Cognitive Biasing Effects in Information Systems: Implications for Linking Real World Information with Human Judgment

K. Galen Kroeck, Pietter J. Kirs, and Anne M. Fiedler

Florida International University

Abstract
This paper describes a model of cognitive analysis of information in IS. Portraying the decision maker (DM) as an active component in an information analysis loop, the model identifies a set of biasing factors in decision making including characteristics of the DM, characteristics of the information available to the DM, cognitive strategies and attributions, and the context of the decision making process. Linkages among different phases of the process are delineated. Implications, examples and suggestions are provided for IS design.

Introduction
Under conditions of uncertainty, a decision maker (DM) is likely to search for any available information to reach a "reasonable" conclusion. Sometimes the information is retrieved from memory, sometimes it is retrieved from external sources such as information systems (IS), and sometimes the decision is based on a combination of both.

This paper explores how individuals combine and process information from various sources in reaching "reasonable" conclusions. The paper is intended to provide a model of cognitive interpretation of data commonly available in information and decision support systems. The model is a proposed set of linkages based on an extensive amount of information found in the fields of cognitive psychology, the decision sciences and the information systems domain.

A preliminary review of literature suggests that much of the research attention directed at the nature of data contained in information systems has minimal regard for the nature of human information processing. By ignoring the DM's cognitive strategies for retrieving and interpreting information, information system (IS) developers may fail to understand the "client". The purposes of this paper are (1) to suggest a paradigm that will generate substantial research in the developing areas of information systems, and (2) to provide a set of considerations for the design of information systems which may be helpful in preventing errors and biases committed by those who are actively seeking and make inferential decisions on the basis of such systems.

After presenting some background review, we present our model of the cognitive analysis of information in IS. Next, we suggest a set of cognitive biases, heuristics and tendencies which have been found to be common in human judgment processes. The relevance of these cognitive processes to the nature, scope and type of information often available in IS is discussed. Finally, we describe the model using an example of how such biases can affect actual decisions in the rapidly growing area of Human Resource Information Systems. We first must lay some groundwork for our model of cognitive analysis of information in IS.

Some Background Theory
A number of theories and models have been advanced to describe human information processing. Most of these theories view such cognitive processes as a set of information filtering and organizing mechanisms (Broadbent, 1966; Norman, 1968). Because humans are inundated with enormous amounts of stimulus information, they tend to utilize a variety of mechanisms to cope with their environment. Coping mechanisms include chunking of information (Simon, 1959, 1978), the use of heuristics (Tversky and Kahneman, 1974), programmed strategies (Huber, 1981) and various other information categorization processes (Abelson, 1981; Hamilton, 1976).

Assigning observations to categories has been described as a primary function of cognitive representation (Rosch and Lloyd, 1978). The individual is seen as actively seeking information which augments or discounts the categorical assignment of other information. In fact, the active search for confirmatory and disconfirmatory information about the causes of observed events and information has consistently been shown to be one of the most profoundly motivated of all human action tendencies (Wong and Weiner, 1981). Stated simply, humans seem to make sense of the world through assignment of observed events and what causes them to a set cognitive categories. These cognitive categorization processes have been commonly referred to as schema or implicit theories (Neisser, 1976).

Many cognitive processes that are not directly observable have been labelled as various constructs. These constructs have generated substantial research which has evolved into a variety of sophisticated models of human use of information. These models describe and explain why there are often biases and errors in human judgment and decision making. Typically, biases and errors are due to limitations of cognitive complexity, miscategorization of information, biased search for information (Simon, 1959) or biases due to over-reliance on information-simplifying heuristic mechanisms (Tversky and Kahneman, 1974). Implications for reducing errors of judgment and decision making are the products of many cognitive models. These models, however, are rarely linked in any specific or direct application to the design of information systems.

A Model Of Cognitive Analysis Of Information In IS
In Figure 1 we present our model of cognitive analysis of the type of information found in typical information systems. The model is based on a set of linkages among different components. These components include (a) the supply of information resulting from the universe of real world events, (b) the information system representation of real world events and resulting data, (c) the decision maker with his/her personal schema, implicit theories, biases and reliance on heuristics, (d) the decision maker's judgmental and behavioral responses to the information analysis, and (e) the task environment or context in which the decision process is conducted. The linkages among the components, numbered from 1 to 5 in Figure 1, are described in the following sections. For each linkage, potential biases and errors are discussed. Following our explanation of the linkages and examples of potential problems in each linkage, considerations to moderate the problem potential are suggested for IS design.
The supply of events in the real, physical world is represented in some abstract way by information systems. Of course, the system is not a mirror of reality, and is very limited in the scope of its representation of the total information supply. Some subset of reality is abstracted by those who construct such systems. The biases of those who construct such systems become the biases of the system (Paradice & Courtney, 1986). The potential for error and bias in this linkage is the result of incompleteness.

Information System - Decision Maker Linkage

The Information Analysis Loop shown in Figure 1 suggests that the decision maker (DM) incorporates perceived information into his/her schema and implicit theories. The arrow shown is bidirectional to indicate that the DM actively seeks out information to augment or discount categories developed in prior information analysis and held in memory. Corresponding to Hogarth's (1987) Acquisition Phase of decision analysis, information search and retrieval processes involve both the DM's memory and environment. As will later be discussed, combining the information from internal and external sources has specific problem potential in reaching an ultimate judgment or "reasonable" conclusion.

The information system contains a variety of information types and formats. Some information is highly salient, some is obscure. Information can be displayed and reported in a variety of formats which, for different Decision Makers, may be more or less readily retrieved and differentially interpreted. Some research on how people process information, as presented in the following sections, is particularly relevant to this aspect of the Information Analysis Loop.

Human Information Analysis Tendencies

In the Information Analysis Loop, the DM actively seeks information to analyze the cause of observations and to categorize the input in a meaningful interpretation. What information the DM seeks is clearly of concern in IS design. Implications are particularly relevant for judgments about the success or failure of various agents about which information systems often provide performance information. Information about the performance of agents such as stocks, products, organizations, groups and individuals is often the basis of data contained in an information system. How the decision maker interprets, analyzes, causally attributes, categorizes, and projects such information into expectations and behavioral responses should be of critical concern in the design of IS, particularly when the DM's analysis can be readily altered by information available. Causal attributions about performance, for example, have been demonstrated to be alterable by manipulation of the salience of some agent such as an individual or organization or the salience of situational conditions under which performance was exhibited (Eisen, 1979; Taylor and Fiske, 1978).

Attribution Theory

Attribution theory portrays the individual as a perceiver who, in order to understand the causes of events, actively seeks various kinds of information (Kelley, 1973). Forsythe (1980) catalogued four functions which causal attributions fulfill for the attributor. Two of these are of particular relevance to this discussion. Explanatory attributions promote an understanding of observed information through implicit theories about the environment; predictive attributions facilitate the development of expectations concerning the
likelihood of future events. Other functions, such as self-serving biases in attributions may also be relevant to the causal conclusions people formulate through their search processes. That people form "mitigating circumstance" explanations for their own failures is not uncommon; however, the conditions under which observers seek information to form a "mitigating circumstance" explanation for another agent's success/failure is not well defined. One explanation of information used in cognitive information search and analysis is found in Kelley's Covariation Cube.

**Covariation Analysis.** Covariation Analysis is that which is based upon multiple pieces of information. Three particular categories of information have been found to be commonly combined to reach causal assumptions about observed information. These information categories include consistency, consensus or base rate, and distinctiveness information. Attributes are the result of observed covariation of a particular event or behavior across other occasions (consistency), across other individuals (consensus or base rate), and across other stimuli (distinctiveness). These three informational cues are assumed to be combined so as to result in either an internal or external causal attribution depending upon the pattern of information in a "mental analysis of variance." For example, behavior that is consistently exhibited by an agent but not by many others in response to a stimulus is attributed to some internal aspect of the agent. When an event is not consistently but distinctively exhibited by an agent in response to a particular stimulus and most other agents exhibit the same response to the particular stimulus, an attribution to the stimulus properties or to external conditions rather than to an internal aspect of the agent is formed (Argote and Seabright, 1986). When pieces of covariation information are missing, the DM will seek them out, and either locate the information, or somehow "read it into" the information that is available. The potential for problems of misattribution can be exacerbated by an IS which provides insufficient or misleading covariation information.

**Configuration Analysis.** Kelley (1973) also described causal attributions which are formed on the basis of a single piece of information. When time or mental economy do not permit an extensive information search, a fast attributional analysis is invoked. Kelley discussed such attributions as observer reliance on causal schema or assumed configurational patterns in the information. In order to explain the cause of some event, the most plausible cause for observed behavior is attributed to the event. The role of a given cause in producing a given effect may be discounted if other plausible causes are also present (Zuckerman, Colwell, Darche, Fischer, Osmun, Spring, Winker, and Wolfson, 1986). For example, an external cause such as high task difficulty may be known to inhibit success on a particular task, thus failure at the task may not be attributed to the ability or effort of the agent, but rather to the external constraint of task difficulty such as a poor economy or market. External conditions may be facilitative as well as inhibitory: failure on an easy task, due to an external cause like high task difficulty or to an internal cause like low agent ability/effort depending upon the available information.

### The Information System-Decision Maker-Heuristics and Biases Linkage

Input to the Information Analysis Loop is filtered through not only the DM's schema and implicit theories, but is also interpreted so as to simplify and constrain its scope. Categorizing processes are facilitated by use of cognitive heuristics. Heuristics are commonly invoked in information analyses. For example, the availability heuristic can result in biases as the DM tends to assess the frequency of occurrence of cases or events (size of category membership) based on the ease with which examples can be retrieved. When examples of a category are difficult to generate or retrieve, the DM is likely to underestimate the size or importance of the category. In our model of the Information Analysis Loop, the DM is portrayed as an active participant in information retrieval rather than a passive recipient. When the DM finds it difficult to retrieve examples of a category from the IS, decisions may be biased against that category.

Heuristic principles are used to reduce complex decision-making into simpler judgmental operations. Heuristics often lead to systematic errors and biases (Tversky and Kahneman, 1974; Teng and Sethi, 1987). Some of the most common ones are listed below.

**Common Cognitive Heuristics, Biases and Tendencies**

**AVAILABILITY.** This heuristic refers to the ease with which events or occurrences of behavior can be brought to mind. The more salient an event the more likely it is to be retrieved from memory for later use. While this use of availability can have some merit because items of a larger population are usually recalled better and faster than items of smaller populations (Tversky and Kahneman, 1973), it can often cause bias due to retrievability. A population with highly salient occurrences will often seem much larger than an equal size population with less salient events (Pyry and Kirs, 1977).

**ANCHORING.** People have a tendency to anchor their evaluations. If a person has made previous evaluations on a given subject these previous evaluations will become an anchor. If there is insufficient information for a given subject a mean of previous evaluations for a referent population may be used. When making a new evaluation of each subject for each occurrence of behavior people tend to start at the anchor position and adjust the evaluation up or down (Tversky and Kahneman, 1974). Database systems often provide misleading anchors (Sniezek and Reeves, 1986).

**REPRESENTATIVENESS.** The cognitive strategy of stereotyping by degree of similarity deals with the belief that members of a given population will have traits similar to other members of that population or members of similar populations. We, therefore, expect to see what is typical of what could occur. We expect to find very tight distributions (Kahneman and Tversky, 1972; Hogarth, 1987).

**SELECTIVE PERCEPTION.** People develop knowledge bases and schema through which they view the world. This forms a filter through which all information must pass. Cognitive processes register information for which there is available context, information contrary to cognitive categories may be filtered out.

**ORDER OF PRESENTATION.** When a large amount of information must be processed people tend to give the greatest weight to events occurring at the beginning and the end of a period. The former is known as the primacy effect while the latter is the recency effect. Events that occur in the middle of a period tend to be overlooked (Hogarth, 1987). Rather than result in very different attribution depending on the order in which consistency, distinctiveness, and consensus information is presented (Jones and Goethals, 1972; Ruble and Feldman, 1976).

**CONCRETE INFORMATION.** Single, vivid events tend to be much more salient than more abstract or statistical information. The more clearly an event is perceived by the greater the chance it will be recalled. Personal experience, even second hand, often has a greater effect than numerical data which tends to be more passive and is therefore easier to overlook. (Borgida and Nibbett, 1977).

**FREQUENCY.** The number of successes/failures is the primary consideration. There is no concern for ratios of success/failures. (Hogarth 1987). For example, a salesperson may be evaluated only on the number of closed sales. The proportion of the number of closings to the number of calls made would not be considered. Displayed information may be judged as important due to being frequently encountered without regard for the actual frequency of its relevance or importance. (Ward and Jenkins, 1965).
MISCONCEPTIONS OF REGRESSION. If an event or behavior varies significantly from the mean, people tend to attribute the cause to some external agent or event and ignore the regression phenomenon. This phenomenon is that cases will fluctuate around a mean score and that extreme cases will usually be followed by cases that regress toward the mean. However, the casual assumption about some relationship may be conceived with the case being a consideration of a member of some different distribution. (Tversky and Kahneman, 1974; Hogarth, 1987).

LAW OF SMALL NUMBERS. It has been shown that people, including researchers, often extrapolate results from very small samples to larger populations without checking for significance. The size of the sample does not affect the perceived similarity between a sample statistic and a population parameter. (Tversky and Kahneman, 1974).

ILLUSORY CORRELATION. When people are faced with large volumes of information they tend to eliminate areas that are unclear or would require more information for clear definition. They focus their attention on what they consider to be the most likely hypothesis even though this outcome has not been tested or verified (Keller, 1985). People tend to make assumptions about the interrelations among events and characteristics of the agents they observe. They often assume that events and characteristics are correlated merely due to temporal concurrence or same category membership (Croceter, 1981; Golding and Rorer, 1972).

These biases are based on descriptions by Tversky and Kahneman (1974) and Hogarth (1987). Examples of potential problems and design considerations for information systems that might help to minimize effects of these biases are summarized in a table later in our discussion. Suggestions for moderating the effects of these biases and other aspects of the model are also discussed in detail in later sections of this paper.

Decision Maker—Decision and Response Linkage

This linkage involves the mechanisms by which categorized information from various sources is combined to reach a "reasonable" decision. In part, this mechanism is related to the causal attributions formed about information held in memory as well as the set of future expectations and predictions resulting from those attributions. Information about the nature of causes is combined with assumptions about the likelihood of the presence of these causes in the future (Cvrt, Dill and March, 1958). This mechanism involves the combined processes of retrieval of information from memory and conditional inference (Wyeer and Hartwick, 1980).

Retrieval of information from memory could be expected to be based upon the manner in which information is organized in memory, specific tendencies, heuristics, recency, and the results of previous, related processing impact upon the retrieval process. The memory search process, like the information system search process, could also be expected to be a search for hypothesis confirming or disconfirming information (Snyder and Swann, 1978). However, in the case of this linkage, the DM consciously directs the search to intentionally formulate assumptions, inferences and comparisons regarding specific premises and categories of information and their respective validity for the decision at hand. The cognitive processing involved in this linkage is a more formalized one, with the conscious expectation of reaching a logical conclusion based on the evidentiary information.

One memory retrieval model is particularly relevant to situations such as would be expected in decisions based on IS information. Snull and Wyeer (1980) developed a "bin" model of memory search leading to conditional inference. The "bin" model is a mechanical memory metaphor postulating that information is stored in and retrieved from a set of revolving bins. The hypothetical bins are ordered from the top-down in order of "deposit" of information in the memory bin. Once a piece of information is retrieved, it is redeposited at the top of the bin. Therefore, when the bin is searched, the information at the top will be most readily retrieved. A similar process was suggested by Rosch and Lloyd (1978) to describe hierarchical categorization processes. For the purposes of our model, the bin metaphor describes the process by which information is retrieved to form conditional inferences.

Numerous models of how information is combined to reach a conditional inference have been advanced. Proposed models include the syllogistic reasoning model (McGuire, 1969; Wyeer, 1976), the psychological model (Heider, 1958), the Bayesian model (Sovic and Lichtenstein, 1971), the algebraic model (Anderson, 1981), and the configurual model (Abelson, 1976). Different situations seem to elicit different mental processes. Conditions which elicit different inferential processes have yet to be identified.

Many decisions require a choice between two sets of mutually exclusive premises. For the DM, if A is true, then B is not. Most real world conditional inference problems require some probability estimate about the validity and importance of various pieces of information about A and B. So, for example, A is believed true only if the premises about A are true and are relevant to the decision. Each premise is likely to have attached a probability value for its veracity and an importance weighting value. Information systems and heuristics are likely to have a profound effect on the perceived validity and importance of information about such premises (Schwenk, 1986). The DM, for example, is likely to give greater importance and validity to information obtained from the system merely because the judgment important enough by the system designer to be included in the IS. Obvious problems exist when system information is included merely due to the ease with which it is readily available.

Different individuals could be expected to place greater weight on premises that are presented according to different formats in information systems. Often, when two or more pieces of information converge to imply the same conclusion, the premises are assigned greater weight through conjunctive reasoning. Individuals require more information than others to reach a conclusion in conjunctive reasoning (Leddo, Abelson and Gross, 1984; Thaler, 1985). The attachment of greater importance and validity to narrative, numerical or graphical data could be expected to differ from individual to individual. Ultimately, the information system can be expected to have a direct influence on the decisions and responses made to the information contained in it, particularly in regard to how the information is presented (Dickson, Senn and Chervany, 1977). For many DM's, the system may do more than provide support information: the system design may be a particular type of decision to the exclusion of others.

Decision—Task Environment Linkage

This linkage involves the context within which decision making is conducted. Various factors in the decision making environment affect the DM's judgment and behavioral responses. Four primary factors which affect decisions and behavioral responses based on decisions should be considered in IS design. These factors are (a) time constraints (Pollay, 1976; Wright, 1974), (b) the purpose of the decision (Tversky and Kahneman, 1986; Einhorn and Hogarth, 1982; Detmer, Fryback and Gassner, 1978), the importance and complexity of the decision (Taylor, 1988; Payne, 1976) and (c) decision—response policies prescribed by the context in which decision making is conducted (Davis and Banko, 1986; Gavanski and Hoffman, 1987). Extensive discussion of this linkage exceeds the scope of this paper, but we have included it to describe the entire model. This linkage has broad implications for IS design.

Modifying the Problem Potential in the Information Analysis Loop

The characteristics of the information stored and retrieved are viewed as modifying variables in the model given in Table 1. The Gorry and Scott Morton (1971) framework identifies these informational characteristics as source, scope, level of aggregation, time horizon, currency, required accuracy, and frequency of use. Since each of these properties span a broad continuum, and it is not always feasible to include or consider the entire spectrum in
Table 1.

Moderating Biases in the Information Analysis Loop

<table>
<thead>
<tr>
<th>Type of Bias</th>
<th>Impact on Decision Making</th>
<th>Potential Problems</th>
<th>Design Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>The ease by which an event can be brought to mind proportionately affects the decision</td>
<td>Readily recalled outcomes tend to be distinctive and not representative of typical events</td>
<td>Provide complete data; Factor in consistency and consensus information</td>
</tr>
<tr>
<td>Anchoring &amp; Adjustment</td>
<td>Judgments tend to be mere adjustments of initial or earlier impressions</td>
<td>Major or distinct changes in events or behaviors may be underestimated or overestimated</td>
<td>Set pre-determined exception indicators; Clearly define scales</td>
</tr>
<tr>
<td>Representativeness</td>
<td>Events are associated with similar events and expected to have the same tendencies and outcomes</td>
<td>Events may not be judged on their unique characteristics; Invalid expectations/predictions</td>
<td>Seek data independency; Check correlations between events</td>
</tr>
<tr>
<td>Selective Perception</td>
<td>Tendency to seek and accept information consistent with previous decisions and disregard inconsistencies</td>
<td>Interpretations are modified to augment categories and expectations; Unique outcomes may be ignored or discounted</td>
<td>Establish quantifiable criteria and goals; Make important information salient and specific</td>
</tr>
<tr>
<td>Order of Presentation</td>
<td>Greater weight given to initial and most recent observations</td>
<td>Consistency of outcomes is inadequately considered</td>
<td>Provide summary and accumulated information</td>
</tr>
<tr>
<td>Concrete Information</td>
<td>Emphasis on readily quantifiable/statistical data</td>
<td>Information may not be statistically significant or valid; Qualitative aspects are ignored</td>
<td>Quantify as many factors as possible; provide significance/validity checks</td>
</tr>
<tr>
<td>Frequency</td>
<td>Emphasis on frequency of events without regard to intervening factors</td>
<td>Relevance of task/event uniqueness or complexity is either underestimated or overestimated</td>
<td>Break down information about tasks/events into as many components as possible</td>
</tr>
<tr>
<td>Misconceptions of Regression</td>
<td>Outliers misinterpreted as indicative of a trend or changing base rate</td>
<td>Distinctive outcomes may set unrealistic expectations for later events</td>
<td>Identify outliers; apply trend analysis models; supply base rate information</td>
</tr>
<tr>
<td>The Law of Small Numbers</td>
<td>A small number of observations used as an evaluation norm</td>
<td>Outcomes may be unique resulting in establishment of misleading base rates; Validity is assumed</td>
<td>Provide tests of significance and levels of confidence</td>
</tr>
<tr>
<td>Illusion of Correlation</td>
<td>Evaluation criteria used for familiar events substituted for distinctive events</td>
<td>Assumed relationships between events may be unsubstantiated; Conclusions overly generalized</td>
<td>Provide accurate analysis of correlations and relationships among events</td>
</tr>
</tbody>
</table>
developing the IS or in the decision making process, a selection process occurs.

With respect to L1, the systems analyst and/or designer, operating with a set of personal schema and implicit theories, biases the subset of information which is included in the system. Although guided by the user's information requirements, the inputs selected for the IS are modified by the developer's understanding and interpretation of the data needed. Further, the systems designer is constrained by such technical concerns as physical storage, entity relationships, and processing capabilities. As a result, the working IS is itself, a biased representation of the universe of "real-world" information.

The DM modifies the system outputs (L2) through the manner in which he/she selects the information desired (L3). The characteristics selected, the range chosen for each characteristic, and the weight or emphasis assigned to each selected characteristic all impact directly on the information obtained.

In IS which impact on decision-making where biases are frequently evident, care should be given not only to the selection of the type of information required, but also to the specific characteristics of that information. The following characteristics are especially relevant for consideration in IS design:

1. SOURCE OF INFORMATION. Both external and internal sources or information are needed to overcome potential problems with availability, anchoring and adjustment, representativeness, and selective perception. Sources should be identified.

2. SCOPE. Although physical storage limitations must be recognized, in order to circumvent biases arising from insufficient data, as wide a base of information as possible should be employed. Information regarding consistency, distinctiveness, and base rates should usually be included.

3. LEVEL OF AGGREGATION. Since these types of decisions rely upon an extensive number of independent variables, emphasis should be given to aggregate information vs. overwhelming the DM with details. Whenever possible, however, tests of significance and reliability should be employed to avoid biases resulting from misinterpretation of statistically based information (i.e., concrete information, frequency, misconceptions of regression, the law of small numbers, and the illusion of correlation). Sample sizes should be identified.

4. TIME HORIZON. In order to reduce the likelihood of biases which are especially sensitive to changes over time, information should usually be based on historical data which spans as long a time period as possible. However, care must be taken not to obscure significant changes in events or behaviors. Consistency information should be of sufficient length to assess performance stability and to identify distinctive behavior and events.

5. CURRENCY. The currency of the data should range over the entire continuum from quite old to highly current. However, in order to alleviate biases due to anchoring, representativeness, selective perception and order of presentation, a weighting scheme could be used. Date of information input should be identified.

6. REQUIRED ACCURACY. Although highly accurate information is desirable, the DM must recognize that this characteristic is not always attainable. To underscore this possible drawback, confidence intervals, significance and reliability data should be provided. Care should be exercised to minimize the possibility that inaccurate information augments credibility of erroneous conclusions or discounts the credibility of accurate information.

7. FREQUENCY OF USE. Since judgments often have major organizational impact, care should be taken in specifying the output reports. Both the DM and system designer should recognize that, essentially, each time the system is run a unique set of outputs, not merely a modification of previous runs, should be generated. Problems of "tuning out" information that is encountered on a highly frequent basis due to selective inattention can be avoided in carefully designed systems.

In general, subtle characteristics of information contained in an IS like those described above can have as much effect on decision making as the more explicit characteristics of information content. Accurate decision making, the ultimate goal of most IS plans, can be much more likely when system designers give careful consideration to the nature of the information included in the system. It should always be remembered that the DM will seek out and utilize the information available in the IS to make important decisions. Information should not be incomplete or be capable of misinterpretation. In the next section, we provide an example of the model of information analysis to illustrate how IS can inadvertently misguide decision making outcomes.

Conclusion

The model illustrated in this paper is an integration of a broad spectrum of research and ideas that converge on the field of Information Systems. It is intended to generate research regarding a proposed set of linkages which portray the Decision Maker as an active component in the Information Analysis Loop. We expect that researchers will disagree with aspects of the model toward it's improvement. Converging empirical research in the different knowledge-based sciences can only add to the sophistication of each of the different fields (Sage and Rouse, 1986). Furthermore, we can enhance our understanding of our "aesthetically appreciated" normative models by conducting that research in realistically complex environments (Lopes, 1986). The study of decision makers actively using real-world information systems is the only way to accomplish this.

References


