number of studies investigated the factors relating to successful decisions, few if any offered useful prescriptions for improving the chances of decision success. We are faced, then, with defining a good decision and then using that definition to judge whether a good decision has been made.

The following definition of a “good” decision is offered: A good decision results in the attainment of the objective or objectives that gave rise to the need for a decision within the boundaries and constraints imposed by the problem’s context. In other words,
if we reach our goal given the limitations of our situation, then we have made a "good" decision. Another way of looking at it is that if by our decision we solved the problem at hand without causing any new problems, then our decision must have been a good one. The problem is that we really do not know whether a decision is a good one until after it is made. We are, therefore, faced with analyzing our intended decision in terms of the intended ends that will be accomplished by the means available to us, which partly explains why decisions are often hard to make. We will explore this issue more in the next chapter when we look at the various theories associated with decision making. In the meantime, we need to better understand the various forces that shape the problem context and, thus, both the decision process and its outcome.

DECISION FORCES

Several models attempt to explain the variety of potential forces and constraints that can act on a problem context, and thus on a decision maker, during the course of making a decision. Each of these models suggests that the decision maker must balance the forces acting upon the process and must contend with the dynamics of the forces in formulating and implementing a final decision. Figure 2-5 illustrates these forces. Although each problem context is unique, it may exhibit the majority, if not all, of the forces listed in one form or another during a typical decision-making process. Let's briefly review each of the major categories of forces and constraints found in a typical decision process.

![Figure 2-5: Forces Acting upon a Typical Decision Maker](image-url)
Personal and Emotional Forces

The decision maker does not live in a vacuum and is not without typical human needs. As such, the conditions that relate to his or her feelings, health, security, rewards, frustrations, anxieties, and maybe most important, cognitive limitations can all be of consequence during the process of selecting the appropriate alternative. Each of these personal forces can serve to either reinforce or debilitate the manager’s ability to make a sound decision. As a result, the personal forces acting upon the decision process must be given careful consideration by the decision maker during the formulation of a decision strategy.

The human mind has often been referred to as infinite in its capacity and power. However, the practical nature of our understanding of human cognitive processes suggests we are limited in our present ability to store and process knowledge. Compared to the rate at which knowledge is advancing, we possess only a modest amount of knowledge relative to all that is known. Moreover, studies show that we are limited in our capacity for processing the knowledge we do possess. Miller (1956) suggested the concept of “the magic number seven, plus or minus two.” We typically are not capable of processing more than five to nine distinct pieces of knowledge at a time. We will see in Chapter 3 that the use of certain strategies for decision making can overcome this and other cognitive limitations, but cognitive limits still act as a significant force in the decision-making process.

Economic/Environmental Forces

This category includes limits on resources, governmental regulation, societal values such as views on the moral or ethical nature of the decision being considered, competitive pressures of the marketplace, the demands of the consumer, the needs and demands of the individual stakeholders potentially affected by the decision outcome, and the emergence of new technology. Individually or in combination, these forces require the decision maker to respond in a manner that may alter the final decision itself in order to account for, or control for, their effects.

In 1994, Intel discovered a bug in its new Pentium processor that caused inaccuracies in certain calculations (see Figure 2-6). The basic problem affected simple division requiring accuracy to sixteen significant digits. Intel executives decided to inform their consumers about the problem but maintained that it was so minor in nature that it would occur only once every 25,000 years for the typical user and that it required no recall by the manufacturer or action on the part of the consumer. Intel failed to consider certain market forces, however, in the making of this decision. IBM, a major consumer of Intel processors, had a significant inventory of 486-class machines in its warehouses. A market excited about the new Pentium processor had stopped buying 486 machines in anticipation of the Pentium. When IBM heard of the Pentium bug, it began a public campaign to discredit Intel’s claims. IBM claimed that the problem was much larger than Intel was suggesting, arguing that it could occur once every 24 days and that the typical user would most surely be affected. Although neither side was able to provide substantive evidence to support its claims, the public began to lose their enthusiasm for the Pentium and reverted to purchasing 486-class machines—something that certainly pleased IBM. Intel’s failure to simply replace the processors when the original announcement was made magnified the effects of IBM’s counterattack on the consumer. Because Intel neglected to account for the environmental forces associated with its competition and with the introduction of new technologies, it
FROM: Dr. Thomas R. Nicely  
Professor of Mathematics, Lynchburg College  
1501 Lakeside Drive, Lynchburg, Virginia 24501-3199  
Phone: 804-522-8374  Fax: 804-522-8499  
Internet: nicely@acavax.lynchburg.edu

TO: Whom it may concern  
RE: Bug in the Pentium FPU  
DATE: 30 October 1994

It appears that there is a bug in the floating point unit (numeric coprocessor) of many, and perhaps all, Pentium processors. In short, the Pentium FPU is returning erroneous values for certain division operations.

For example, 1/824633702441.0 is calculated incorrectly (all digits beyond the eighth significant digit are in error). This can be verified in compiled code, an ordinary spreadsheet such as Quattro Pro or Excel, or even the Windows calculator (use the scientific mode), by computing

\[(824633702441.0) \times (1/824633702441.0),\]

which should equal 1 exactly (within some extremely small rounding error; in general, coprocessor results should contain 19 significant decimal digits). However, the Pentiums tested return 0.999999996274709702 for this calculation. A similar erroneous value is obtained for \(x \times (1/x)\) for the above values of \(x\). The Pentium FPU will fail to return the original \(x\) (in fact, it will often return a value exactly 3072 \(= 6 \times 0x200\) larger).

The bug has been observed on all Pentiums I have tested or had tested to date, including a Dell P90, a Gateway P90, a Micron P60, an Insight P60, and a Packard-Bell P60. It has not been observed on any 486 or earlier system, even those with a PCI bus. The bug appears to disappear; but then the Pentium becomes a "586SX", and floating point must run in emulation, slowing down computations by a factor of roughly ten. I encountered erroneous results which were related to this bug as long ago as June, 1994, but it was not until 19 October 1994 that I felt I had eliminated all other likely sources of error (software logic, compiler, chipset, etc.). I contacted Intel Tech Support regarding this bug on Monday, 24 October (call reference number 51270). The contact person later reported that the bug was observed on a 66-MHz system at Intel, but had no further information or explanation, other that the fact that no such bug had been previously reported or observed.

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FIGURE 2-6 Excerpt of E-mail Posting of First Observed Intel Pentium Division Problem

Source: Courtesy of Dr. Thomas R. Nicely and Lynchburg College.

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lost the momentum created by the hype over the new Pentium processor in addition to suffering a $475 million fourth-quarter loss. The dust of course settled, and Intel more than recovered from their “bad” decision. Nonetheless, this example serves as notice of the need to account for economic/environmental forces.

**Organizational Forces**

Within the manager’s own organization, forces and constraints exist that must be accounted for in the process of making a decision. Policies and procedures, issues of group conformity, organizational culture, and coordination of staffing and other resources can affect the nature of the decision process. The degree to which the manager interacts with superiors and subordinates combined with the overall policy structure of the organization can significantly alter a decision process and, thus, its outcome. Consider an organizational climate that tends to discourage new or innovative thinking and prefers to reward conformance to existing policy and procedures. A decision
maker in this organization will soon become frustrated with constantly being turned
down when suggesting new or innovative decision outcomes. Over time, the omission
of creativity from the organization’s decision process will become institutionalized, and
the decisions made by its managers that remain will be constrained by an organiza-
tional culture characterized by lack of vision and foresight.

Contextual and Emergent Forces
A significant source of constraint and consequence to the decision process is the prob-
lem context itself. This category faces issues relating to skill inventory, time require-
ments, motivation to reach a decision, and the perception of importance by the deci-
sion maker. Probably the most important and noticeable of these is time requirements.
Even if all other forces acting upon the situation are effectively dealt with, time limits
 can create severe pressure and stress on the decision maker and, if left unattended or
 ignored, can significantly increase the probability of error or poor-quality decision out-
comes. Cognitively demanding activities are often classified as such not because the
activity itself is demanding but because the time limitations associated with each deci-
sion in the activity make it so. Consider the multitude of decisions an airline pilot must
make. Activities associated with deciding to ascend or descend, turn left or right, or
increase or decrease power are in and of themselves not necessarily cognitively
demanding or stressful. But when those decisions must be made by a pilot traveling at
350 miles per hour while approaching another aircraft traveling at a similar speed, the
time limitations completely change the nature of the decision process. The 2 or 3 sec-
onds allowed for these decisions may preclude the consideration of all relevant infor-
mation or the consideration of multiple decision strategies. Bear in mind that this type
of situation is not out of context for a discussion of managerial decision making. The
pilot’s office is the cockpit and his job is to make these types of decisions on behalf of
his organization. In a relative sense, many of the decisions faced by managers on the
ground have a time limitation that can induce the same levels of stress found by the air-
line pilot facing a collision situation.

2-4: HOW CAN A DSS HELP?

This entire book is devoted to answering the question of how a DSS can help, but it is
appropriate at least to begin to list the ways in which a DSS can assist in the decision
process with respect to the various forces we just discussed.

Recall from Chapter 1 that a DSS, while useful, is not a universal solution with
regard to supporting all that needs to be addressed in the course of making a decision.
The DSS is not intended to replace the decision maker. Rather, it is intended to pro-
vide him or her with focused support for one or more activities within the decision
process. Because of this limitation, we must become aware of the nature of available
support a DSS can offer. Then we can see the need to incorporate DSS technology in
those problem contexts where it is appropriate. Table 2-2 lists the basic types of sup-
port that a DSS can provide.

The types of support listed are not always mutually exclusive nor are they always
appropriate for a particular problem context. These distinctions make the design,
DECISIONS AND DECISION MAKERS

CHAPTER 2

TABLE 2-2 Common Types of Support Provided by a DSS

- Explores multiple perspectives of a decision context
- Generates multiple and higher quality alternatives for consideration
- Explores and tests multiple problem-solving strategies
- Facilitates brainstorming and other creative problem-solving techniques
- Explores multiple analysis scenarios for a given decision context
- Provides guidance and reduction of debilitating biases and inappropriate heuristics
- Increases decision maker’s ability to tackle complex problems
- Improves response time of decision maker
- Discourages premature decision making and alternative selection
- Provides control over multiple and disparate sources of data

implementation, and application of a DSS challenging and unique from all other information systems. Properly applied, however, a DSS can become an essential element in the creation of a “good” decision.

2-5: WHY ARE DECISIONS SO HARD?

How is it that we often seem to know in advance that a decision is going to be hard to make? When you think about it, our ability to size up many decision situations rather quickly in terms of classifying them as easy or hard is quite spectacular. Faced with the responsibility of deciding whether to spend the day at the beach with friends or stay at home and mow the grass, almost immediately we sense that this decision will not be a difficult one to make. Conversely, if we bear the responsibility of adopting a new technology into our organization that will decrease operational costs while simultaneously improving product quality, but will mean the layoff of as many as 1,000 employees, we also seem to know intuitively that this decision will be no day at the beach. The real question is how do we know whether a decision will be easy or hard before we even begin to gather information about it or to make it?

The answer depends on a variety of structural, psychological, physical, and environmental factors. The difficulties (or lack thereof) associated with making a decision can be the result of innumerable combinations of complexity, uncertainty, organizational and environmental pressures, and individual decision-maker limitations. In this chapter, we will explore four key areas that can individually or collectively determine the relative difficulty of a pending decision: (1) structure, (2) cognitive limitations, (3) uncertainty, and (4) alternatives and multiple objectives.

STRUCTURE

Recall from Chapter 1 that Simon (1960) proposed to classify problems on a continuum from completely structured to completely unstructured. Figure 2-7 illustrates this classification and contains examples of decision structures that would exist at each end of the continuum.
Simon distinguished between the two ends of the spectrum by discussing the degree to which a decision is programmed:

Decisions are programmed to the extent that they are repetitive and routine, to the extent that a definite procedure has been worked out for handling them so that they don’t have to be treated de novo each time they occur. Decisions are non-programmed to the extent that they are novel, unstructured, and consequential. There is no cut-and-dried method of handling the problem because it hasn’t arisen before, or because its precise nature and structure are elusive or complex, or because it is so important that it deserves a custom-tailored treatment. . . . By non-programmed I mean a response where the system has no specific procedure to deal with the situations like the one at hand, but must fall back on whatever general capacity it has for intelligent, adaptive, problem-oriented action. (pp. 5–6)

In other words, programmed decisions are easy because all the parts necessary to make the decision are immediately available to us; we have a “program” to make the decision. Nonprogrammed decisions are hard because, in addition to gathering the necessary information and making the decision, we must also “write the program,” or design the process by which the decision is made. In applying Simon’s classification method to the realm of the DSS, Keen and Scott Morton (1978) chose to refer to the ends of the continuum as structured and unstructured, and we will adopt this convention as well.

As can be seen in Figure 2-7, the degree of structure of a decision is determined by a variety of factors. Decisions made repeatedly during the normal course of activity
Decisions and Decision Makers tend to be (or become) structured. An airline pilot frequently makes decisions about takeoffs and landings, routing, and passenger comfort such as whether to turn off the seat belt sign. Such decisions, due to their commonplace and repetitive nature, are relatively structured. If, however, the pilot is faced with deciding to land an aircraft with one engine out at an unfamiliar airfield for which no maps are available, the decision becomes much more unstructured.

COGNITIVE LIMITATIONS

We cannot know everything. Sometimes we cannot even handle all that we have to know for the situation at hand. Even worse, occasionally we cannot even summon forth into our conscious mind information we have previously encountered and stored. Worse yet, when we do successfully retrieve previously stored information, it is often not completely accurate. Although the human mind is a marvelous (and theoretically infinite) reasoning, computational, and storage mechanism, our present understanding of it suggests that we are indeed limited in our ability to process and store information and knowledge.

One of the most famous and oft-cited investigations into cognitive limitations is the work of Miller (1956). His research has long stood as an example of the cognitive limits of the human mind. Through a series of experiments using a large sample of human subjects, Miller determined that the immediate field of awareness of the human mind is limited to the manipulation of five to nine distinct pieces of information. In other words, at any given moment, we can only consciously keep track of “the magic number seven plus or minus two” active items of knowledge during the processing of a decision. Miller introduced the term chunk to describe an “organized unit of information” stored in the working memory. In essence, Miller’s conclusions suggest that the brain’s capacity to handle information is constrained by the number of chunks in the receiving stimulus. He also demonstrated that humans tend to develop ways of organizing information into larger chunks according to past experience, with experts being more proficient at chunking information than novices in a given knowledge domain. Although we have developed many methods of aggregating information in an attempt to mitigate this limitation, the basic conclusion of Miller’s work remains true. Because decision making is a cognitive exercise, the cognitive limitations of the individual decision maker can substantially increase the degree of difficulty of making a particular decision. We will explore the issue of cognitive limits in more detail later in this chapter.

UNCERTAINTY

The concept of “20/20 hindsight” is a good way to develop an understanding of uncertainty. When one looks back at the outcome of a decision and the process by which it was made, one can see with complete certainty what the outcome of that decision process was. If we could predict the outcome of a particular decision with the same degree of certainty, all decisions would be easy to make.

Total certainty implies complete and accurate knowledge regarding the outcome of a pending decision. Genuine uncertainty suggests that the outcome of a pending decision cannot be determined even within the confines of a probabilistic framework. The bad news is that we are generally faced with some degree of uncertainty in a decision-making situation and that total certainty seldom exists. The good news is that
genuine uncertainty is almost equally as uncommon. Usually, the decision maker can assign some subjective probability to the expected decision outcome so that some degree of certainty is assumed. In most cases, the accuracy of such subjective probabilities is based upon the degree of completeness and accuracy of the information used to assign them. Implicit in this assessment is that most decision outcomes contain an element of risk on the part of the decision maker. In Chapter 4, we will look at a variety of methods developed to assist the decision maker in assigning high-quality subjective probabilities to decision outcomes as well as techniques that can be used to reduce the degree of uncertainty in a given decision context. For now, let’s assume the axiom that the more uncertain a decision outcome is to the decision maker, the more difficult the decision becomes to make.

ALTERNATIVES AND MULTIPLE OBJECTIVES

Regardless of the context in which a decision is being made, the objective of the exercise is to produce a desired outcome. We can characterize an outcome or a result as the product manufactured during the decision process. In fact, whether the decision is made by an individual, a team of individuals, or at the level of the organization, the objective remains the same: to choose from a selected set of alternatives the one that will produce the greatest number of desirable outcomes with the least number of undesirable consequences. Because we do not know with certainty that any of our outcomes will actually occur we must carefully consider each of the possible outcomes associated with a given decision strategy to determine whether the desired effect will be achieved.

At this point, the complexity or difficulty of a given decision can be significantly increased by the presence of multiple alternatives or objectives. Each new alternative needs to be thoroughly analyzed and compared to the other alternatives. Including additional alternatives in the selection set increases the difficulty of the decision. To further exacerbate this problem, the decision maker may have more than one objective or goal at any given time. As such, the selection of one alternative that, by itself, satisfies the criteria of the decision objective may also impede the progress of another related goal. Now the process is compounded by the shared values and goals of the decision maker in addition to the issues of multiple alternatives.

One method commonly used by managers to cope with this situation is to discard the marginally acceptable alternatives early in the choice process. By doing so, the decision maker can devote energy to concentrating on those remaining alternatives that appear to be better suited to produce the desired outcome. Although this process of elimination appears to assist in making the correct choice, we will see later in this chapter that it may not be a correct assumption. In fact, this very method may actually eliminate the best alternative in light of the objectives and constraints.

2-6: A TYPOLOGY OF DECISIONS

Decisions, decisions, decisions. No two are completely alike. The myriad of decisions facing a manager in his or her lifetime is staggering. In fact, the typical day of a manager can be jam-packed with decisions. The kind of support needed for one decision
may be entirely different from the support required for the next decision. We need a method of reducing the vast number of possible decision contexts into a more manageable set of categories.

Many different methods can be used to classify decisions. We could classify them according to managerial level, for instance: line-level decisions versus middle manager decisions versus senior management decisions. Or we could classify them according to their focus, say strategic versus administrative decisions. What about classifying them according to the strategy used to make the decision: computational versus judgmental? You can see that decisions can be logically categorized by a variety of notions. Regardless of the method employed, however, if we are to design and successfully implement a support technology for a given decision context, we must be able to classify (or better yet, isolate) those decisions for which the DSS can be expected to be useful and those for which it cannot. We need a typology. Figure 2-8 illustrates one example of a typology of decisions based on a combination of several methods found in decision-making and DSS literature. Let’s focus for a moment on the classification schemes contained in the figure.

NEGOTIATION-BASED DECISIONS

Delbecq (1967) proposed a three-point classification scheme based on the notion of negotiation:

1. **Routine decisions.** The decision maker or makers are clear on the desired goal or objective and the policies, procedures, and technologies that exist to achieve the goal. Routine decisions can be thought of as analogous to Simon’s programmed decisions.

2. **Creative decisions.** Novel approaches are needed to handle the complexity of these decisions. An agreed-upon strategy or method is lacking and the outcome is uncer-
tain due to incomplete knowledge or absence of a known strategy. These decisions can be thought of as analogous to a nonprogrammed or semistructured decision.

3. **Negotiated decisions.** Conflict exists in either goals or approaches to the decision at hand. Therefore, the various opposing factions must confront each other in an effort to resolve the differences. In these decisions the manager may not be the decision maker at all but rather a participant in the decision-making process.

### ACTIVITY-BASED DECISIONS

Mintzberg (1973) proposed a typology of decisions that focuses attention on the activity with which the decision is most associated:

1. **Entrepreneurial activities.** This type of decision is generally characterized by high levels of uncertainty. The selection of alternatives is motivated primarily by proactive considerations and is typically focused on near-term growth over long-term issues.

2. **Adaptive activities.** Also characterized by high levels of uncertainty, these types of decisions are typically motivated by reactive considerations and are focused more on the short-term issues at hand.

3. **Planning activities.** This decision environment is characterized by high risk and the decisions made are motivated by both proactive and reactive considerations. The focus here is more on growth and efficiency over the long term.

As can be seen from Mintzberg’s approach, the support necessary for decisions classified in this manner would be determined primarily by the environment in which the decision was being made rather than by the actual structure of the decision itself. In this regard, Mintzberg’s classification suggests a differentiation based on decision strategy rather than decision structure as with Simon’s or Delbecq’s approaches.

### STRATEGY-BASED DECISIONS

Yet another division in our typology of decisions is represented by the approach taken by Thompson (1967). His classification scheme differentiates decisions based upon the primary strategy used in making the final choice:

1. **Computational strategies.** Considerable certainty exists with regard to outcomes and cause/effect relationships. Strong preferences exist for possible outcomes.

2. **Judgmental strategies.** Preferences for possible outcomes are quite strong but outcomes and cause/effect relationships are highly uncertain.

3. **Compromise strategies.** High certainty exists regarding the outcomes and cause/effect relationships, but the preferences for possible outcomes or alternatives are weak or unclear.

4. **Inspirational strategies.** Preferences for possible alternatives or outcomes are weak or unclear and a high degree of uncertainty exists regarding cause/effect relationships.

In Thompson’s approach we find two dimensions in which the strategy is formed: certainty and outcome preference. In this case, necessary support would be determined based upon which strategy would appear most effective given the decision being undertaken.
Despite the method of classification employed, all methods share certain characteristics. As shown in Figure 2-7, they can all be further classified into one of two categories—those of a routine, recurring nature with high certainty and those of a non-routine, nonrecurring nature with high uncertainty. Using this metaclassification approach we can reduce the complexity of determining what type of support may be warranted given the basic characteristics of the decision type. In other words, by gaining a better understanding of the classification of the decisions to be made in a given context we might be better able to determine what specific features of a DSS would be useful in support of that context.

2-7: DECISION THEORY AND SIMON’S MODEL OF PROBLEM SOLVING

If we are to understand what is actually going on in the “black box” world of the decision maker, we need some point of reference or “lens” through which to view the various behaviors and begin to explain their relationships. This lens is usually found in the form of a theory of the process. Numerous theories attempt to explain the process of decision making. Keen and Scott Morton (1978) proposed a categorization of decision-making theory that organizes the myriad of decision theories into five main perspectives. Table 2-3 contains their taxonomy of decision-making perspectives and provides a brief description of each.

Regardless of which theoretical approach we embrace, it is important to realize that the development of a good prescriptive approach to decision making—such as the design and implementation of a DSS—is rooted in the development of a workable and sound descriptive theory. For our purposes, we will explore and build upon the work of Simon and his colleagues by investigating the decision-making process as a process of rational behavior.

Figure 2-9 illustrates Simon’s (1960) three-phase model of problem solving. Though elegantly simple in construction, Simon’s model continues to withstand the test of time and, even today, serves as the basis for most models of management decision making. Notice that the model depicts the problem-solving process as a flow of events that can proceed in either a linear or iterative fashion. That is, at any point in the process, the problem solver may choose to return to the previous step(s) for additional refinement. Let’s look at each phase of the process in more detail.

Intelligence

The process begins with the intelligence phase. During this phase the decision maker is “on the lookout” for information or knowledge suggesting the presence of a problem or the need for a decision. This scanning activity may be either periodic or continuous in nature. Problems tend to manifest themselves as a noticeable (real or perceived) difference between a desired state and the present state. Implicit in the “activation” of the problem-solving process is the detection of a problem that can be “owned” by the problem solver. If the decision maker or his or her organization cannot solve the problem, then it cannot be owned and therefore does not trigger the next phase of the process. Instead, such conditions tend to be classified as constraints or conditions that may be necessary to consider when solving problems that can be owned. An example
TABLE 2-3 Keen and Scott Morton Classification of Decision-Making Perspectives

Rational Manager Perspective
- Classic conception of decision making
- Assumes rational, completely informed, individual decision maker
- Favored by proponents of cost-benefit analysis
- Requires analytic definition of decision variables
- Requires precise, objective criterion for choice

Process-Oriented Perspective
- Focuses on how decision maker can effectively function with limited knowledge and skills
- Emphasizes heuristics and search for solutions that are “good enough”
- DSS design goal is to assist in improving existing solution, not to seek the optimum

Organizational Procedures Perspective
- Seeks to understand decisions as output of standard operating procedures
- Design goal is to determine which of these procedures might be supported or improved
- Stresses identification of organizational roles
- Includes focus on communication channels and relationships

Political Perspective
- Decision making is viewed as a personalized bargaining process between business units
- Assumes that power and influence determine the outcome of any decision
- Design goal focuses upon the decision-making process rather than the decision itself

Individual Differences Perspective
- Focuses on individual problem-solving behaviors
- Design is contingent on the decision-making style, background, and personality of intended user

FIGURE 2-9 Simon’s Model of Problem Solving
can be found with environmental conditions such as taxes or interest rates. A decision maker may perceive the tax rate imposed on his imports or exports to be excessive. Nonetheless, this perceived difference between the current state and the desired state is beyond the decision maker's direct control. As such, the “problem” must be classified as a constraint or externality that must be considered when solving other “ownable” problems.

Problems within the scope of the decision maker generally manifest themselves during the scanning activity. For example, a daily review of a production log may reveal a need for maintenance. Another example can be found in the cockpit of a commercial airliner. An old adage among pilots describes flying as “hours of boredom occasionally interrupted by stark, raving terror.” Most activity in the cockpit of an aircraft consists of scanning the multitude of instruments that provide the pilot with feedback about the aircraft and the environment in which the aircraft is flying. The pilot develops an expectation of the value of each of these bits of information under a variety of conditions. When one or more of the instruments does not conform to this expected range of values, the pilot detects a problem and must move on to the next phase of the problem-solving process.

**Design**

After identifying the problem and formally defining it, the decision maker must begin activities related to the formation and analysis of alternatives intended to serve as potential solutions to the problem. This phase is critical in the process. The host of potential solutions to the problem must be explored and reduced to a workable subset. Each potential solution must be carefully analyzed and compared to all others with regard to expected outcome, cost, probability of success, and any other criteria deemed critical by the decision maker.

Another critical activity performed during this phase is the analysis and selection of a problem-solving strategy. Determining the range of feasible solutions is one thing, but determining how to go about actually selecting an acceptable solution and implementing it is quite another. As you can see, the process of problem solving sometimes involves decisions within decisions and problems within problems. It is one reason why making decisions is often difficult and fraught with risk and error. The decision maker must decide on the best approach to modeling the problem, identifying the key factors or variables to be contained within the model, and discerning the relationships among those variables. Finally, decisions must be made regarding what analytical tools are most appropriate for testing the integrity of the chosen model and its possible outcomes. During this phase, the decision maker may find that he or she needs more information regarding the problem at hand and may return to the intelligence phase in an attempt to satisfy that need before returning to design further phase activities and proceeding to the third phase of the process.

**Choice**

Intuitively this phase should be the most clear-cut of the three in terms of associated activities; however, we will soon see that it is exactly the opposite. It is also where the concept of decision making as a rational behavior will be explored in detail.

In this phase, the decision maker selects one of the available solution alternatives generated and analyzed in the previous phase. Once again, we find complexity as a result of decisions within decisions. For instance, before the decision maker can select a
feasible solution to the problem, a secondary scanning of the internal and external environments must be conducted to ensure that the solution about to be implemented is still the best choice given the constraints at hand. Although many decisions can be made in environments of reasonable stability and expectation, in some cases the dynamics of a decision-making environment are so fluid that solutions cannot be selected based upon conditions that exist at the moment but must be based upon the expected or estimated conditions at the time the solution will be physically implemented. The petroleum industry is a perfect example of this issue. Consider the problems facing a typical global petroleum producer. The decisions regarding the price of oil and refined petroleum products must be made in an environment of constant flux. An error of a single penny per gallon can cost the company millions of dollars in future revenues. In addition, the decision as to pricing (the solution) must be made for a future period, thus requiring an estimation of the market conditions some time in the future.

This dichotomy of environmental conditions (stable versus fluid) often requires a return to the previous design phase for further refinement of the selection strategy and definition of the feasible solution subset. In addition, a decision maker must consider what constitutes an acceptable solution. Does the situation require an “optimal” solution or will an “acceptable” one suffice? What level of risk are we willing to assume in the selection of a solution alternative? The stability or fluidity of the decision context can serve to determine the answers to these questions and thus the selection of a decision-making strategy. Table 2-4 identifies several modeling and analysis strategies associated with our decision either to optimize or to satisfy.

### 2-8: RATIONAL DECISION MAKING

Before we go any further, let’s take a closer look at our two strategic alternatives. The concept of optimization suggests that the decision maker will choose the alternative that is clearly the best possible one providing the best overall value and outcome. Such an optimal solution may manifest itself as the lowest cost, the highest goal attainment, or the highest ratio of goal attainment to cost. Regardless of the structure of the outcome, the optimal solution is the “best of all possible solutions.” The problem is, how do we know what “all the possible solutions” are? We will address that question shortly.

### TABLE 2-4 Modeling and Analysis Strategies

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<th>Satisficing Strategies</th>
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<td>Linear programming</td>
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<td>Forecasting</td>
<td>Goal programming</td>
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<td>“What-if” analysis</td>
<td>Simple queuing models</td>
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<tr>
<td>Markov analysis</td>
<td>Investment models</td>
</tr>
<tr>
<td>Complex queuing models</td>
<td>Inventory models</td>
</tr>
<tr>
<td>Environmental impact analysis</td>
<td>Transportation models</td>
</tr>
</tbody>
</table>

*Note: Techniques such as Markov analysis and queuing are advanced methods of determining probabilities of events. For a detailed explanation of such methods the reader is referred to any good management science text.*
In many circles, particularly the disciplines of economics and management science, optimization is considered rational behavior. In other words, it is rational to make a decision that, after review of all possible alternatives, brings the maximum satisfaction or utility to the decision maker. “The end of rational behavior, according to economic theory, is the maximization of profits in the case of business firms and the maximization of utility in the case of people in general” (Katona, 1953, p. 313). Most normative economic theory, such as laws of market equilibrium or supply and demand, is built upon the assumption that man is distinctly rational in behavior and will always seek the optimal solution to a problem.

Despite the attractiveness of optimization as a decision-making strategy, its practical application in managerial decision-making contexts is problematic. A number of conditions exist in the realm of management decisions that make optimization difficult, if not impossible, to operationalize. First, many decisions managers face are distinctly qualitative in nature and thus do not lend themselves to the quantitative approaches associated with optimization. For example, the decision faced by General Motors in 1984 regarding the location for its new 4 million-square-foot Saturn manufacturing facility was one of a complex, qualitative nature. Admittedly, issues of a quantitative nature such as cost of land, cost of labor, transportation and shipping issues, availability of necessary resources, and taxes were relevant to the final decision. However, other issues such as quality of life afforded for the employees, quality of available education, and other life-sustaining services were equally relevant. Although the quantitative issues could be accurately measured, the relevant qualitative issues could not. As such, optimization is of little value in this scenario. Simon (1960) identified a second problem with optimization as a viable solution strategy. He made the point that it is just not feasible to attempt to search for every possible alternative for a given decision. The cost of doing so is easily enormous. Furthermore, the ability of humans to keep track of all possible alternatives and to effectively compare them to one another is limited by our cognitive capacity (remember, seven plus or minus two). In the next section, we will look at a more narrowly defined and more realistic approach to rational decision making that does not suffer from these impracticalities and offers a more accurate model of what is occurring in that “black box” between our ears.

2-9: BOUNDED RATIONALITY

Once again, we must look to Nobel Prize–winning scholar Herbert A. Simon for a more practical theory of problem-solving behavior than the rational model. Simon can be credited for his “demolition” of the rational, economic man. In his early work, he questioned the concepts of maximization and optimization as they were applied to normative economic models. Simon suggested that the concept of man as a profit-optimizing entity tenable, price tags would not exist. Think about it: If man truly wanted to maximize profit, then each transaction would be a negotiation for the highest possible price. Although some buyers would obtain the product at a lower price than the last buyer, others might be willing to pay much higher prices. This practice would, over time, theoretically result in optimized profits. So why doesn’t the “economic” man do this?
It’s much too hard, that’s why! Simon argued that the cognitive limitations of humans make it impractical to consider all possible alternatives to a particular problem. And even if we could review all relevant alternatives, we would not be able to assimilate all the information so that we could make an appropriate decision. Instead, Simon suggested that we tend to “simplify reality” by focusing our energy on finding a solution that meets our preconceived notion of what an acceptable solution looks like. When we find such a solution, we immediately adopt it and stop looking for a better one. In the case of our price tag example, we decide upon an acceptable margin of profit and then we openly price our product to reflect that margin. Although this procedure may not result in optimal profits, it does satisfy our criterion of profiting from our sales, and it is much easier than negotiating each sale to a quantifiable end. Simon used the term *satisficing* to refer to this search-limiting strategy. Further, because decision makers are bounded by the cognitive limitations of all human decision makers, they actually do make rational decisions that are bounded by often uncontrollable constraints, which Simon referred to as *bounded rationality*.

**PROBLEM SPACE**

Simon’s concept of bounded rationality can best be understood by an example. Figure 2-10 contains a graphical representation of a typical problem space.

Assume that the graphic on the left represents the boundary of the identified problem at hand and all possible solutions to that problem: good ones, bad ones, great ones, OK ones, and so on. In addition, the problem space contains the “best” or optimal solution to the identified problem. The rational model of decision making suggests that the problem solver would seek out and test each of the solutions found in the problem space until all solutions were tested and compared. At that point, the best solution would be known and identifiable.
Simon argued that what really happens in a typical decision-making scenario is illustrated by the graphic on the right. The decision maker actually develops a model of what an acceptable solution to the problem looks like. Then he or she searches the problem space for a sufficient match to that preconceived solution model. When such a match is found, the search ends and the solution is implemented. Thus, the decision maker will most likely not choose the optimal solution because the narrowed search of the problem space makes it improbable that the best solution will ever be encountered. Using this approach, the decision maker settles for a satisfactory solution to the given problem rather than searching for the best possible solution.

So how does bounded rationality relate to the design and use of a DSS? To begin with, we can see that a human decision maker is not likely to expend the energy necessary to gather all relevant information available regarding a particular decision. Next, we can assume that even if all information were available, the decision maker probably could not assimilate it and thus would not use it. Finally, given the concept of bounded rationality, it appears that left alone the typical decision maker preconceives the structure of a desired solution before the search for a solution even begins. All these factors suggest the need for guidance and structure in the identification of a problem and the selection of a satisfactory alternative—thus, the need for a DSS.

A secondary issue of some importance to this discussion is the strategy used by the decision maker in exploring the problem space and selecting the final alternative. A method is needed to “measure” each alternative encountered against the preconceived model. Simon suggested that decision makers tend to develop a set of heuristics, or “rules of thumb,” to manage their search. These heuristics arise from experience, perception, opinion, intuition, bias, and training. These search rules, while intended to improve the efficiency of the search process, often reduce the decision maker’s effectiveness rather than improve it. We will explore this issue in detail in the last section of this chapter.

**PROBLEMS VERSUS SYMPTOMS**

One aspect of bounded rationality that can have a debilitating effect on the decision-making process is the typical decision maker’s confusion between a symptom and a problem. Not understanding or consciously distinguishing between the two can lead to disastrous results.

As defined previously, a problem represents the difference between a perceived condition and a desired condition. If you have a headache (the perceived condition) and you really don’t want one (the desired condition) then you believe you have a problem. So, then, what exactly is a symptom?

The notion of symptom is rooted in the concepts of cause and effect. Let’s go back to the headache example as a rather simple but effective method of understanding the differences. The headache is perceived as undesirable and therefore is classified as a problem. We determine the situation to be undesirable and wish to “solve the problem” by taking action to eliminate the headache. This action results in a trip to the doctor. Here is where the difference between symptoms and problems becomes clearer.

If the doctor chooses to classify the headache as a problem then he will prescribe some medication, let’s say aspirin, and before long the headache goes away. Everything seems okay until we sit down the next day in class and begin taking notes on the material being presented on the blackboard. Suddenly, the headache returns. We learned
about a desirable relationship between the headache and aspirin so we take some and the headache, once again, goes away. Unfortunately, the next day it comes back. So what is the problem?

The “problem” is that our bounded rationality is allowing us to become temporarily satisfied with “treating the symptom” rather than “treating the disease.” The headache is simply a manifest condition of a more deeply rooted phenomenon: We need eyeglasses! Therein lies the distinction between symptoms and problems. A symptom is evidence of a problem but not necessarily the problem itself. Think of a symptom as simply a deviation from the norm. Defined this way, a symptom does not necessarily have to be bad to be a symptom. If during the review of a periodic budget versus actual report the reviewer notices that costs for a particular item exceeded estimates, then a perception of a problem immediately manifests itself. Further review shows that sales for the product manufactured with that high-cost item are way up in a certain region. That sounds good. Would that “favorable variance” trigger the perception of a potential problem? Probably not, but it should. In both cases, the variance was a deviation from the expected norm. At the very least, these deviations should result in a more detailed review. Although they may seem unrelated or rooted in completely different areas, they may in fact be highly related and point to a deeper problem. Suppose the higher-than-expected sales in a particular region were due to an overzealous marketing manager reducing the price of the product severely below market simply to increase sales. Without a reason-able short-term strategy for increasing market share or competing with a local vendor, this price reduction is unacceptable. Moreover, this sudden increase in sales also accounts for the sudden increase in costs associated with the material necessary to make the product. If each variance were treated as a core problem then the real problem would not be solved. Moreover, depending on the method used to treat the symptoms, they may simply disappear, thus masking the problem from further investigation.

It should be clear that distinguishing between a problem and its related symptoms is critical to successful decision making. We can define a symptom as a manifest effect of an underlying cause. The real difference lies in the results associated with the symptom’s elimination. The treatment of a symptom normally results in the elimination of the symptom (effect) but does not result in the removal of the associated problem (cause). The reverse, however, is not true. If we take the time and energy to fully identify and define the root problem, we will be able to craft a solution that will result in not only the elimination of the problem but of its associated symptoms as well. We will explore how a DSS can assist in sorting through the symptoms to get to the problems in Chapter 5. For now, just remember that if we get eyeglasses, we see better and we don’t have a headache. If we simply take aspirin, we get rid of the headache for a little while, but we never will be able to see clearly.

2-10: THE PROCESS OF CHOICE

In a sense, the choice phase of the problem-solving model represents the climax of the decision-making process. Simon suggests:

The decision itself is the culmination of the process. Regardless of the problem, the alternatives, the decision aids, or the consequences to follow,
once a decision is made, things begin to happen. Decisions trigger action, movement, and change. . . . All of these images have a significant point in common. In them, the decision-maker is . . . at a moment of choice, ready to plant a foot on one or another of the routes that lead from the crossroads. All of the images falsify decision by focusing on its final moment. All of them ignore the lengthy, complex process of alerting, exploring, and analyzing that precede that final moment. (1960, p. 1)

In other words, if we expend all of our energies focusing on the choice phase as our goal, we will not do justice to the entire process and will, most likely, not make a good decision. The key is, as Simon points out, to identify the problem before trying to solve it.

The choice phase focuses principally on those decisions of the semistructured to unstructured type. Again, if a decision is highly structured, it is not much of a decision at all. Where there is true choice, there is uncertainty. The decision maker is faced with the selection of an alternative derived from a primarily judgmental decision strategy. Quantitative models can be used to compare and evaluate the alternatives and, in some cases, can reduce the level of uncertainty facing the decision maker. Nonetheless, in the end, the uncertainty is always present and the decision maker must make a choice in the face of it.

**NORMATIVE VERSUS DESCRIPTIVE CHOICE**

It is important to understand the difference between the normative and descriptive, or behavioral, approaches to decision making. In the normative approach, choice is a theory in and of itself, whereas in the behavioral approach, choice is simply a step within a process. This distinction is crucial to the successful design and use of a DSS. Theories of choice make the assumption that future consequences are predictable to a degree of certainty and that the decision maker has to make a guess concerning the future preference of one of those consequences. Theories of choice address uncertainty simply by assigning a probability distribution to each of the future consequences. What these theories do not address, however, are the activities associated with framing, developing alternatives, determining goals and objectives, and implementing the decision once it has been made. Despite this seemingly narrow focus on the process, we must have a thorough understanding of the tools developed to assist in a normative decision-making approach because the use of a computer decision aid implicitly follows a normative perspective. This statement does not suggest that a DSS cannot support a behavioral decision process, because it most certainly can. What it means is that the majority of the support within the capabilities of a modern DSS is distinctively normative in nature. Many of the other activities associated with a behavioral approach must often be supported by means other than the DSS itself. We will explore the advantages and limitations of these normative support approaches in greater detail in Chapter 4.

**MEASURABLE CONSTRAINTS**

Another aspect of the choice phase that we must consider in the design of a DSS is that choice challenges the decision maker with a number of measurable constraints. Table 2-5 lists a number of characteristics generally associated with models of choice.
TABLE 2-5  Common Characteristics of Models of Choice

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfamiliarity</td>
<td>Degree to which decision task is foreign to decision maker</td>
</tr>
<tr>
<td>Ambiguity</td>
<td>Degree to which decision task is unclear to decision maker</td>
</tr>
<tr>
<td>Complexity</td>
<td>Number of different components to decision task</td>
</tr>
<tr>
<td>Instability</td>
<td>Degree to which decision components change during or after choice</td>
</tr>
<tr>
<td>Reversibility</td>
<td>Degree to which choice can be reversed if outcome appears undesirable</td>
</tr>
<tr>
<td>Significance</td>
<td>Importance of choice to both decision maker and the organization</td>
</tr>
<tr>
<td>Accountability</td>
<td>Degree to which decision maker is culpable for choice outcome</td>
</tr>
<tr>
<td>Time/Money</td>
<td>Constraints on decision process and solution set</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Amount of relevant knowledge possessed by decision maker</td>
</tr>
<tr>
<td>Ability</td>
<td>Degree of intelligence and competence of decision maker</td>
</tr>
<tr>
<td>Motivation</td>
<td>Desire of decision maker to make a successful decision</td>
</tr>
</tbody>
</table>

Source: Adapted from Beach and Mitchell (1978).

Obstacles such as cognitive limitations, incomplete or inaccurate information, time limitations, and cost restrictions all place boundaries on the possible solution set during the choice phase. In addition, the decision maker is further constrained by his or her own psychological makeup. Stress, perceived commitment to a course of action, fear of failure or reprisal, and personal biases further intensify the constraints of the choice process. “There can be little doubt that human frailty pervades the act of choice and renders the entire decision-making process amenable to scrutiny and question at virtually every point” (Harrison, 1995, p. 58).

2-11: COGNITIVE PROCESSES

We touched on many cognitive processes so far but need to focus a bit more on several of them. Remember, one of the primary reasons a decision maker needs a DSS in the first place is because the cognitive processes of human decision makers are limited in many ways. The successful design and implementation of a DSS depends to a great extent on our complete understanding of the cognitive processes in place during decision-making activities.

COGNITIVE LIMITATIONS

Table 2-6 contains a list—based on research—of many of the psychological factors that contribute to the cognitive limits of the human decision maker.

As the list indicates, the decision maker faces a formidable task if he or she is to overcome, or at least compensate for, these cognitive limitations. It appears that the typical decision maker uses many techniques that do not fall within the normative concept of choosing an ideal alternative. Probably the most important technique associated with attempting to overcome cognitive complexity is the natural tendency toward simplification.

Any constraint on an activity, no matter what the context, serves to increase the complexity of the activity and can normally be expected to increase the effort necessary to complete it successfully. Cutting a large tree down in the middle of a forest or a
TABLE 2-6 Factors Contributing to Cognitive Limitations

- Humans can retain only a few bits of information in short-term memory.
- Decision makers display different types and degrees of intelligence.
- Decision makers that embrace closed belief systems tend to inordinately restrict information search.
- Decision makers that employ a concrete thinking approach tend to be limited information processors.
- Propensity for risk varies among decision makers. Risk takers require less information than risk avoiders.
- Decision maker’s level of aspiration is positively correlated with desire for information.
- In general, older decision makers appear to be more limited than younger ones.


pasture is significantly easier than cutting the same tree down next to a house. The very existence of the house constrains how one might go about cutting down the tree. If knowledge and analysis prevail, then the tree will come down only if a feasible method of preventing any damage to the house is found. Otherwise, the tree stays put. In most cases, a method can be designed to reach the objective within the confines of the situation, but that method may radically depart from the normal, and probably easier, method. If knowledge and analysis do not prevail, however, the tree may still come down, but the chances of damage to the house are great. In this case, the decision maker may attempt to relieve some of the cognitive pressure associated with the problem by simplifying the situation. In essence, he or she may simply “wish” the house away.

The previous example is not as far-fetched as it may seem. Cognitive limitations can often cause a decision maker to simplify a decision context to a more manageable level of complexity. One method for reducing complexity is to create a simplified model of reality. Once this model of reality is constructed, the decision maker can focus attention on solving the problem represented by the model rather than the one represented by reality. If the simplified model accurately represents the salient characteristics of the problem then this strategy should result in an acceptable decision. If, however, as is often the case, the construction of this simplified model of reality omits several subtle, yet salient, factors, then the probability of a successful outcome markedly decreases. At this point, one might wonder how any rational person could ignore a house that stands in the way of a falling tree. In Section 2-12, we will see exactly how this seemingly irrational behavior occurs. For the moment, believe that it can, and does, happen.

PERCEPTION

Perception is a special kind of cognitive limitation. Decision makers tend to act upon what they can “see.” This form of “selective discrimination” applied to the structure of a particular decision context may effectively limit the decision-making process. It is, however, through perception that the degree of constraint or limitation imposed by an internal or external force gains its significance.

Perception is key to the decision-making process because it is the “filter” through which all facts must pass. Once the facts pass through the perception filter, they emerge as much more aligned with the decision maker’s version of reality. In other words, reality is what one perceives it to be. This filtering of facts can result in a decision that is
based on the perceived reality of a problem context rather than its true structure. Depending upon the degree to which the decision maker “filters” reality, the perception of a given problem-solving context may be significantly distorted. When a distortion happens, successful decision outcomes become questionable.

Several factors make up a decision maker’s perceptual filter. The most common factor is simply the uniqueness of the decision maker him- or herself. Perception is the cumulative result of experience, personal frame of reference, goals, values, beliefs, motivations, and instinctive biases. In addition, a person’s cognitive limitations often extend to his or her inability to accurately perceive a situation at all. These perceptual blocks may even filter out the facts. Table 2-7 lists several perceptual blocks.

One of the most common perceptual blocks is the inability of the decision maker to isolate the problem at hand. Often the complexity of the symptoms makes it difficult to identify the underlying problem. Without a structured approach to the collection and organization of symptoms, the problem may go undetected. If we cannot isolate the problem, we cannot solve it.

Bounded rationality is another form of perceptual block. In attempting to make the problem conform to a preconceived notion of reality, decision makers can blind themselves to potential solutions to the problem that deviate from the expected solution. This perceptual block is often referred to as “thinking inside the box.” Adams’s (1979) classic nine-dot puzzle serves as an excellent vehicle for demonstrating this concept. Figure 2-11 shows the initial layout of the puzzle.

### Table 2-7 Common Perceptual Blocks

<table>
<thead>
<tr>
<th>Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty in isolating the problem</td>
</tr>
<tr>
<td>Delimiting the problem space too closely</td>
</tr>
<tr>
<td>Inability to see the problem from various perspectives</td>
</tr>
<tr>
<td>Stereotyping</td>
</tr>
<tr>
<td>Cognitive saturation or overload</td>
</tr>
</tbody>
</table>

*Source: Clemen (1991).*
The problem is to find a solution in which, without lifting your pencil from the page, you draw no more than four straight lines that connect all nine dots. At the end of this chapter you will find the “standard” solution to this problem as well as a number of extremely creative solutions collected by Adams over the years.

So what does this puzzle have to do with perceptual blocks and DSS design? Decision makers often impose constraints or rules on a problem that do not exist in reality. In doing so, they create artificial boundaries on the solution set that limit the range of potential solutions. As you can see by the common solution offered to this problem, one must be sure not to create tacit or unspoken constraints if the problem is to be solved effectively. DSS design must acknowledge the common tendency of the user to impose artificial constraints and must be designed so that real constraints are recognized and artificial or self-imposed constraints are questioned. Chapter 14 will focus more on this topic.

Yet another perceptual block is the practice of stereotyping. We all do it to some degree, and it acts as a barrier to seeing the true facts of any situation. Suppose, for instance, that you are a passenger in the first-class cabin of a commercial aircraft. You are sitting quietly reading a magazine, enjoying a beverage, and occasionally gazing out the window at the serenity of the clouds and sky above and below you. You haven’t a care in the world and you feel quite safe knowing the pilot is a professional and highly trained individual. In fact, you recall being impressed with how smooth the takeoff and climb to cruising altitude were compared to other flights you have taken.

Suddenly, you look up and notice the cabin attendant speaking with a man chewing on a toothpick dressed in blue jeans and a tee shirt. His hair is shoulder length and he is wearing two hoop earrings on one earlobe. The attendant appears to be focused on his every word and smiles respectfully as he opens the door to the flight deck and disappears. Your curiosity takes over. You immediately motion to the flight attendant and inquire as to the man’s identity. “Why that’s Captain Conway,” replies the flight attendant. “He is one of our most experienced pilots. It’s always a delight to be assigned to his crew,” he continues. Just what are you thinking and feeling at that moment?

The true facts of the situation are that Captain Conway is an experienced pilot and his demonstration of that ability up to that moment was truly exemplary. So what is the problem? The problem is that the persona of Captain Conway is not what you expected it to be and, because of this single incident you begin to question all of the facts associated with the pilot. Granted, a commercial airline pilot is expected to be in uniform and well groomed, but the fact that he isn’t doesn’t change the reality of the situation; you are under the care of a highly skilled, professional aviator. Stereotyping is simply a self-imposed perceptual barrier to reality.

**JUDGMENT**

Although numerous strategies exist with regard to the comparison and evaluation of solution alternatives, judgment often appears to be the most favorable. Using judgment, the decision maker makes a choice based upon experience, values, perception, and intuition. One reason judgment is often preferred is that, when compared to detailed analysis, judgment is much faster, more convenient, and less stressful. When properly applied in harmony with other selection strategies, judgment is a meaningful and useful tool in the choice process and can contribute significantly to decision quality. When applied in isolation, however, judgment is nothing more than a guess.
One of the primary reasons judgment cannot be used exclusively in the choice process is that it relies heavily on the decision maker’s recollection and recognition of events. If the situation allows for accurate recall of experiences and a factual identification of the current set of events with those experienced in the past, then judgment will be effective in determining the appropriate choice. If, as is more often the case, recollection is “blurred” by cognitive limitations, then judgment becomes flawed and other analytic strategies must be employed to confirm or deny the decision maker’s judgment. Table 2-8 lists several ways that cognitive limitations can affect judgment.

In the next section, we will explore various biases and heuristics that are often inherent in a decision maker’s strategies and that can contribute to “errors” in perception or judgment.

### 2-12: BIASES AND HEURISTICS INDECISION MAKING

**HEURISTIC SEARCH AND THE “RULE OF THUMB” APPROACH**

No matter what the situation, no matter who we are, no matter how well trained we become in decision making and problem solving, we have certain “rules of thumb” that we rely on in making decisions. “It never rains here on the Fourth of July,” or “Only buy stocks with a price/earnings ratio of less than 9,” or “Professors never cover anything important on the first day of class” are all examples of rules of thumb that we use when making decisions. Another term for such “rules” is heuristics. The word heuristic comes from the Greek word for “discovery.” This derivation is appropriate because heuristics are often developed through trial-and-error experience that, over time, is subjected to a wide variety of analysis and experimentation. If a heuristic is well tested and thought out it can serve as a reliable tool for reducing the search process to more manageable levels. This approach is referred to as heuristic search or heuristic programming. This type of search process tends to follow a series of steps based on the “rules” known to the decision maker until a satisfactory solution is found. Such searches are often less costly and more efficient than a completely blind search where all alternatives are tested in the order of discovery. Moreover, several researchers, such as Zanakis and Evans (1981), showed that heuristic searches can provide solutions very close to those produced by a comprehensive blind search. Table 2-9 lists the major advantages associated with the use of heuristics as well as situations where the use of heuristics may be more appropriate than an optimization strategy.

<table>
<thead>
<tr>
<th>TABLE 2-8 Ways in Which Cognitive Limitations Can Affect Judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Judgment is more dependent on preconceptions and bias than relevant new information.</td>
</tr>
<tr>
<td>• Intuitive judgments are often misleading.</td>
</tr>
<tr>
<td>• Availability is an intuitive judgment about the frequency of events or proportion of objects (see Section 2-12).</td>
</tr>
<tr>
<td>• Representation attempts to classify concepts and is often illusory.</td>
</tr>
<tr>
<td>• Judgmental fixation describes the anchoring of an individual regarding consequences.</td>
</tr>
</tbody>
</table>

A common problem used to demonstrate combinatorial complexity also serves as an excellent example of a heuristic solution strategy: the problem of the traveling salesperson.

The nature of the problem is rather simple. A traveling salesperson must visit customers in several cities across the country. Because of policies relating to efficiency and cost restriction for travel, the salesperson can only visit each city once during the trip and must visit all the cities along the route before returning to home base. Because the salesperson’s costs are primarily associated with the total distance traveled, the solution should be one where the policies of the company are followed and the route taken is the shortest possible route. Sounds simple enough, doesn’t it?

Figure 2-12 depicts the cities in which the salesperson visits customers and the distances between each city.

The complexity of the problem increases as the number of cities increases. If we assume a route to go only in a single direction (because of the rule of not visiting the same city twice) then the total number of unique routes can be determined by the following formula:

\[
\text{number of unique routes} = 0.5 \times (\text{number of cities} - 1)
\]

If the number of cities is 9, as shown in the figure, then the total number of routes is 20,160. If we increase the number of cities by 1 for a total of 10 cities, the number of routes jumps to 181,440. Adding only one additional city raises the total to more than 1.8 million, and with 12 cities the number jumps to just under 20 million possible routes. Even with a computer the solution to this problem becomes time consuming and difficult. One method of finding the solution is a quantitatively based method known as branch and bound. This method, although effective, is not necessarily effi-
efficient for combinations of any significant magnitude. This problem can be satisfactorily solved by following a heuristic. One heuristic might be the following: “Starting from your home base, go to the closest city. Continue going to the closest city until the last city is visited. Then return to your home base.” Figure 2-13 shows the solution derived from following this heuristic.

As you can see, the solution seems to be relatively reasonable and acceptable although we do seem to “pass by” cities we have already visited (see the routes from Miami to Chicago or Salt Lake City to New York City, for instance). What if we modify our heuristic to the following: “Always follow an exterior route so that a connection between two cities is never crossed and no backtracking is performed.” Figure 2-14 shows the derived solution based on this modification.

With a single modification we improved upon our first solution by 575 miles. More importantly, we didn’t have to test all 20,160 solutions to find an acceptable one. This scenario is but one example of how, when employed properly, heuristics offer a valuable problem-solving tool.
HEURISTIC BIAS

In some situations, however, the use of heuristics can be detrimental to finding an effective solution. Geoffrion and Van Roy (1979) explain:

Common sense approaches and heuristics can fail because they are often arbitrary. They are arbitrary in the choice of a starting point, in the sequence in which assignments or other decision choices are made, in the resolution of ties, in the choice of criteria for specifying the procedure, in the level of effort expended to demonstrate that the final solution is in fact best or nearly so.
The result is erratic and unpredictable behavior—good performance in some specific applications and bad in others. (p. 117)

The typical decision maker develops a set of simplified models of reality in the form of decision heuristics and then relies upon that set of rules to make the decisions at hand. If the rules are arbitrarily developed, as suggested by Geoffrion and Van Roy, then less than stellar solutions will result.

In the early 1970s, Tversky and Kahneman published a series of papers focusing on the various biases they observed with regard to the use of arbitrarily developed heuristics. Their results show that decision makers tend to rely on a limited set of heuristic principles that often lead to severe and systematic errors in their thinking. Table 2-10 contains a description of common biases demonstrated by individual decision makers.

Of the extensive list of biases and heuristics developed by Tversky and Kahneman four of the most common categories are (1) availability, (2) adjustment and anchoring, (3) representativeness, and (4) motivational. Each of these categories is relevant to the design and use of an effective DSS.

**Availability**
The availability bias is the result of the typical individual’s inability to accurately assess the probability of a particular event occurring. Individuals tend to assess an event’s probability based upon past experience, which may not be representative. In other words, we tend to judge the probability of an event occurring according to the ease with which we can recall the last time it occurred. Before Hurricane Andrew hit in August of 1992 (see Figure 2-15), most individuals (including myself), and even most insurance companies, grossly underestimated the probability of total devastation of the magnitude that Andrew produced. I would have estimated that the probability of losing everything I owned was very small—and it very well might have been. Despite my low probability estimate I insured my house and belongings to their fullest value. The day after Andrew struck I realized that the chances of losing everything had suddenly risen to 100 percent! The insurance companies suddenly realized it too, much to their dismay. The point is that all of the estimates were based upon the recollection of the last time a storm of that magnitude occurred. In my case, it was never. Even in the case of most native Floridians it was never. Nonetheless, it did happen and only a few were well prepared.

**TABLE 2-10** Common Biases of Individual Decision Makers

<table>
<thead>
<tr>
<th>Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>They tend to overestimate low probabilities and underestimate high probabilities.</td>
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<tr>
<td>They appear to be insensitive to the true sample size of their observations.</td>
</tr>
<tr>
<td>They adjust their first estimate incrementally based on additional evidence.</td>
</tr>
<tr>
<td>They tend toward overconfidence in their ability to estimate probabilities.</td>
</tr>
<tr>
<td>They tend to overestimate the ability of others to estimate probabilities.</td>
</tr>
<tr>
<td>They tend to compare pairs of alternatives rather than a whole list.</td>
</tr>
<tr>
<td>They tend to minimize reliance on explicit trade-offs or other numerical computations.</td>
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<tr>
<td>They often exhibit choices that are inconsistent.</td>
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<tr>
<td>They tend toward viewing mutually exclusive events.</td>
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</table>

*Source: Adapted from Harrison (1995).*
This same bias resulted in the general decline in security at U.S. airports, which materially contributed to the tragic events of September 11, 2001. What were the odds of four commercial aircraft being simultaneously hijacked with two from the same airport? Obviously not zero, and someone figured it out.

A subset of the availability bias is the bias of illusory correlation. In this case, an individual decision maker inappropriately assumes that because two events appear to have
CHAPTER 2  ♦  Decisions and Decision Makers  ♦  75

occurred frequently in relation to each other, then they must be strongly correlated. During late 1996 and early 1997 a large number of black churches were the sites of apparent arson. It seemed obvious that these fires were all related, yet after a thorough investigation no evidence of relationship could be established. Several individuals were apprehended and found guilty of the crime of arson, yet no relationship among them could be demonstrated. In fact, several of the fires were later determined not to be the result of arson at all. In other words, the evidence suggested that the fires were not correlated, at least not in the sense that they were set by the same person or group of people. Illusory correlation can serve to bias a search process for an appropriate solution.

A structured review and analysis of objective data can reduce the effects of the availability bias. In the absence of such data, a decision maker can at least attempt to honestly assess the potential bias in his or her recollections and then adjust the estimate up or down accordingly. In any event, support for a decision process must include provisions for the identification and control of availability and illusory correlation wherever reasonable.

Adjustment and Anchoring
People often make estimates by choosing an initial starting value and then adjusting this starting point up or down until they arrive at a final estimate. Unfortunately, people have a tendency to underestimate the need for adjustments and to remain biased, or anchored, to their original starting estimate. For example, an individual might estimate the number of people in attendance at an event to be 22,000. This starting value may be based upon observation or logic such as knowing how many seats exist at the location and then estimating the percentage of empty seats. Or it may be based on a number that appeared to the decision maker to be representative of the number of people in attendance. In either case, any change in the estimate will be made in the form of an increase or decrease from that initial starting point of 22,000, and will tend to be biased toward it. Because of this tendency to underadjust, most subjectively derived probability distributions are too narrow and fail to estimate the true variance of the event.

One method a DSS might employ to minimize error from this bias is to require the user to assess the intervals associated with more than one point. Instead of assessing the variability from a single point, say the mean, a DSS asks the user to assess an interval from the 0.05 fractile to the 0.95 fractile. Implicit in this single estimate is the fact that the true value may lie outside the ends of the interval. Then the DSS asks the user to estimate the quartiles (0.25 to 0.75). The combination of these estimates is then used to determine a midpoint of final estimate. Accuracy can be improved in this manner by assisting the user to avoid anchoring on a central value where possible.

Representativeness
A third common heuristic bias, representativeness, is quite similar to the bias of illusory correlation. Decision makers often attempt to ascertain the probability that a person or object belongs to a particular group or class by the degree to which characteristics of the person or object conform to a stereotypical perception of members of that group or class. The closer the similarity between the two, the higher is the estimated
probability of association. Tversky and Kahneman offer a simple problem as evidence of the effect of representativeness. Consider the following:

Tom W. is of high intelligence, although lacking in true creativity. He has a need for order and clarity, and for neat and tidy systems in which every detail finds its appropriate place. His writing is rather dull and mechanical, occasionally enlivened by somewhat corny puns and by flashes of imagination of the sci-fi type. He has a strong drive for competence. He seems to have little feeling and little sympathy for other people and does not enjoy interacting with others. Self-centered, he nonetheless has a deep moral sense.

The preceding personality sketch of Tom W. was written during his senior year in high school by a psychologist on the basis of projective tests. Tom W. is now a graduate student. Please rank order the following nine fields of graduate specialization by the likelihood that Tom W. is now a graduate student in each of these fields (adapted from Tversky and Kahneman, 1973):

1. Business Administration  
2. Computer Science  
3. Engineering  
4. Humanities and Education  
5. Law  
6. Library Science  
7. Medicine  
8. Physical and Life Sciences  
9. Social Science

The usual classification for Tom W. is based on the subjective assessment that he is a “nerd.” As such, most people tend to classify him either in computer science or engineering. If, however, we use a different method of determination, say the base rates of graduate students in a particular discipline, we might come to a completely different conclusion. The fact is, despite the popularity of the two fields mentioned, many more graduate students can be found in humanities and education or social science programs than in either computer science or engineering. Simply stated, the probability of Tom W. being in either field 4 or 9 is greater than for fields 2 or 3. Failing to consider base rates in favor of representativeness can negatively affect a decision outcome.

Another form of this bias is commonly referred to as gambler’s fallacy or insensitivity to sample size. In this case, individuals draw conclusions of probability from highly representative small samples despite their extreme sensitivity to statistical error. Take the case of the man standing next to the roulette wheel at a casino. You approach the table and the man turns to you and whispers, “Put everything on black!” You ask why you should, and the man replies, “Listen friend, I have been standing here for the last half hour and red has come up fifteen times in a row. C’mon man, black is due!”

His mistake is twofold. First, your friend failed to realize that the spin of a roulette wheel (assuming it is fair) is an event independent from either the previous or subsequent spins; the number of times red comes up in a row has nothing to do with the probability of either red or black occurring again. Second, he based a probability esti-
mate on a small sample size. We know from the laws of probability that if the roulette wheel is spun a large number of times the true probabilities of each occurrence will be manifest. Small samples can be highly biased above or below their true mean.

Yet another form of representativeness bias is failure to recognize regression to the mean. Tversky and Kahneman related an anecdote to illustrate this bias. A flight instructor always made it a point to praise a student for a good landing and to reprimand a student for a poor landing. The instructor began to notice that when a student was praised, the next landing was not as good. When, however, a student was reprimanded the next landing was much improved. The instructor concluded that a reprimand was an effective form of feedback whereas a compliment was not.

The instructor’s conclusion was clearly in error. When a phenomenon is random, then extreme examples tend to be followed by less extreme ones, because the true mean lies somewhere between the two examples. The laws of probability suggest that given enough trials the true mean will be realized. So an extremely good landing will probably be followed by one that is not so good and an extremely bad landing (not too bad, we hope) will tend to be followed by a better one.

Motivational

So far, the biases discussed are related to each other by their cognitive roots and based on the way an individual processes information received during the course of problem solving. A person, however, may be subject to a noncognitive bias that can dramatically affect solution outcomes. Incentives, either real or perceived, often lead the decision maker to estimate probabilities that do not accurately reflect his or her true beliefs. These incentives are referred to as motivational biases. The estimates derived under the conditions of a motivational bias often reflect the personal interests of the decision maker who is providing them. Such estimates can also come from an information provider who is thought to be an expert in a particular field. In that case, the decision maker must be aware of the potential for motivational bias and must decide how much credence to give the expert’s estimates.

Motivational biases can manifest themselves in a number of scenarios. For example, a salesperson may be required to provide a monthly sales forecast indicating expected sales productivity. A motivational bias may cause the salesperson’s estimate to be lower than reality so that exceeding a forecast helps the salesperson’s performance look exceptionally good. In another example, evidence suggests that weather forecasters tend to report chances of rain slightly higher than the true probability. This bias apparently exists primarily at the subconscious level. It is thought that weather forecasters subconsciously prepare people for bad weather and have them be pleasantly surprised by the sunshine rather than have them expect good weather and be disappointed.

This type of bias may be the most difficult to address through the design of a DSS. One possible method would be to have the DSS solicit a number of estimates from similar sources both related to and unrelated to the problem context. Given enough information, the user may be able to detect motivational bias in a trend associated with estimates obtained from related parties that does not exist from unrelated sources. Although this approach is not foolproof, it may heighten the awareness of the decision maker to the potential of motivational biases.
In Chapter 1, we learned that a major goal of a DSS is to improve the effectiveness of decision outcomes. It is probably the most important claim in the entire body of DSS literature. A close second is the desire to improve the efficiency of the decision-making process for a given context. These two concepts, although complementary in nature, are nonetheless distinct and often are in conflict with each other in the design and implementation of a DSS. Distinguishing between the two concepts is necessary to fully understand their impact on the usefulness of a DSS.

Effectiveness in decision making is focused on what should be done, whereas efficiency is focused on how we should do it. To be effective requires careful consideration of the various criteria influencing the decision at hand. If we are to design a DSS that can assist in increasing the decision maker’s effectiveness, we must uncover his or her perception of the decision context. In contrast, improving efficiency implies focusing only on issues that will minimize completion time, cost, or effort. Often a tension exists between the two goals because an increased focus on one can result in a reduction of the other. Keen and Scott Morton provide a good example of the distinction between effectiveness and efficiency:

A company’s computer center . . . proudly boasts of its efficiency: it generates more output—management reports—than almost any other center in the country. The computer downtime is low and the machine is fully utilized, with minimal idle time. Inputs are quickly processed and outputs are delivered promptly. Unfortunately, the reports produced are not seen as useful by their recipients. Managers instruct their secretaries either to file the hundred-page summary of last month’s operations unread or to throw it in the wastebasket. The center is efficient in its pursuit of an ineffective goal. (Keen and Scott Morton, 1978, p. 7)

Table 2-11 lists some outcomes from the use of a DSS categorized by their contribution to efficiency and effectiveness.

The primary difference between the two goals is that effectiveness requires constant adaptation, learning, and rethinking, often at the risk of slow progress and many false starts, whereas efficiency simply focuses on more economical ways of doing the same thing. A good example of the tension between the two can often be seen in the research

<table>
<thead>
<tr>
<th>TABLE 2-11 Contributions to Effectiveness and Efficiency from DSS Use</th>
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<tbody>
<tr>
<td><strong>Effectiveness</strong></td>
</tr>
<tr>
<td>• Easier access to relevant information</td>
</tr>
<tr>
<td>• Faster and more efficient problem recognition and identification</td>
</tr>
<tr>
<td>• Easier access to computing tools and proven models to compute choice criteria</td>
</tr>
<tr>
<td>• Greater ability to generate and evaluate large choice sets</td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
</tr>
<tr>
<td>• Reduction in decision costs</td>
</tr>
<tr>
<td>• Reduction in decision time for same level of detail in the analysis</td>
</tr>
<tr>
<td>• Better quality in feedback supplied to the decision maker</td>
</tr>
</tbody>
</table>
and development (R&D) function in an organization. R&D can be argued to be a grossly inefficient expenditure of resources for the purpose of providing future effectiveness. R&D could be eliminated because it is not needed to perform any current operational tasks, and its elimination would have a significantly favorable impact on the current year's profits. If the scale is tipped in favor of efficiency then this argument is virtually irrefutable. If, however, effectiveness is the goal, then the elimination of R&D could be the death of the organization. In the interest of effectiveness, efficiency must often be sacrificed. It becomes a significant task for the DSS designer to create the appropriate balance between these two, often conflicting, goals. Heuristically speaking, the more unstable the environment, the more the focus is on effectiveness. If the environment is stable, then a company can focus its attention on performing next year's operation more efficiently than it did this year's. In the years to come managers' focus will more likely favor effectiveness over efficiency. And the DSS will become a primary tool in support of that focus.

2-14: CHAPTER SUMMARY

This chapter demonstrated that even though all people may be created equal, all decision makers are not. Decision makers come in many different forms. Some are individuals, others come in groups, yet others are part of teams or organizations. Each type faces unique problem contexts, and each requires unique sources and kinds of support to reach a particular decision. The unique characteristics associated with different types of decision makers combined with the unique nature of the problem contexts faced by each type reinforce the reasoning behind the statement that a generic DSS does not, and probably never will, exist. In the next chapter we begin to examine the process of making a decision and various models of decision making in use.

We also discussed the processes involved in making a decision. The difficulty in programming a decision bears a relationship to its structure. Easy (structured) decisions involve repetitive and routine procedures. On the other hand, a decision is difficult, or unstructured, when cognitive limitations and relative uncertainty cloud the decision-making process. When random factors affect an outcome in ways that cannot be determined, the accuracy of the pending decision is equally uncertain.

Decisions can be classified by type: activity-based, negotiation-based, or strategy-based. Activity-based decisions focus attention on the activity with which the decision is most associated. Negotiation-based decisions are classified into three types based on the notion of negotiation. Finally, strategy-based decisions are differentiated based on the primary strategy used in making the final choice.

The process of making a decision is complex and often unclear to even the most proficient decision makers. Being aware of the natural barriers to effective decision making can help to improve both the process and its associated outcomes.

**Key Concepts**

- Profile of a decision (2-1)
  - Stimulus
  - The decision maker
  - Problem definition
CHAPTER 2 • Decisions and Decision Makers

Alternative selection
Implementation

• Classes of decision makers (2-1)
  Individual
  Multiple
  Group
  Team
  Organizational
  Metaorganizational

• Factors intertwine in the formation of decision styles (2-2)
  Problem context
  Perception
  Personal values

• Decision styles (2-2)
  Directive
  Analytical
  Conceptual
  Behavioral
  Context/decision style interaction

• Definition of a good decision (2-3)
  A good decision results in the attainment of the objective or objectives that gave rise to the need for a decision within the boundaries and constraints imposed by the problem’s context.

• Decision forces (2-3)
  Personal and emotional
  Economic/environmental
  Organizational
  Contextual and emergent

• Difficulties of decision making (2-5)
  The difficulties associated with making a decision lie in a variety of structural, psychological, physical, and environmental areas:
  Problem structure
  Cognitive limitations
  Uncertainty of decision outcomes
  Alternatives and multiple objectives

• A typology of decisions (2-6)
  By gaining a better understanding of the classification of the decisions in a given context, we can better determine what specific features of a DSS would be useful in support.
  Negotiation-based decisions:
  Routine decisions
  Creative decisions
  Negotiated decisions
Activity-based decisions:
Entrepreneurial activities
Adaptive activities
Planning activities

Strategy-based decisions:
Computational strategies
Judgmental strategies
Compromise strategies
Inspirational strategies

Metaclassification:
Decisions of a routine, recurring nature with high certainty
Decisions of a nonroutine, nonrecurring nature with high uncertainty

• The design and implementation of a DSS is rooted in the development of a workable and sound descriptive theory. \( (2-7) \)

Simon’s problem-solving model \( (2-7) \)
Intelligence
Problem perception and definition process
Design
Alternatives formation and analysis
Problem strategy selection and analysis
Choice
Alternatives selection process

• Optimization is considered a rational decision-making behavior in which the decision maker will choose the alternative that is clearly the best in providing overall value and outcome. \( (2-8) \)

• Satisficing strategy \( (2-9) \)
Decision makers tend to find the first acceptable solution that meets their preconceived notion instead of looking for the optimal one.

• Bounded rationality \( (2-9) \)
Bounded by their cognitive limitations, decision makers make rational decisions subject to uncontrollable constraints.

The confusion between a symptom and a problem, one issue of bounded rationality, can have a debilitating effect on the decision-making process. The difference between a problem and its related symptoms lies in the results associated with its elimination. \( (2-9) \)
The treatment of a symptom results in the elimination of the symptom but does not result in the removal of the problem.
The elimination of the root problem results in not only the removal of the problem but the removal of its associated symptoms as well.

• One of the primary reasons for a DSS is the many limitations of the cognitive processes of human decision makers. \( (2-11) \)
Perception is the cumulative result of experience, personal frame of reference, goals, values, beliefs, motivations, and instinctive biases. Common perceptual blocks include difficulty in isolating the problem, bounded rationality, and stereotyping.
CHAPTER 2 ♦ Decisions and Decision Makers

Using judgment, decision makers make a choice selection based upon experience, values, perception, and intuition. When judgment is applied in isolation, it is nothing more than a guess with often little basis in reality.

- Decision makers tend to rely on a limited set of heuristic principles when making decisions. Biases will be introduced if these rules of commonsense approaches and heuristics are arbitrarily developed. Four of the most common heuristic biases are availability, adjustment and anchoring, representativeness, and motivational. (2-12)

- It is a significant task for DSS designers to create a balance between the two, often conflicting, goals of a DSS. (2-12)

Effectiveness

With constant adaptation, learning, and rethinking, decision makers focus on the improvement of decision outcome.

Efficiency

By using more economical ways, decision makers focus on the improvement of the decision-making process for a given context.

Questions for Review

1. List the major components of the decision-making process.
2. Define stimulus and describe its place in the decision-making process.
3. Depict the dual roles of a decision maker in the decision-making process.
4. In which portion of the decision-making process is a DSS most helpful for decision makers? Why?
5. List and briefly describe the classes of decision makers.
6. Define individual decision makers and describe the various traits that affect the way they make decisions.
7. Specify the unique differences between decisions made in a group environment and a team environment.
8. Identify the characteristics of decision makers at the organizational level. What is the special type of DSS developed for them?
9. Describe the three forces that affect a particular individual's decision style.
10. Briefly describe the classifications of decision styles based on the nature of problem context, cognitive complexity, and value orientation.
11. Why is the understanding of decision makers' decision styles important to the design and implementation of a DSS?
12. What makes a good decision a good decision?
13. List and briefly describe the forces that can act on a problem context and on a decision maker during the course of making a decision.
14. How do personal and emotional forces act upon the decision process?
15. How do organizational forces and constraints influence the decision process?
16. What is the role of a DSS in relation to a decision maker?
17. State the difficulties of decision making from the perspective of problem structure.
18. Why is the understanding of a decision typology so important to the design of a DSS?
19. Describe the activity-based typology of decisions. Give an example of each class.
20. Briefly describe the components of Simon’s problem-solving model.
21. Is it possible to make an optimal decision? Why or why not?
22. What is satisficing?
23. Why is the concept of bounded rationality important to the decision process?
24. What is the difference between a problem and a symptom?
25. What is the impact of confusing a problem and a symptom during the decision-making process?
26. What are the dangers associated with simplifying a decision context?
27. Describe the effect of a decision maker’s perception on the decision-making process.
28. What is the effect of a decision maker’s judgment on decision making?
29. What are the benefits of using a heuristic search (heuristic programming) approach?
30. Define heuristic bias.
31. List and briefly describe the four most common heuristic biases.
32. Compare and contrast the concepts of effectiveness and efficiency.

For Further Discussion

1. In the decision-making process, which element do you think is most important? Please state your reasons.
2. Discuss the nature of multiple and group decision makers. Give an example for each of them. What are the differences between them?
3. Observe a decision maker in an organization that you are familiar with. Based on the nature of the problem context, and personal perception and values of the decision maker, specify his or her decision style(s).
4. We all understand that designing the system to complement the user’s decision style can provide additional support to the decision process and failing to do so can inhibit the success of the process. Find a case that can support this point.
5. Analyze a good decision made by an organization. Discuss the reasons why you think it was a good decision. How did the decision maker(s) make it?
6. You are about to buy a car. Using Simon’s problem-solving model, list your activities in each phase.
7. Assume that you are going to make a decision about the price of a new product. Use the typologies described in this chapter to classify this decision. State any assumptions needed.
8. Give an example of the concept of bounded rationality from your own experience.
9. Analyze a problem you encountered recently. List the symptoms and classify the cause(s) of these symptoms. What exactly was the problem?
10. Analyze the cognitive limitations you experience during your decision making. Can a DSS help? If yes, how can it help?
11. Make a list of heuristics that are used regularly by someone in your family, school, or company.
12. Analyze a bad decision made by an organization. Discuss the reasons why it failed. Was the failure related to the cognitive limitations or heuristic biases of the decision maker?
Answers to the Nine-Dot Problem

The common solution to the puzzle is shown in the figure on the left. The figure on the right shows an alternate three-line solution. Other solutions that have been collected by Adams include the following:

- Fold the paper so that the dots line up in a row. Then a single straight line can be drawn through the dots.
- Roll up the paper and tape the ends together so that a spiral can be drawn through all the dots.
- Cut the paper into strips and tape them together so that the dots are in a single row.
- Draw very small dots close together in a square pattern and then draw a single fat line through all of them at once. (This solution was provided by a 10-year-old girl.)