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Domain-Independent Decision Aids for Managerial Decision Making

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ABSTRACT

An examination of the literature on managerial decision making provides insights for improving the design of Decision Support Systems. Frequently, these systems are designed using one dominant decision making model; some ignore them altogether. This paper incorporates conflicting decision making constructs into an overall framework for designing Decision Support System and discusses the evolution of Decision Support Systems within this framework. This framework is then used to examine advances in decision support research.

Perceived usefulness and applicability of decision support tools demonstrate the trend toward domain-independent General Decision Support Systems. Domain-independent systems are those which can be adapted to many different problem areas, usually by the addition or deletion of pertinent data and models. We conclude with an evaluation of the advances that artificial intelligence techniques can bring to decision support system research.

The major purpose of this paper is to identify aspects of managerial decision support where techniques of artificial intelligence may provide useful contributions. In addition, a framework is developed for positioning and evaluating current research efforts on AI-based Decision Support Systems (DSS) vis-a-vis other approaches identified in the literature. The paper is organized as follows: The first section presents a brief review of the organizational and individual decision making literature relevant to the design and evaluation of DSS. The next section outlines the evolution of DSS design philosophy over the last two decades with a view toward identifying major contributions made to managerial decision making. Finally, the third section examines recent advances made in AI-based DSS.

MANAGERIAL DECISION MAKING A REVIEW

Since managerial decision making takes place in an organizational context, we

first describe the major models of organizational decision making in order to shed some light on the environment in which individual managers make decisions. Following this, we outline

models that describe the decision process of individual managers. The review is purposely brief since our emphasis is on the implications of alternative decision processes for the design of DSS.

Organizational Decision Making

There are essentially four broad categories of models that describe organizational decision making: rational choice models, bureaucratic models, political models, and decision process or "organized anarchies" models (Pfeffer, 1981. Also see Keen and Scott Morton, 1978).

Rational Choice Models

Simply stated, the rational choice models (Cyert, et al., 1956) posit the following sequence of well defined stages to describe organizational decision making. All decision making activities are purposive and oriented toward the achievement of predetermined goals. A set of decision alternatives is assembled, each distinguishable from the other, and represent all possible courses of action available to the decision maker. An assessment is made of likely outcomes or consequences of alternate courses of action. The course of action which shows the most promise of enabling the organization, or the manager, to maximize attainment of the goals or solving the problem is chosen.

Though intuitively appealing, many organization theorists have questioned the validity of this sequence in describing organizational decision processes. For example, March and Simon (1958) argue that, under "bounded rationality," the search is conducted only until satisfactory alternatives are uncovered and hence, the set of alternatives is finite. There is no a priori reason to believe in the assumption of "substantive" rationality that underlies the rational choice

model. Decision making may, in fact, not be goal-directed or problem-centered. Furthermore, different managers within the organization may pursue different goals and this undermines the notion of a "consistent set of goals."

Bureaucratic Models

In bureaucratic models, "procedural" rationality replaces "substantive" rationality. The major claim here is that decision making in organizations is characterized by a reliance on standard operating procedures and rules and consequently, "decisions are viewed less as deliberate choices and more as outputs of organizations functioning according to standard patterns of behavior" (Allison, 1969). At the very extreme, these models suggest that decision makers may be replaced by a set of mechanical rules, the application of which would mirror the decision making that occurs in the organization.

Political Models

These models view organizations as pluralistic and divided into various interest groups with diverse interests and goals. Decision making is characterized as a process of bargaining and compromise among the various participants, who may perceive different aspects of an issue and have widely differing preferences for the decision alternatives. Indeed, the alternative chosen is unlikely to represent the preferences of any one manager. Goal and preference incompatibility leads to a permanent state of organizational conflict, and the relative power of decision making participants will determine how conflicts are resolved.

Decision Process Models

These models view organizations as "organized anarchies" and posit that a large degree of randomness charac-

terizes organizational decision making. Decision processes are unstructured, no overall goals are maximized, and no powerful interest groups with defined preferences determine the decision outcome. Rather, each situation determines what choice is made and each decision process may be analyzed only after the outcome is known. In the garbage can model (a popular version of the decision process model), a decision is viewed as the result of a context dependent flow of problems, solutions, people, and choice opportunities (Cohen, et al, 1972). The predictive ability of these models is quite limited and indeed the underlying notion here is that prediction of the decision process or outcome is virtually impossible.

Although all four models appear to have some face validity, empirical support is limited. Mintzberg, et al (1976), and Srivastava (1982) studied strategic decisions in organizations and found support (in varying degrees) for all four models described above. Our perspective is that each of these models may be appropriate in describing decision making in different organizational or problem contexts. As a consequence, we believe that research efforts should be directed at developing DSS that may be readily adapted to different modes of decision making in organizations. In Table 1, we summarize the four models of organizational decision making on several dimensions important for the design of Decision Support Systems. With this

Table 1. Models of Organizational Decision Making
(adapted from Pfeffer (1981, page 31))

	<u>Rational Choice</u>	<u>Bureaucratic</u>	<u>Political</u>	<u>Decision Process</u>
Philosophy	Efficiency, Effectiveness	Stability, Fairness, Predictability	Struggle, Conflict, Power	Loose couplings, Randomness
Decision process	Orderly, substantively rational	Procedural rationality	Disorderly, push & pull of various interest groups	Ad-hoc
Decision outcome	Value maximizing choice	Precedent determined	Bargaining & compromise, conflict resolution	Intersection of persons, problems & solution
Information requirements	Systematic, extensive	Systematic, not so extensive	Extensive, but not centrally available	Haphazard, may or may not be extensive. Not systematic
Requirements of decision aids	Analytical support	Ready reference support	Flexible, dynamic support	Multipurpose, dynamic support

brief look at organizational decision making concluded, we now turn to individual decision making.

Individual Decision Making

Decision theorists and cognitive psychologists, among others, have attempted to model human decision making and problem solving. Decision theorists have largely focused their attention on identifying and analyzing the phases of a decision process. Psychologists on the other hand, have tried to characterize cognitive styles¹ and their influence on decision making behavior.

Decision Phases

Simon (1960) proposes three major decision process phases: Intelligence, Design, and Choice. Intelligence refers to activities associated with problem identification. Design involves inventing, developing, and analyzing possible decision alternatives (courses of action). Choice refers to the selection and implementation of a particular decision alternative from those generated.

McKenney and Keen (1974) refer to the design and choice phases as a Search-Analyze-Evaluate sequence, but their ideas are conceptually similar to Simon's decision phases.

The three phase process suggests a sequence of activities characterizing the decision process. However, it is important to note that the notion of a sequence of stages is not as critical as the notion of a set of distinct

phases constituting the decision process. It is also noteworthy that in an organizational context, a continuous stream of communication between managers is an intrinsic feature of the decision process.

In a field study, Mintzberg, et al. (1976), identified the following activities comprising strategic decision making. The Identification phase consists of Recognition, activities that recognize opportunities, problems and crises in the environment, and Diagnosis, activities by which stimuli are understood and tentative cause and effect relationships posited. The Development phase consists of Search, aimed both at discovering alternative courses of action and the consequences of the actions, and Design aimed at developing new alternatives for the problem. The Selection phase consists of Screening, the elimination of obviously inappropriate alternatives, Evaluation-choice, determination of the choice criterion and then selecting an alternative, and Authorization, to obtain the requisite approval, if necessary, to commit the organization to the chosen course of action.

The decision process sketched above has important implications for DSS design. Sprague (1980) observes that Management Information Systems have made major contributions to aid in the Intelligence phase while Management Science/Operations Research have been primarily useful at the Choice phase. What is required now are Decision Support Systems that can provide support in all three phases with particular emphasis on the Design phase.

Cognitive Style

Recent contributions in human information processing emphasize an individual's characteristic modes of dealing with information, i.e., cognitive or decision style. This literature has

¹Cognitive styles are characteristic, self-consistent ways by which individuals deal with information, especially through perception, memory and thought (Witkin, 1964).

influenced several MIS researchers to study the impact of decision style on the design of DSS. It is widely believed that incorporation of the decision style variable in the design of DSS will enhance its acceptance, use, and effectiveness. We will briefly review some of this work; more detailed reviews and critiques may be found in Zmud (1979), Huber (1983), and Keen and Bronsema (1981).

Several frameworks have been proposed in the literature to categorize decision styles, differing with respect to the dimensions on which they are characterized (Taylor and Benbasat, 1980; Taggart and Robey, 1981). Zmud (1979) identifies three dimensions that dominate in MIS-related research. The simple/complex dimension "pertains to structural characteristics of perception and thinking," the field dependent/field independent dimension reflects "whether an individual is bound by external referents or can make use of internal referents in structuring cognitions," and the systematic/analytic dimension reflects "whether an individual utilizes abstract models and systematic processes in cognition or whether the approach taken is based more on experience, common sense, and the practicalities of a situation."

Witkin (1964) hypothesized that individuals with high field independence prefer problem solving approaches that emphasize detail and basic relationships, while field dependent individuals prefer more global and perhaps intuitive approaches to problem solving. Following Witkin, Huysman (1970) and others have suggested that analytical individuals reduce problems to a set of underlying relationships, while heuristic individuals emphasize pragmatic solutions based on common sense or intuition or by recalling the solution to an analogous problem. More recently, Driver and Mock (1975) argue that a flexible style represents a

preference for multiple solutions with minimal data, while a hierarchic style denotes a preference for a single solution with maximum amount of data, and an integrative style is characterized by a preference for multiple solutions and maximum data. (See also Watkins, 1981).

Similar frameworks have been suggested by McKenney and Keen (1974), Mason and Mitroff (1973), and Hellriegel and Slocum (1975). However, attempts to integrate these frameworks have not been successful (Henderson and Nutt, 1980; Keen and Bronsema, 1981). Empirical research to date shows that decision styles do affect decision making behavior and MIS success (Zmud, 1979; Henderson and Nutt, 1980). However, equivocal and inconsistent results have been obtained with respect to relating decision style and performance, suggesting that no single decision style is inherently superior (McKenney and Keen, 1974; Libby and Lewis, 1977). Huber (1983) argues convincingly that research on cognitive styles has not produced operational guidelines for DSS designs and the prognosis is bleak.

Our perspective is that even if research on cognitive styles is able to demonstrate specific decision linkages between particular decision styles and decision performance, the key issue now in DSS design should be to develop flexible systems that are capable of simultaneously supporting a variety of decision styles. This orientation does not undermine the research efforts directed as cognitive style and its impact on decision making behavior or performance. The perspective simply suggests that DSS design philosophy should not be guided by "How best to design systems tuned to the user's cognitive styles?" but rather by "How to provide the capabilities that can support a wide range of cognitive styles and idiosyncratic predispositions?"

DECISION SUPPORT SYSTEMS - AN OVERVIEW OF THEIR EVOLUTION

In the last decade, DSS have become increasingly prominent as aids to decision makers in organizations. The impressive growth of computer technology and the availability of a wide range of supporting software have now made feasible a variety of computer based aids for decision making.

It is difficult to define precisely what is meant by a DSS because the area is still evolving and various researchers have developed their own notions of what a DSS should be. Following the definition of Keen and Scott Morton (1978) we may define a DSS to be a computer based system that supports or enhances decision makers' decision making abilities with respect to a specified class of problems (domains). This definition, however, is too broad and implies that any system that supports a decision in any manner is a DSS. More restrictively, we may define a DSS as an interactive computer based system that helps decision makers utilize data and models to solve semistructured or unstructured problems (Sprague and Carlson, 1982).

There are several ways to classify existing Decision Support Systems. A classification that is useful for tracing the evolution of DSS would be: Model-oriented DSS, Data-oriented DSS, Decision-oriented DSS, and General Decision Support Systems (GDSS). We describe each type of DSS and relate it to the decision making literature discussed in the first section.

Model-Oriented DSS

The focus here is on the models that are developed to aid in decision making. Model-oriented systems provide accounting, simulation, or optimization procedures and are used in the context of a specific problem area

(Alter, 1980). Largely because these systems are developed for well structured problems, they have limited flexibility (in terms of user-friendliness, capability to change and evolve, etc.) and also have limited transportability over problem areas. In terms of the decision making frameworks discussed in the previous sections, model-oriented systems are particularly useful for:

- (a) Organizations and/or decisions that follow the rational choice or bureaucratic models. Examples of model-based DSS are the allocation of sales force resources (Zoltners and Sinha, 1980), determination of appropriate financial structure (Blanning, 1982), and the development of corporate budgets based on norms evolved in past years.
- (b) The "choice" phase of the decision process. These DSS provide optimization and simulation routines that enable users to consider many decision alternatives in order to pick the optimal alternative.
- (c) Decision styles that may be described as field independent (Witkin, 1964), analytic (Huysman, 1970; Benbasat and Dexter, 1981), systematic (McKenney and Keen, 1974), decisive, hierarchic (Driver and Mock, 1975), having low-complexity (Watkins, 1981) etc.

Data-oriented DSS

These systems resulted from the recognition that a key to effective decision making in an organization is the existence of a well designed information system that would provide the right information at the right time to decision makers. One way of achieving this is by increasing the capability of the DSS to recognize and carry out requests for information while simultaneously decreasing the decision

makers' efforts in specifying these requests. Thus, data-oriented systems provide functions for data storage, retrieval, and update (De and Sen, 1981). Some of these systems also provide for simple data analysis and generation of reports. Developments in the field of Database Management Systems (DBMS) have increased the flexibility and transportability of data-oriented systems.

The most important limitation of these systems in terms of their decision support capabilities is their naive view of decision makers and their needs. In order for a DSS to be effective, it must emphasize what a user can do with the data, in contrast to merely supporting the user's information needs. It is not enough to merely provide facilities for the user to browse through the data in order to classify and summarize them. The user may in fact want to interact repeatedly and creatively with the same data set. Thus, a DSS must provide additional analytical capabilities that will generate useful insights into what the data means in the particular decision context and to generate decision alternatives.

Examples of data-oriented systems are Airline Reservation Systems (Klaas, 1977) and several Inventory Management Systems.

Most decision making situations call for data of one form or another and therefore data-oriented DSS are useful to some extent in all four modes of organizational decision making. However, systematic information requirements are particularly crucial to the rational-choice and bureaucratic organizations. The major contribution of these DSS is in the "intelligence" phase of decision making, i.e., in problem recognition. For example, a DSS generated report showing declining market shares for a brand can trigger many decision making activities in the

organization. In terms of cognitive style, these DSS are suitable for individuals who may be described as field-dependent, heuristic, intuitive, flexible, integrative, high-complexity, etc.

Decision-oriented DSS

The primary objective of these systems is to support a specific decision process or decision maker within an organization. Unlike the model-oriented systems which are preoccupied with the problem structure, and the data-oriented systems which emphasize data handling capabilities, these systems shift the focus to the specific decision(s) that need(s) computer based support. Thus, emphasis shifts away from operational details toward the issues of managerial problem solving, especially for unstructured problems. ADBUDG (Little, 1970), and MYCIN (Davis, 1977) an expert system for Medical Diagnosis, are examples of this type of DSS.

The key characteristic of these systems is their flexibility in terms of handling a variety of problems in any given problem domain. Their major contribution as a decision aid is in the "design" phase. This is a consequence of the built-in capabilities that enable users to generate a repertoire of decision alternatives relevant to a problem. The design philosophy is based on satisfying user needs and their decision styles. This is both an advantage and a limitation. It is an advantage because the DSS can exploit unique aspects of a particular decision process and may be tailored to the decision style of a particular user, thus making them efficient (not necessarily effective) in handling specific problem areas. However, this would impose inflexibilities in terms of transportability to other problem domains and in terms of other users having to conform to the idiosyncracies of a specific decision style. By

and large, decision-oriented DSS provide some modeling and data-handling capabilities and would therefore conform to the requirements of the rational choice and bureaucratic modes of organizational decision making.

General DSS (GDSS)

The above three approaches are not exclusive categories in any way. In fact, several examples may be cited from the literature which overlap these categories. For example, REGIS (Joyce and Oliver, 1977) combines relational database concepts with a unified command language interpreter and statistical, graphical, and data access components.

The current trend is toward building Decision Support Systems that encompass multiple decision areas, models, and data. It is now recognized that a DSS should consist of a database, a model base, and software to link the user to each of these (Sprague and Carlson, 1982). According to these emerging ideas, the major requirements of a GDSS are:

1. Domain-Independence: The same GDSS should be capable of being implemented in different problem areas or domains such as marketing, finance, etc. This is possible if all application or domain specific knowledge resides in the model base or database instead of being coded within the problem processor (see Figure 1).
2. Dynamic construction of a decision aid: Instead of being a static pre-defined aid, the GDSS should provide facilities for the user and/or the system to speedily generate a new decision aid in response to a new problem. In addition, it should be capable of supporting "what if" type questions to quickly generate alternate scenarios.

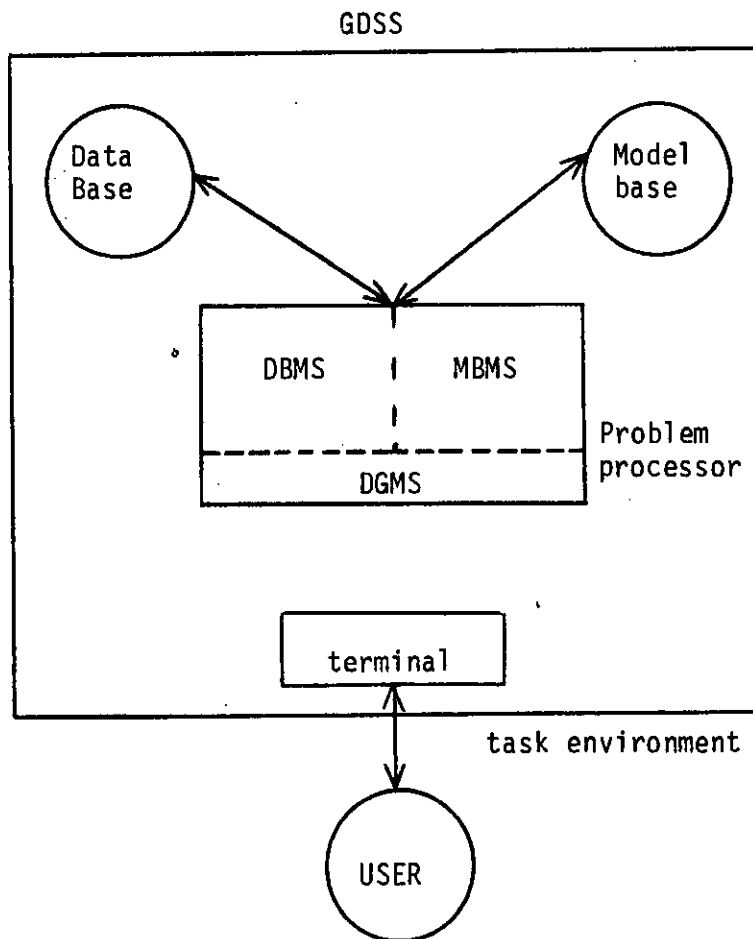
3. Flexibility: This refers to its capability for modification. To support a variety of cognitive styles and decision phases, the GDSS must provide tractable methods for speedy alteration of the user's view of models, data, and their inter-relationships.

4. User-friendliness: The GDSS should be non-threatening, easy to use for a novice, and quick in responding to the many types of questions that managers have.

Examples of some systems that fulfill some of these requirements are the Geodata Analysis and Display System (GADS) that supports decisions related to geographic areas (discussed in Sprague and Carlson, 1982) and Interactive Financial Planning System (IFPS), a product of Execucom Systems Corporation.

A simple architecture of a GDSS adapted from Sprague and Carlson (1982) is given in Figure 1. The problem processor is responsible for directing the entire system in response to the user request.

GDSS represent an ideal which if realized would provide the most extensive decision support capabilities. These systems may be used in different problem domains and can simultaneously support many decisions and decision makers within an organization. They can provide decision support under all four forms of organizational decision making with perhaps limited support in the case of decisions that are made purely according to the political model. They can provide support in all three phases of decision making and can accommodate a variety of decision styles. In the next section, we discuss some current research efforts in artificial intelligence that show the promise of developing systems that satisfy the requirements of a GDSS.



Text: DBMS: Database Management System

MBMS: Model base Management System

DGMS: Dialog Management System

Figure 1. GDSS Architecture

Table 2 summarizes the applicability of the different types of DSS under the various decision making models. Simply for the purpose of comparing these DSS, it is assumed that decision making pertains to one common domain such as the domain of merger and acquisition decisions. As remarked earlier, GDSS may be used across different domains.

AI-BASED GENERAL DECISION SUPPORT SYSTEMS

Artificial Intelligence is a field of study that encompasses linguistics, computer science, cognitive psychology, logic, and mathematics. The application of AI techniques to decision support provides a mechanism for GDSS implementation and success. AI

Table 2. DSS Comparisons

Decision Model DSS	Organizational Decision Making				Individual/Managerial Decision Making			
	Rational Choice	Bureaucratic	Political	Decision Process	Decision Theory Model			Cognitive Style Support*
					Intelligence	Design	Choice	
Model-oriented	✓+	✓					✓+	✓-
Data-oriented	✓-	✓-	✓-	✓-	✓+			✓-
Decision-oriented	✓-	✓-				✓		✓+
GDSS	✓	✓	✓-	✓	✓	✓	✓	✓

Notes: A check mark indicates that the particular type of DSS might be provuctively used for decision making characterized by a particular decision model. A plus indicates high degree of applicability while a minus indicates limited applicability.

* Model-oriented and data-oriented DSS support a single style of decision-making as discussed in the text. Decision-oriented DSS can be designed to suit any given style. GDSS may be adapted to suit a variety of decision styles.

tools enable the GDSS designer to incorporate the necessary characteristics of domain independence, dynamic construction of decision aids, flexibility, and user-friendliness. These capabilities, in turn, fulfill the major requirements of decision making models set out in the first section.

Domain Independence

Central to the development of domain-independent GDSS are the concepts of "DSS generator" (Sprague and Carlson, 1982) and "knowledge base." A DSS generator interfaces user queries with the knowledge base. It provides the capability for the user and/or the system to generate a specific decision aid in response to queries that fall within the domain encompassed by the knowledge base. DSS researchers employ several terms for DSS generators. Bonczek, et al. (1981a), refer to them as problem processors while Elam, et al. (1980), refer to them as model management system executors.

The key to achieving domain independence in a DSS is to assure that all domain specific and application specific knowledge resides outside the DSS processor, perhaps within the knowledge base. To do this, we envision the knowledge base as consisting of:

(a) Module base: These specify operational relationships between input data and output data. Blanning (1983) extends this notion when he suggests that a module may be viewed as a virtual relation with input and output attributes. A regression module, for example, takes a set of observed values of the dependent and independent variables and produces a set of regression coefficients. More generally, we may think of a module as changing one "information state" to another.

(b) Database: This represents the computerized storehouse of organized data, suitably coded and structured. The database may physically belong to the organization or to an external source. Recent advances in Database Management Systems (DBMS) have provided efficient and flexible methods for handling large databases.

(c) Module-data "links": These specify the correspondence between the input/output parameters of the modules and the data elements in the database. These links are required to provide values to the parameters in the instantiating modules before executing them.

(d) Data-data "links": These specify the relationships between the data elements; in other words, they represent the user's view of the data. Data models, such as the relational model, the Entity-Relationships model, etc., are discussed in standard textbooks on DBMS (e.g., Date, 1981).

(e) Module-module "links": These provide the operational relationships between modules and are used primarily for configuring modules to form larger or more comprehensive models. Thus, an Expense module, a Revenue module, and a Profit module may be configured to determine company profits.

Some knowledge bases (e.g., Sprague and Carlson 1982), contain only the module and databases. The "links" are provided by the user prior to a run, and will vary from run to run. If the "links" reside in the knowledge base, we refer to the GDSS as a system-driven (e.g., AI-based) GDSS. On the other hand, if the links are specified by the user (perhaps using higher language constructs or menu-driven dialogs), we refer to the GDSS as "user

driven." We will expand on these concepts later in our discussion.

Knowledge Representation

There are several techniques available for the logical representation of declarative, domain-dependent knowledge in the knowledge base. (We do not address issues related to physical representation in this paper). A common method applies well-formed formulas of first order predicate calculus, a method used, for example, in the CANDID system (Lee, 1980), in the DSS by Bonczek, et al. (1981b), and in our GDSS (Henschen, et al., 1983). In this approach, the modules, data, and links of the knowledge base are specified only once. Therefore, a change in any aspect of the knowledge base requires a change in only the affected module, data, or link. No reprogramming or resequencing of instructions is necessary.

In a logic-based GDSS, alternate decision making models and decision styles (i.e., flexibility and dynamic construction) may be accommodated to a large extent by providing mechanisms for speedy alteration of the user's view of the knowledge base - i.e., the user's view of modules, data, and their links. In our implementation, we will achieve this by using a "knowledge representation system" that provides the following features:

- (i) Translates user views of the knowledge base into clause form expressions.
- (ii) Compiles clauses into connection graphs (Kowalski, 1979).
- (iii) Handles both permanent and temporary changes (for speculative and "what if" type queries) to the knowledge base.

The reader familiar with this literature will recognize that our approach to GDSS is conceptually similar to the pioneering efforts in this direction

due to Bonczek, et al. (1981a, 1981b). However, the implementation scheme suggested by them, especially the resolution technique² for the DSS processor, is at best inefficient and at worst non-terminating (Chen, et al., 1982). We overcome these problems with an approach based on "connection graphs." A full discussion of these techniques is beyond the scope of this paper. (See Chen, et al., 1982; Henschen, et al., 1983 for details.)

Other methods of knowledge representation include the use of frames, variants of the frame structure, and semantic networks (Elam, et al., 1980). The major advantage of frames or semantic networks over logic representation is that for each entity (e.g., objects, events, concepts, models), all relevant information are grouped together. This may be particularly useful for answering questions such as "What is production?" or "How is production different from distribution?" (Elam, et al., 1980). While support for answering these questions may be essential in specialized expert systems, our experience is that first order predicate logic is a suitable language for representing knowledge about a domain in a GDSS for managerial decision making. Knowledge representation continues to be an area of intensive research in artificial intelligence.

User-friendliness in GDSS

A factor that enhances the use of GDSS is the minimization of the sequence dependent (or procedural) instructions that the user must provide to get an answer to a particular query. In the ideal case, a user merely states the problem or requests data and the GDSS

²Resolution is an artificial intelligence for simulating logical deductions on the computer.

handles the rest. The trend in DSS design has been toward non-procedurality in both model usage and data handling.

One school of thought advocates that the GDSS be completely user-driven, implying that the function of a GDSS processor is to provide a set of capabilities (such as menus, a higher level language, etc.) that would enable the user to procedurally generate a solution to the query. A manager using such a GDSS would combine several modules (from the module base) in some sequence of his choice in order to construct a decision aid. It should be obvious that the user-driven approach assumes a fair amount of user familiarity with the GDSS and user involvement in developing the system. Keen and Scott Morton (1978) and Sprague and Carlson (1982), for example, are proponents of this approach.

Another school of thought recommends the automatic formulation of a decision aid by the GDSS in response to a user query. This is the system-driven approach. Here, the user states the problem and the GDSS then selects a suitable set of modules, data, and linkages in a manner capable of satisfying the user query. The logic-based GDSS is designed to be system-driven.

The essential difference in DSS philosophy in these two approaches lies in the allocation of problem solving responsibility between the user and the system (Lee, 1980). The system-driven GDSS demands little user knowledge of computers or programming and also considerably reduces housekeeping chores. The user-driven GDSS on the other hand, affords much greater flexibility while sacrificing some level of user friendliness. A choice between these two types of GDSS can only be made after studying the specific requirements of an organization and the domains of interest.

We have presented a framework for incorporating conflicting decision making constructs into the process of DSS design. We examine four categories of DSS, including model oriented DSS, data-oriented DSS, decision-oriented DSS, and general DSS (or GDSS). The organizational and individual decision making constructs are studied with respect to the types of DSS best suited to their support. The GDSS provides the most comprehensive set of capabilities to encompass the diverse decision styles and strategies encountered in most organizations.

We examine the role of artificial intelligence in GDSS design. We show that a GDSS based on mathematical logic can provide the capabilities required by a system-driven GDSS. A comparison of system driven and user-driven systems are presented. We note here that the logic-based system, although inherently system-driven, may be implemented with both sets of capabilities if so desired. Thus, we maintain that an AI approach to GDSS design shows great promise of universal applicability and simplicity of use in managerial decision making. We have initiated several studies, both technical and managerial, in this area of research.

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