# Chapter 5
# Judgment and Decision Making, Part IV: Information Technology and Decision Aids

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The use of decision aids shows great promise in accounting and other areas of professional decision making. The primary reason is that humans often perform poorly when compared to formal structured models (Kleinmuntz 1990). Decision aids assist the decision maker, either in collecting information cues or in combining the cues, or both. Effective decision aids improve the decision maker's ability to collect and combine important cues by imposing structure on the decision process.

Advances in information technology (IT) have improved the ability of information systems to gather data from a variety of sources, combine the data quickly, vary the ways it is combined, and modify the presentation of the information generated. These improvements increase both the potential scope of decision aids and the efficiency of their use. The interaction of technology and decision aids is an important one for accounting research as accountants move forward in their role of information providers (Elliott 1992).

The purpose of this chapter is to identify decision aids, analyze the relationship of IT to these decision aids, summarize the research findings relating to IT and decision aids, and identify issues of potential research interest in this area. To provide a more complete understanding of the area, we have drawn upon both the accounting and the information systems literature. The review is intended to provide insight into the various research streams and include a representative sample of articles in that stream, not to provide a comprehensive literature review.

The remainder of the chapter proceeds as follows. First we discuss decision-aid characteristics and identify the framework that will be used for this paper. Next we present past research findings organized with the framework. Finally we provide suggestions for future research and summarize our findings.

## 1.0 DECISION AID CHARACTERISTICS

Decision aids are tools that assist the decision maker in gathering, processing or analyzing information for a decision (Libby 1981). Decision aids can range from paper and pencil, to checklists, to statistical programs for analyzing information, to expert systems that encompass the knowledge of a group of experts.

Decision aids are not well defined in the accounting literature. Kachelmeier and Messier (1990) use Rohrmann's (1986, 365) characterization of a decision

aid as "any explicit procedure for the generation, evaluation and selection of alternatives (courses of action) that is designed for practical application and multiple use." As such, any tool that has a practical use and can be used repeatedly for making decisions qualifies as a decision aid. The focus of this chapter is on decision aids that are implemented using IT or that will rely on IT for their actual implementation.

Decision aids implemented by using IT may differ in presentation media, observable format, or substantive content. Differences in presentation format, such as a checklist on a computer screen rather than on paper, use IT as a substitute for another presentation method, with no other changes in the aid. Differences in observable format, such as a checklist that omits some items based on earlier entries, uses IT capabilities to adjust the aid to the specific use being made. Differences in substantive content, such as a checklist that "learns" from each application, use IT to create an aid that would be impossible without IT. All three differences are considered to be important implementations of decision aids with information technology. When the differences are important for this discussion, they will be identified individually.

Decision aids can be categorized in a variety of different ways. Gorry and Scott-Morton (1971) categorized decisions in a two-dimensional matrix. The matrix represents decision structure on one axis, ranging from highly structured to unstructured, and represents decision level on the other axis, ranging from operational to strategic. With this framework, decision aids can be identified by both structure and decision level. For example, an expert system validating credit limits might be considered a semi-structured, operational decision aid, while a statistical analysis program for analyzing trends on demand may be an unstructured, management control decision aid. Using this framework, a decision aid would be identified by the particular type of decision for which it was used, regardless of the specific characteristics of the aid.

Frameworks categorizing decision aids by looking at the aid rather than the decision also exist. Ives et al. (1980) identify several characteristics of information systems that apply to IT-implemented decision aids. Decision models are first identified by the approaches used to generate and/or model evidence (Mason and Mitroff 1973) and then classified by presentation form, timing and data source. For example, a decision aid that uses contemporaneous graphical outputs to automatically alert a decision maker of contradictory evidence in a set of data may be categorized as Hegelian,[1] on-line and graphical. A decision aid that produces a single recommendation from a set of historical data using a set of well-established, agreed-upon, predetermined rules may be categorized

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[1] A Hegelian information system creates conflict within the decision model through the introduction of contradictory alternatives from the same set of data. The conflict promotes deeper analysis of the problem and assumptions underlying the problem. These aids would be most appropriate for unstructured problems (Mason and Mitroff 1973).

as Lockean,[2] periodic and textual (see Mason and Mitroff 1973). This framework looks at specific characteristics of the aid, without regard for the user or the decision context.

A third framework follows the suggestion of Libby (1981) to focus on the portion of the decision process that the decision aid assists. The three stages of decision making—intelligence, design and choice—identified by Simon (1965), can be used to discuss different computer- or IT-based tools, such as decision aids (Sabherwal and Grover 1989). Libby (1981) identifies decision aids that assist in hypothesis generation and information searches (intelligence), information integration (design), and action choice (choice). At each stage of the decision process, decision makers perform tasks that can potentially be aided.

The Libby (1981) framework actually incorporates components from the first two frameworks that were discussed. It allows an examination of decision aids that concentrate on the important area of decision making from the Gorry and Scott-Morton (1971) framework, while providing the focus to discuss the characteristics of the aid itself from the Ives et al. (1980) framework. Since the focus of this chapter is on the behavioral effects of decision aids as they relate to behavioral accounting research, we will use the Libby (1981) framework for the remainder of our discussion. Intelligence-stage decision aids provide support for both determining what data to gather and for gathering the desired data. Design-stage aids are modeling tools for combining the information into usable sets. Choice-stage aids help the decision maker decide among the alternatives presented.

A review of research in decision aids since 1981[3] is presented next. We emphasize research in the accounting domain, but also include research from information systems where that literature has studied issues pertinent to accounting. The review uses the intelligence, design, choice framework to discuss the aids. In addition, we include two sections that encompass areas that are not conducive to discussion under the stages of decision making.

## 2.0 REVIEW OF PAST RESEARCH IN DECISION AIDS

This section reviews the primary streams of research on decision aids implemented through IT and research on decision-aid characteristics that are relevant due to the capabilities of IT. The review begins with decision aids designed to meet the needs of decision makers at various stages of the decision process. Following that discussion, research that cuts across all the phases of the decision process is discussed. One important area of research related to IT-supported decision aids examines the impact of the decision aid on the decision

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[2] A Lockean information system builds consensus models based on empirical evidence, resulting in agreed-upon outputs. These aids are most appropriate for structured problems with general agreement about how to resolve the problems (Mason and Mitroff 1973).

[3] Libby (1981) provided a comprehensive review of decision aids related to accounting up to that point in time. While his discussion did not center around IT specifically, it did encompass any studies that included IT.

maker as opposed to the decision (i.e., decision aids that result in increased knowledge or that direct the decision process of decision makers). The final portion of this review discusses decision aids as they relate to IT-specific issues.

## 2.1 Decision Aids for the Decision Process

The majority of the research into IT-related decision aids has studied support for the actual decision-making process. This section discusses decision aids as they relate to the three stages of decision making: intelligence, design and choice (Simon 1965). The decision aids are either implemented through IT or are interesting because of the capabilities of IT. For example, the research on information presentation is discussed here because of the capability of IT to produce different formats for users of decision aids. The fact that simple spreadsheet software can present tabular information that can readily be transformed into a graphic format makes the determination of the issue of information presentation on IT relevant.

### 2.1.1 Intelligence-Stage Decision Aids

At the intelligence stage, decision aids assist in determining what information to gather and then in gathering the needed information. Decision aids that help generate alternate hypotheses highlight information to be gathered, while other decision aids directly assist in gathering information. Information gathering using IT increases the speed with which information can be collected, and allows the decision maker to collect from a wider range of information sources. The major findings of the studies presented in this section are presented in table 1.

An important use of decision aids to assist in gathering information is to promote the collection of all relevant information. Decision aids designed to collect (or prompt decision makers to collect) information contrary to the proposed alternative as well as information supporting the proposed alternative provide a more complete set of information for decision making (Libby 1981). Likewise, decision aids designed to counteract cognitive biases of decision makers, whether general to most decision makers like recency biases, or specific to particular decision makers such as intuitors (see Chenhall and Morris 1991), will alert the decision maker to information gaps he or she is likely to encounter. Biases in decision makers have been studied, but the use of decision aids through IT to assist in overcoming those biases is not yet well understood.

Decision aids also assist in gathering information through the generation of alternatives. Generating appropriate alternatives leads to determining information that is important for the decision. Decision aids have been shown to increase the number of alternatives examined before arriving at a decision in some task situations (Chu 1991; MacCrimmon and Wagner 1994; Sharda et al. 1988). By increasing the number of alternatives considered, the decision maker may consider more information. IT provides assistance through the use of specialized software, by keeping track of multiple potential solutions, or by prompting decision makers to consider other solutions. Therefore, decision aids

leading to alternative generation are useful for focusing information gathering by increasing the population of solutions for which information must be gathered.

Another stream of research related to the intelligence phase focuses on executive information systems (EIS) to deal with increasing competition and government regulation, to identify historical trends and operational data, and to be more proactive (Watson et al. 1991). These characteristics of executives' decisions have led to the need for specialized computerized decision aids that focus on gathering information. These characteristics include the need for immediate information, the need to look at overall data and the need to make strategic decisions. The preponderance of the work to date has concentrated on the determination of information requirements (Watson and Frolick 1993) and assessing the value of the EISs to specific organizations (for an example, see Belcher and Watson 1993).

The ability to use IT to access new data sources has generated some of the current interest in the Internet and on-line databases. Decision aids such as Web-browsers, gopher search facilities and database data filters provide assistance to decision makers attempting to use these data sources. Due to the recent development of these decision aids, little research in the accounting or information systems literature has addressed these aids.

### 2.1.2 Design-Stage Decision Aids

At the design stage, decision aids provide models to manipulate and combine information into meaningful and useful sets. Two general types of decision aids useful for the design stage are data manipulation models and presentation tools to vary presentation formats (Libby 1981). Data manipulation models may be used to assist a decision maker, or can be given the general authority to make choices on their own, such as models that automatically place orders for inventory. Strategic and organization-wide decisions may require decision aids that combine the expertise and judgment of a group of individuals (see chapter 4 of this book for a discussion of decision aids designed to support group decision making).

Data manipulation models include decision aids, such as regression models, simulations and optimization models, that depend totally upon the availability of IT to perform in an efficient and useful time frame. Other decision aid models, such as checklists, quantitative and qualitative algorithms, and decision rules, can be implemented with or without IT, but are often more feasible with IT. Modeling tools require a presentation mode, such as graphs, tables, schematic faces,[4] or other formats. These are combined with issues of timing, color, sequence and platforms (Kleinmuntz and Schkade 1993), resulting in a wide variety of presentations that can be incorporated into decision aids. Although these are discussed in the design-stage section, they are sometimes important in the choice stage as well.

Data presentation tools to provide differing formats include tables and graphs, with more complex presentations, such as schematic faces, occasionally

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[4] More commonly known as Chernoff's faces, see Chernoff (1973).

used. Differences in methods of presenting data include using numbers, text or pictures to represent values (Stone and Schkade 1991) and in methods of scaling values (Stone and Schkade 1994). Table 2 provides an overview of studies in this phase.

**2.1.2.1 Data manipulation models.** In the accounting literature, expert systems, specialized data manipulation programs, and generalized spreadsheet programs are the most commonly studied decision aids implemented with IT. Expert systems are specialized computer programs that, by definition, require IT for implementation. The knowledge bases from which they come could be created and presented manually, but the level of efficiency and the interaction of the rules is impossible without IT. Expert systems can recommend a solution, explain the logic behind how data are combined, provide a set of possible solutions based on variations of inputs (as in a sensitivity analysis), or question the evaluation of the decision maker. Studies of expert systems as decision aids have shown them to be effective in improving the performance of decision makers, especially relatively novice decision makers (Dorr et al. 1988; Eining et al. forthcoming).

Specialized data manipulation programs assist decision makers in combining data to produce alternative potential solutions. They allow the decision maker to try different data combinations, examine various ways of analyzing the data, and to create alternative solutions to the ones already at hand. Specialized data manipulation programs vary from providing mathematical formulas (Kachelmeier and Messier 1990), to reducing the needed effort to do calculations and comparisons (Todd and Benbasat 1991), to providing spreadsheet templates for "what-if" analysis (Kottemann et al. 1994).

One line of research involving data manipulation programs relies on the well-established theory that decision makers trade off the cognitive effort (cost) of implementing decision strategies against the increased decision quality (benefit) resulting from using more difficult strategies (Beach and Mitchell 1978).[5] Using this theory, researchers have built and studied aids that reduced the cost of implementing normatively preferable, but cognitively difficult, decision strategies, anticipating that the reduced cost will increase the use of these strategies.

In the accounting literature, models created as decision aids to reduce the cognitive effort of implementing decision strategies provide mixed results. Todd and Benbasat (1991) designed an aid to reduce the effort of evaluating multiattribute alternatives by mechanizing data manipulations. In their studies, Todd and Benbasat (1991, 1992) specifically identified various decision strategies and designed the aid to provide differential benefit for the different strategies. Use of this aid indicates that decision makers will adapt their strategies to use the decision aids available (Todd and Benbasat 1991) and that decision aids may reduce effort but not increase the amount of information considered in a

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[5] See Beach and Mitchell (1990) for some of their more current ideas regarding decision making. Nonetheless, the cognitive cost benefit model has produced robust results over time and across domains (Payne et al. 1993).

decision (Todd and Benbasat 1992). Creyer et al. (1990) found that unaided decision makers responded consistently with the cost benefit model of strategy selection when presented with incentives to increase accuracy or reduce effort. In a more recent study, Todd and Benbasat (1994) used a decision aid and found that reduced effort through use of the aid promotes the use of an aided strategy, but only after the effort crosses a threshold level that makes it less effortful than the decision maker's other available strategies. Todd and Benbasat (1994) also point out the potential negative aspect of reducing the effort required for implementing a non-optimal strategy. In this case, decision makers may forego accuracy and respond to reduced effort to an excessive degree.

**2.1.2.2 Presentation format.** The second major area of research where decision aids assist in the design stage of decision making is presentation format. Libby (1981) emphasized that, in the accounting literature, there was little discussion of the appropriate presentation formats for decision making. Since then, decision aiding presentation characteristics have been studied extensively. Kleinmuntz and Schkade (1993) identify three fundamental characteristics of information displays: form, organization and sequence. Form is the visual aspect of the information: numeric, textual or pictorial. Organization is how the information is juxtaposed; for example, in a multiattribute alternative choice decision, the information can be ordered by listing all the attribute values for each alternative or by all the alternative values for each attribute, or in a matrix that presents both (see Jarvenpaa 1989; Todd and Benbasat 1994). Sequence is the order in which individual items or set of items appear (Kleinmuntz and Schkade 1993). Sequence affects decision making, at least partly, by influencing the order that the information is processed (Ashton and Ashton 1988; Hogarth and Einhorn 1992).

A primary area of presentation format research relating decision aids and IT deals with the form of information. The relationship between form and IT lies primarily in the belief that IT allows great flexibility in reporting and therefore information form can be readily changed from one presentation format to another. Given this belief, research has centered on determining the forms that are the most appropriate for decision makers. Much of the research, however, has not been directly tied to IT. The relationship to IT is still based primarily on the, as yet minimally researched, contention that IT capabilities can be meaningfully brought to bear on problems through flexibility in information presentation.

Much of the work in the tables and graphs arena has sought to determine the most appropriate method to make decisions more efficient and of higher quality. Several authors have prepared extensive discussions of the two main presentation forms studied, graphs and tables (DeSanctis 1984; Jarvenpaa and Dickson 1988; Vessey 1991). One finding in graphs versus tables studies seem quite robust. Pictures are often not worth a thousand words. Task characteristics determine when graphs provide benefits to the decision maker (DeSanctis and Jarvenpaa 1989; Dickson et al. 1986; Jarvenpaa and Dickson 1988). DeSanctis (1984) presented a framework for studying graphics as decision aids and called for introducing strong theoretical components into the research.

More recent work has provided some important clues to the presentation format questions. The theory of cognitive fit, which states that "for most effective and efficient problem solving to occur, the problem representation and any tools or aids employed should all support the strategies (methods or processes) required to perform that task" (Umanath and Vessey 1994, 795), has been explored to determine the information presentation format most desirable for decision making (Vessey 1991; Vessey and Galletta 1991; Umanath, Scamell, and Das 1990; Umaneth and Vessey 1994). Vessey and her colleagues have expanded this research into cognitive fit, tying the presentation format to both task and decision strategy (Vessey and Galletta 1991; Umanath and Vessey 1994). This stream of research is beginning to explain some decision maker/presentation format relationships in relatively structured decision situations.

Further research on presentation form has developed along several lines. Expanding on the graph and table research, studies have added other types of pictures to represent information, such as schematic faces and polygon shapes (Amer 1991; Stock and Watson 1984; Umanath and Vessey 1994). These studies have been inconclusive. They seem to follow the concept of cognitive fit, but difficulty in implementing these studies and the relative newness of the work in this area has limited the interpretability of the results. Umanath and Vessey (1994) found that schematic faces were less effective than graphs for bankruptcy prediction. Amer (1991) seemed to support that finding. However, Stock and Watson (1984) found that schematic faces improved the ability of decision makers to detect changes in bond ratings. One of the difficulties in this area is the lack of a useful taxonomy of tasks. Task differences may drive these findings. Without the ability to distinguish among the relevant characteristics of different tasks, integrating these findings into a coherent theory or interpretation is problematic.

Henson et al. (1995) propose that some decision processes cannot be described by mental models, and must be directly measured through methods such as electroencephalography (EEG). Personal traits that require increasingly complex models or processes increase the difficulty of interpreting the extant research. As researchers move from relatively simplistic presentation formats and structured decisions, the theoretical models and operational measures used must also become richer and more complex. The findings will become more difficult to interpret but will be more applicable to practical situations.

Another line of research investigates decision maker performance when individual data points are represented by various forms. Stone and Schkade (1991) found that textual information presentation led to more alternative-based information search, while numeric information led to more compensatory processing. In a more recent study, Stone and Schkade (1994) found that the method of scaling attributes affects both the speed of the decision process and the accuracy of the decision. In their study, subjects using information presented on a common size context-irrelevant scale made more accurate decisions, while subjects with context-relevant presentations made faster decisions. These findings show that decision aid designers must utilize care in their choices for presenting information.

Understanding how tasks and presentation format relate will provide some basis for designing IT decision aids that assist decision makers better. Currently, however, the IT component of this research is minimal. Indeed, most of the research is being conducted with paper and pencil. Once the task/format relationships have been established, researchers will need to use IT. The ability for IT to change presentation formats easily has motivated much of the format work. Little work has been done, however, to determine if the characteristics observed in manual experiments remain when using computerized methodologies.

### 2.1.3 Choice-Stage Decision Aids

The choice stage of the decision process requires aids that will help the decision maker decide among the various alternatives. Decision aids can compare alternatives, recommend one of a set, or guide a decision maker through a choice model (Turban 1995). They, in essence, recommend a choice. A number of different aids have been developed to provide this assistance. For example, expert systems may recommend a specific action or alternative based on the impounded knowledge and rules of the system. Likewise, a model can specify an option based on the characteristics of the available choices (Schkade and Kleinmuntz 1994). Decision makers, however, are often reluctant to follow the recommendations of decision aids without question (Ashton 1990). Arkes et al. (1986) built a simple evaluation model to provide recommendations in a simple judgment task. They found that decision makers, even when informed that they were unlikely to be able to outperform the model, tended to rely instead on their own judgment. Arkes et al. (1986) found that increased incentive for accuracy and increased self-assessed expertise in the judgment domain both resulted in decreased reliance on the decision aid. In an auditing context, decision makers provided with decision aids that made recommendations performed better than unaided auditors, but auditors demonstrated some reluctance to use the aids (Ashton 1992). Ashton (1990) found that pressure factors, such as incentives or the requirement of justifying a decision, reduced the reliance on decision aids. Decision makers used the aids as a complement, not a replacement, for their personal judgment in these studies. Table 3 provides an overview of the papers discussed in this section.

The use of a decision aid to make a decision, rather than to assist in making a decision, presents problems. Relying on a decision aid means accepting a level of error inherent in the aid. Accepting the recommendation without using personal, expert judgment opens up possible avenues for liability, both to the decision-aid creator and to the decision maker relying on the aid. Kleinmuntz (1990) recommends that decision aids, as a general rule, be used in conjunction with professional judgment, rather than as a substitute for professional judgment (see also Peterson and Pitz 1986). This supports the actions of decision makers who use the solutions proposed by decision aids as advice.

### 2.2 Decision Aids that Affect the Decision Maker

While there has been considerable research on the effect of decision aids on the decision process or outcome, the effect on the decision maker has not

been studied as intensively. The work in this area tends to concentrate on either learning that occurs from the use of the decision aid or the understanding of the decision process through the guidance of the decision aid. These two areas are discussed in more detail below. A third line of research has investigated the learning that results from developing the decision aid. Although the decision maker is not necessarily the person developing the aid, this learning is important and is discussed in this section.

### 2.2.1 Information Technology Support for Learning from the Aid

Decision aids have some potential for increasing the knowledge of their users. Expert systems, in particular, have been looked at as potential sources of experiential learning. It is important to note that expert systems have been created to serve as tutors with the explicit goal of conveying knowledge. This discussion covers only expert systems created as a decision aid with the side benefit of transferring knowledge to the user. As decision makers use these aids, they may increase their expertise or knowledge through interaction with the expert systems during the process of making the decisions supported by the aid. These effects have been shown in both the study of internal controls (Eining and Dorr 1991) and problem solving in the financial risk domain (Fedorowicz et al. 1992). Pei and Reneau (1990) found that knowledge transfer only occurred when the problem representation matched the ruled-based expert system. Murphy (1990) did not find this increase in knowledge. One possible reason is that his study was conducted all in one day as opposed to the longer time frame of the other studies. This short time frame may not have provided the subjects with enough experience to transfer knowledge. Research attempting to understand the factors that influence the learning process has produced conflicting results. Gal and Steinbart (1992) investigated the role of the user interface and training tasks on the transfer of knowledge. They found that both areas affected the knowledge transferred. Experiments designed to require interaction between the decision makers and the expert systems through a study of the rules presented to the user have resulted in benefits (Pei et al. 1994) and no change (Steinbart and Accola 1994). Odom and Dorr (1994) found effects on development of declarative knowledge, but not on development of procedural knowledge. The studies discussed in this section are highlighted in table 4.

### 2.2.2 Decision Aid Support for Guiding the Decision

One of the major effects of using IT to implement decision aids is the guidance that can be provided in the decision process. Decisional guidance describes how a decision aid influences users as they go through the decision process. This guidance can be either inadvertent or deliberate, suggesting what to do or informing what can be done, and for structuring the decision process or executing the decision process (Silver 1991). IT characteristics can be used to deliberately guide decision makers, or can be designed with the explicit intent to not guide decision makers. As decision aids are implemented, however,

guidance characteristics are important to the overall effects of the aids. Research into this area is limited, but the implications, especially when considering the behavioral aspects of decision makers, have great importance.

Silver (1990, 1991) provides some theoretical basis for beginning the exploration of the guidance component of IT-based decision aids. Guidance issues include such things as menus, which may produce order effects, context-sensitive messages, which may provide information for differentiating among alternatives, and expert rules, which may suggest courses of action (Silver 1991). The theory of cognitive fit has been proposed as a possible basis for designing systems that limit the presentation of information to that most appropriate for the problem to be solved (Vessey 1994). Schkade and Kleinmuntz (1994) found that presentation organization influenced information acquisition, affecting the order and amount of information accessed. A recent study has shown some ability to influence decision makers to follow normative decision strategies by reducing the cognitive cost of the strategies (Todd and Benbasat 1994). In essence, decision aids using IT differentially reduce the cognitive cost of implementing two decision strategies. By making the normative strategy relatively less effortful, decision makers were influenced (guided) to use the strategy. This area of decision aid behavioral affects is not well understood.

### 2.2.3 Learning by Developing the Aid

Several authors have noted that the process of developing decision aids may reveal important decision-making processes. Dungan and Chandler (1992) found that, in an auditing context, the developers discovered ways to modify the audit to increase efficiency and effectiveness. These insights came from creating rather than using the decision aid. Steinbart (1987) created an expert system decision aid for the expressed purpose of understanding materiality judgments. There may be several ways to use decision aids for learning by developing the aid. Creating decision aid structures by requiring the user to fill in the contextual details forces the decision maker to explicitly consider the factors involved in the decision. Requiring the decision maker to create a decision aid could train the decision maker, which may be valuable when the decision will be repeated over time. The decision aid could have long-term benefits, rather than assisting in single decision situations. Research of meta-decision aids that are designed to improve decision making by having the decision maker build specific aids has not been done.

### 2.3 Decision Aids and Technology

The preceding sections have concentrated on the decision-making process and the decision maker. It is important to understand and consider the role of IT separately to provide for a complete discussion of decision aids and technology. While little research has been completed to date, the area warrants consideration.

### 2.3.1 Acceptance of Technology

While a great deal of research has been conducted considering decision aids as they relate to technology, it is important to consider the actual effects of the

introduction of the technology. For a decision aid to be useful, it must first be accepted and used. The specific inclusion of information technology into studies is important to help us understand the actual use and acceptance of these decision aids.

The fact that a decision aid is implemented on a computer can affect its usefulness, depending on the confidence that decision makers have in the computer system (Eining et al. 1992). Reluctance to use computers reduces the value of even the best decision aid, if it is implemented using IT. Although computers have the ability to modify presentation formats readily, to perform computations speedily and reliably, and to remember multiple items flawlessly, unless they are considered credible their value is low. Although there has been some research into decision makers' reluctance to use decision aids in general (Arkes et al. 1986; Ashton 1990, 1992), there has been little work examining how implementing decision aids with computers will affect decision-makers' reliance on the decision aids.

Over-reliance on the decision aid, due to some cachet provided by the delivery system, is equally troublesome. Anecdotal evidence indicates that decision makers may, in some circumstances, accept the results of decision aids because they were delivered over a computer system, without applying sufficient judgment to the problem. Indeed, some of the reluctance to use decision aids shown by decision makers may be an over-reaction to the problems of blindly accepting decision-aid recommendations.

Other research focusing on IT considers how people feel about the use of technology. Information system satisfaction studies provide some understanding of human-IT interactions that have consequences to behavioral researchers. Valid and stable measures of constructs relating to user acceptance of IT are being developed and tested (Adams et al. 1992; F. Davis 1989; Davis et al. 1989). The interaction between several constructs that lead to user acceptance, such as a decision aid's ease of use, perceived usefulness, and relevance to task at hand, make understanding user acceptance of decision aids a complex and important issue (Adams et al. 1992; Keil et al. 1995). As instruments using these measures become more widely used at least one behavioral aspect relating directly to the technology itself, acceptance of technology, can be captured by researchers.

Recent work has shown, however, that user satisfaction measures are potentially inaccurate measures of IT usefulness and effectiveness (Kottemann et al. 1994; Yuthas and Eining 1995). User satisfaction measures may give an indication of how *used* the aids will be, but may not indicate how *useful* they are. Researchers must find ways to both improve the effectiveness of decision aids implemented through IT and find ways to ensure that the decision aids are acceptable to the desired users.

### 2.3.2 Information Technology Capabilities

IT's capacity as a delivery medium for decision aids has been a major motivator for much of the recent research in decision aids. The capabilities of IT

have expanded the sophistication, complexity, speed and variety of decision aids. However, IT's role as an effective delivery system depends on hardware and software characteristics. Much of the decision-aid research to date makes the implicit assumption that the results of the research are constant regardless of the particular hardware and software used. Or, perhaps more accurately, the possibility that there may be some confounding effects due to the hardware and software is not considered. Few studies have examined decision aids and the computer characteristics that are important to implement the aids (see Sabherwal and Grover 1989).

Decision aids supported on IT must be concerned with the platforms on which they will be carried. For the near future at least, decision aids for mainframe computers will not be direct analogs of microcomputer decision aids. The platforms carrying the decision aids may have implications for the range of characteristics of the decision aids. For example, executive information systems, which are likely suppliers of data for decision aids, tend to be mainframe based, with large initial setup and annual maintenance costs (Watson et al. 1991). Watson et al. (1991) call for better integration of executive information systems with other systems, including decision support systems. For this to occur, decision aids must be designed to account for the platforms on which each of these systems operate.

In addition to IT's function as a delivery medium for decision aids, IT may well affect the use of the decision aid. As discussed above, decision aid characteristics such as guidance may be built into the aid by virtue of the fact that the aid is delivered by IT. Without the capabilities of IT, such characteristics may not be possible to implement. However, IT may well have unplanned or unexpected consequences.

Information technology includes the hardware and software available for decision aids. Currently, decision aids built for practice and research tend to be limited in their capabilities, due to the amount of knowledge and decision rules built into the aids, rather than the technology on which they are implemented. The predominant area of research relating to information technology itself revolves around group decisions, where hardware can be a limiting factor, particularly in terms of economics (see Chapter 4 for a complete discussion).

Computerized decision aids are application software-designed for specific or general tasks. Specific aids tend to be created for particular tasks or situations and are often built using spreadsheets, statistical software or graphical software. The behavioral decision aid research to date usually takes a specific aid and attempts to say something about the aid's usefulness for a particular task and generalize from the results. For example, Odom and Dorr (1994) built an expert system for a payroll task, and then interpreted the results of an experiment using the system as potential insights into how expert systems affect learning in general. Likewise, many researchers interested in information presentation issues create aids that differentiate between presentations of similar information for particular tasks, then generalize from the results of decision makers' experiences with the aids (see, for example, Chu 1991; Jarvenpaa 1989; Umanath and Vessey 1994).

Few studies, however, have looked at hardware and software, in general, in an attempt to determine preferred ways to implement IT. The one area that has some history of studies relating directly to the technology is the use of expert systems, a specific kind of applications that must be implemented on IT. Some general guidelines regarding expert systems use have been proposed at a theoretical level. Lamberti and Wallace (1990) studied interface requirements for expert systems in a diagnostic task and identified some general propositions for improving performance through the way that the expert system's explanation facility interacted with the user. Strategies for when to use expert systems as decision aids have been discussed by various authors attempting to identify the problem types and organizational situations that are appropriate for expert systems (Braden et al. 1989; Liang 1988; Meyer and Curley 1991; Turban 1995). Sutton (1990) presented a framework for identifying the expert system methodology most appropriate for a decision domain. These studies have greatly increased our understanding of the types of systems appropriate for particular decisions and some of the characteristics these systems should have to be most useful. While these studies have increased our knowledge of the best use of an IT-bound decision aid, the particular technology used to implement these systems is not studied.

## 3.0 FUTURE RESEARCH DIRECTION

Research opportunities currently exist in both the decision aids themselves and the technology with which the decision aids are implemented. Both the aids and the technology have behavioral aspects, complicating the research by introducing the human component. Future research must integrate IT, decision aids, human responses to both, and their interactions in order to provide meaningful knowledge. The task is to create a research agenda that can capture the richness of the decision aid/IT environment and yet yield results that are interpretable. The remainder of this chapter describes some areas of research that, when taken together, should improve our ability to create and implement useful decision aids through IT.

### 3.1 Decision Aid Characteristics

Decision aid characteristics include the phase or phases of the decision process supported, presentation format, interactivity with the user, guidance provided, and credibility to the user. Each of these areas presents a variety of research opportunities, both as individual issues and, perhaps more importantly, in interaction with each other. Certainly one of the most problematic issues in this entire line of research is the inability to study one issue in isolation from another. While we discuss the issues separately, the separation is only for the sake of exposition.

### 3.1.1 Decision-Stage Supported

**3.1.1.1 Intelligence stage.** Different phases of the decision process require support in different ways. The intelligence portion emphasizes identifying different alternatives and collecting all the relevant information for evaluation of

the alternatives. Although several studies have shown that decision aids can increase the number of alternatives considered for specific tasks (Chu 1991; MacCrimmon and Wagner 1994; Sharda et al. 1988), the intelligence phase of decision making has not been addressed by many researchers. What types of problems should these decision aids be used for? How should the decision aids be used to create meaningful alternatives? When is the generation of additional alternatives counter-productive? Has anything been learned from the implementation of EIS that can be generalized to other areas of decision aids?

Research is needed to determine the value and uses of information gathering tools such as network browsers and database search facilities. Are these tools efficient uses of decision-maker time? How can the search patterns be made more efficient and effective? How should these tools be controlled to both enhance their use and enhance the productivity of the users? Developments in this field proceed rapidly, seemingly without guidance or structure. Guidelines for development may be able to provide both immediate and long term benefits, as new and different tools are developed. It is important to consider the characteristics of these new tools to see if any knowledge gained from the prior studies of decision aids can be adapted to these new tools.

Decision-maker biases can affect the types of solutions they consider and the information they gather for evaluation of the alternative solutions (Haley and Stumpf 1989). Little work has explicitly addressed developing decision aids to mitigate the effects of cognitive biases in decision makers (Butler 1985), although much of the work on increasing decision performance could potentially be framed in this area. Decision aids sometimes affect performance results (Ashton 1992; Northcraft and Earley 1989; Stone and Schkade 1994), but strong theories for why these results occur are seldom presented. Research into decision-maker biases and the affects of decision aids on these biases could strengthen our understanding of how decision aids can be used to improve the way information is gathered in the decision process. Some early research demonstrated that decision-maker differences sometimes accounted for differential performance work (Benbasat and Dexter 1982, 1985). One way to understand how these differences relate to performance results may be to understand which decision-maker biases the decision aid addresses.

**3.1.1.2 Design stage.** At the design stage, the decision process is supported by allowing the decision maker to manipulate information readily and productively, so that the various alternatives can be evaluated. Several research avenues exist in this stage. First, researchers need to determine what decision models can be incorporated into decision aids. This determination involves analyzing the potential costs and benefits of designing the aid, recognizing the likelihood that the aid will be used if it is created, and identifying the IT necessary to implement the aid. Second, researchers need to determine what presentation formats are appropriate for decision aids and how the formats should be communicated. This area has had much activity, but until recently there has been little theoretical development that would allow findings to be used to predict behaviors and results. The cognitive cost/benefit theory has brought

some generalizability to this area, providing some basis for understanding (Umanath and Vessey 1994; Vessey 1991). This work can be extended in several directions. A wider range of tasks needs to be investigated, especially tasks that are relatively unstructured. The cost/benefit theory could be used to determine the effects of personal differences between decision makers. The work of researchers interested in tables versus graphs, linguistic versus numeric, and pictorial versus textual needs to be integrated to determine possible unifying themes.

Whereas form of presentation has been actively studied, organization and sequence (Kleinmuntz and Schkade 1993), information overload (Iselin 1988), information diversity (Iselin 1989), timing and frequency, and other potential characteristics of information presentation are not currently the focus of much research. Some of these characteristics have been shown to be important for decision processes and outcomes (Iselin 1988, 1989; Schkade and Kleinmuntz 1994), and research to tie these results into our understanding of decision aids is necessary.

Much of the research involving information presentation format has been done outside of an operational IT system. The ultimate goal of the research, however, is to find decision aids that work through IT. Research to tie the currently obtained results to IT is needed. As identified above, decision aids used in an IT environment may create responses that differ for an implementation outside that environment. Determining whether the responses found in manual experiments and in unrealistically structured IT experiments occur in a more realistic environment is an important step to creating truly useful decision aids. Research to integrate these findings into a realistic IT environment is needed.

Another vital area for decision-aid research involves the willingness of decision makers to use the aids. Both reluctance to use aids and over-reliance upon aids create dysfunctional use patterns. Determining the decision-aid and decision-maker characteristics that affect willingness to use the aid in appropriate situations is vital to successful development and dissemination of decision aids. Research shows that these dysfunctional patterns exist, but what causes the behaviors, and how to overcome these factors, is not known.

**3.1.1.3 Choice stage.** Research opportunities at the choice stage of the decision process involve two major issues. First, should decision aids be used to make decisions? What types of problems are appropriate for relying on the decision aid rather than on personal judgment? This issue is both philosophical and practical, and must be considered from a broad perspective. Second, assuming that we decide that the aids should, in some cases, be used to make decisions, how do we ensure that decision makers will actually rely on the decision aids? What characteristics of the aids and the users will combine to make the aid credible to the user? What characteristics of the aids and the users will combine to make sure that the user is alerted to instances when personal decision making should over-ride the aid? These questions deal directly with the interaction of aids and users, creating complications for

interpretations and research designs, but resulting in answers that are particularly relevant.

### 3.1.2 Effects on the Decision Maker

**3.1.2.1 Learning from the aid.** Decision aids may provide some inherent capability to disseminate knowledge. The most apparent example is expert systems, in which explanation features can be created to explain reasoning and rules. Other decision aids, such as checklists and algorithms, certainly can be used to educate users as well. Several questions are unanswered, however. What types of knowledge are likely to be learned? Is the learning process valuable for future decisions? When does the learning process become harmful to the judgment of the aid user? Are decision aids efficient and effective methods of transferring desired knowledge? Is the type of knowledge that decision aids are likely to transfer what we would like to see in decision makers? Research from external disciplines such as education, psychology and decision making may well provide insights to how and when using decision aids for knowledge transfer is useful.

**3.1.2.2 Guidance by the aid.** Using decision aids to guide decision making has long been a controversial topic (see Huber 1983). Behavioral accounting research to determine whether and when a decision aid should guide decision making is important for identifying when decision aids should be used, for determining what types of guidance decision aids should provide for the decision makers, and for identifying the IT/decision-aid characteristics that would determine the guidance level provided. Regardless of the decision about whether to provide guidance, the characteristics of the technology and the aid must be considered to determine whether guidance is, in fact, provided. Certainly different IT and decision-aid characteristics will result in direction, whether intended or not. A goal of research in this area should be to determine the effects of this default direction or explicit guidance. Another complicating factor in the decision guidance area is the differential responses by decision makers. The decision-maker characteristics may be of particular importance in this area, as individuals with different traits may respond quite differently to the guidance features in the decision aids. It would also be of interest to consider the ethical dimensions of guidance. Is it ethical to eliminate options from the decision maker? Another aspect is the influence of culture. Do differences in culture effect the decision to provide guidance in the aid? Do cultural differences impact the acceptance of guidance from the aid?

### 3.1.3 Information Technology Characteristics

Information technology characteristics affect the decision maker. Certainly debates about user satisfaction, application transparency, ease of use, and dysfunctional behaviors due to technology reflect differences between different technologies. In accounting behavioral research we must investigate how these differences influence decision making and use of accounting information. What effects have been found in related disciplines, such as computer science,

psychology and information systems? How do we bring these findings into our contextual area? Are there specific issues relating to accounting that need to be handled differently than in the surrounding disciplines? Technological issues, apart from the confounding issues of decision aids and the interaction of humans and decision aids, must be understood vis-à-vis human behaviors in accounting. Issues of user acceptance of technology (Adam et al. 1992; F. Davis 1989), user confidence in technology (Eining et al. 1992), and user perception of technology (Davis et al. 1989) all provide starting points for research in this area.

A complicating factor, of course, is that technology without some context is meaningless. Understanding decision-makers' acceptance of technology inevitably requires some contextual domain. Studies identify specific tasks and domains, then investigate the behavior of decision makers in the prescribed situation and draw some specific interpretations. To draw generalizable interpretations from research about technology, the results must come from a wide array of demonstrably different tasks.

### 3.1.4 Taxonomy of Tasks

As Amer et al. (1987) noted, most research efforts have been focused toward isolated topics, without seeking wide generalizability. One hindrance to wide generalizability is the lack of a good taxonomy of tasks that can be used to identify classes of problems in ways that are relevant for IT-based decision tools. The greatest inroads to this have been accomplished by researchers in the information presentation area, where tasks relevant for different types of presentations have been identified (see Vessey 1991). Sabherwal and Grover (1989) suggest some problem characteristics that could be used to create a taxonomy useful for creating general rules for decision aids. Karan et al. (1993) investigated characteristics of audit tasks, to determine which were most suitable for expert systems development. Further research into task characteristics relevant to decision aid development is needed before broadly applicable decision aids can be created.

Determining a taxonomy of tasks that is relevant for a wide range of situations would provide a useful research and managerial resource. Task characteristics are important to a variety of issues in understanding behavioral responses to decision aids, as well as to IT. Tasks often need to be broken into more elemental components to construct and implement decision aids (Bamber 1993; Karan et al. 1993; Todd and Benbasat 1994). Using cognitive cost/benefit theory to motivate choices of decision aids, or to support the use of one decision strategy with decision aids, requires a structure to differentiate tasks (Beach and Mitchell 1978; Vessey 1991; Todd and Benbasat 1994). Perceived usefulness of IT and the consequent acceptance of technology also appear to be confounded by task characteristics (Adams et al. 1992; Keil et al. 1995). Likewise, task characteristics seem to drive, or at least significantly influence, many behavioral responses to decision aids (Jarvenpaa and Dickson 1988; Umanath and Vessey 1994; Vessey and Galletta 1991). In light of these findings,

a taxonomy that can readily separate different tasks by characteristics important to decision aid use and IT acceptance would be of great value to researchers.

## 4.0 SUMMARY

Behavioral accounting research in decision aids implemented through IT is at an early stage of development. The research draws from a diverse variety of disciplines such as cognitive psychology, operations research, computer science, and human decision making. This diversity makes integration of the concepts and findings difficult, but nevertheless very important. As is typical in any young discipline, early research efforts proceeded without a strong theoretical foundation. As we attempt to understand, guide and assist decision makers, theoretically sound results will start to emerge. The research into cognitive fit is a good example of organizing early work along a theoretical framework, resulting in some predictable results that may stand the test of future discoveries.

Research opportunities abound in the study of decision aids, their use and abuse, and the behaviors of their users. Bringing in the theories from adjacent disciplines may increase our understanding of the use of decision aids in an IT environment and may increase our ability to create decision aids that make significant contributions to decision quality.

## TABLE 1
### Decision Aids to Support the Intelligence Phase

| Study | Type of Decision Maker | Type of Decision Aid | Task | Variables of Interest | Overview of Findings |
|---|---|---|---|---|---|
| Sharda et al. (1988) | Senior undergraduates (96) | IFPS model designed for the specific task | Business simulation game, with multiple decisions and multiple periods | Aided and non-aided | Aided groups performed better, initially taking longer time than unaided, but evening out over time. |
| Chu (1991) | Graduate business students (40) | Spreadsheet | Allocation of demand for services among providers, with multiple sub-goals | Presence of decision aid, number of alternatives generated | Decision aid increased alternatives generated in a simple, but not in a complex, task. Decision aid increased incremental decision making, rather than synoptic decision making. |
| MacCrimmon and Wagner (1994) | Upper-division business students (48) | Creativity software | Generate solutions to several unstructured business problems | Presence of decision aid | Computerized idea generation, via the decision aid, led to more creative alternatives. |

## TABLE 2
## Decision Aids to Support the Design Phase

| Study | Type of Decision Maker | Type of Decision Aid | Task | Variables of Interest | Overview of Findings |
|---|---|---|---|---|---|
| Stock and Watson (1984) | Accounting students, Ph.D. students, faculty (137) | Tables, multi-dimensional graphics (Chernoff's faces) | Detect changes in firm bond ratings | Presentation format | Multi-dimensional graphics improves the decisions made, compared to tables. |
| Benbasat and Dexter (1985) | Marketing undergraduates and graduate students (35) | Color-enhancement, graphs | Allocation of a fixed promotional budget over three marketing areas | Presentation mode (graphs vs. tables, color vs. monochrome), field dependence of subjects | Colored reported improved decision quality, especially for field dependent subjects. |
| Dorr et al. (1988) | Accounting undergraduates (96) | Expert System | Evaluation of internal control | Use of expert system | Performance improved with use of system. |
| Jarvenpaa (1989) | MBA students (60) | Graphs | Choose a restaurant site from a set of alternatives | Decision strategy, graphical presentation format | Information presentation format influenced decision time and selection of strategies by influencing cognitive cost. |
| DeSanctis and Jarvenpaa (1989) | MBA students (48) | Graphs and tables | Forecasting financial status of firms from past financial data | Presentation format | Weak results supporting use of graphs. |
| Kachelmeier and Messier (1990) | Big 8 auditors (152) | Mathematical formula, listing of relevant parameters | Sample size selection | Aided and non-aided; internal control environment | Decision aids increased the sample size selection over intuitive judgments, reducing biases due to the "law of small numbers," while increasing variability of responses. |
| Amer (1991) | Undergraduate accounting students (76) | Tables, graphs, polygon display, Chernoff's faces | Estimate bond ratings, identify violations of debt covenants | Decision aid level, task characteristics | Task characteristics and presentation format interact. Selective tasks are better performed with tables and graphs than with polygons and faces. |
| Stone and Schkade (1991) | Graduate students (24) | Numeric and textual information | Choice of computer system | Type of information format, task complexity | Numeric information led to compensatory processing, with less alternative-based searching than did textual information. |

*(Continued on next page)*

## TABLE 2 (Continued)

| Study | Type of Decision Maker | Type of Decision Aid | Task | Variables of Interest | Overview of Findings |
|---|---|---|---|---|---|
| Todd and Benbasat (1991) | Undergraduate business students and MBA students (84) | Specialized data manipulation functions | Choice of an apartment from a set of alternatives | Presence of decision aid, search strategies supported by the aid | Decision makers tend to adapt their strategies to the decision aids available. |
| Todd and Benbasat (1992) | Undergraduate business students (56) | Specialized data manipulation functions | Choice of an apartment from a set of alternatives | Presence of decision aid, effect of decision aids on cognitive effort | Decision aids reduced the effort expended, but did not increase the amount of information used to make a decision. |
| Eining et al. (forthcoming) | Audit Managers (120) | Expert system, logit model and checklist | Evaluation of risk of management fraud | Type of decision aid, reliance on decision aid | Aided decision makers outperformed unaided with the most benefit for high risk fraud cases. |
| Todd and Benbasat (1994) | Undergraduate students (48) | Specialized data manipulation functions | Choice of an apartment from a set of alternatives | Decision strategy supported by decision aid, decision strategy chosen by decision makers | Decision aids can promote strategies by reducing the effort to use the strategy, but only if reduced relative to alternative strategies. |
| Stone and Schkade (1994) | Undergraduate students (396 in two experiments) | Information scaling differences: UCR, CCI and UCI | Choice of word processing system, college, whiskey | Type of information scaling | Common, context-independent scaling improved accuracy; uncommon, context-relevant scaling increased speed. |
| Schkade and Kleinmuntz (1994) | MBA students (60) | Sequence, format and organization of data | Evaluate of loan applications based on company criteria | Differences in information presentation format | Information organization strongly influenced information acquisition, form influenced combination and evaluation. |
| Umanath and Vessey (1994) | MBA students (33) | Graphs, tables and schematic faces | Bankruptcy prediction | Type of decision aid available | Schematic faces, because of the inability to determine individual values, were less effective than graphs, which were better than tables, due to the ability of graphs to integrate data. Cognitive fit was supported. |
| Kottemann et al. (1994) | MBA students (26) | What-if analysis spreadsheet | Production scheduling simulation | Presence of decision aid | What-if analysis increased confidence in decisions, but not the accuracy of decisions. |

## TABLE 3
## Decision Aids to Support the Choice Phase

| Study | Type of Decision Maker | Type of Decision Aid | Task | Variables of Interest | Overview of Findings |
|---|---|---|---|---|---|
| Arkes et al. (1986) | College undergraduates (226, 42) | Decision rule | Judgmental rating of students and athletes | Knowledge of decision aid accuracy, incentives, on use of decision aid | Understanding led to better use of the rule, incentives led to decreased use of the rules, self-assessed expertise led to decreased use of the rules. |
| Peterson and Pitz (1986) | MBA students (20) | Decision rule | Decide most valuable baseball player | Level of existing task knowledge | With aid, moderate-knowledge group outperformed high-knowledge group, but did not perform as well as the aid. |
| Ashton (1990) | Auditors (182, 62) | Regression formula | Predict bond ratings | Presence of decision aid, face validity characteristic, three forms of pressure | Presence of pressure reduced reliance; decision aid with high face validity relied on more. |
| Ashton (1992) | Auditors (59) | Decision model presented as text | Predict bond ratings | Presence of decision aid, requirement to provide written justification | The decision aid and requirement for justification both increased judgment performance. |

## TABLE 4
## Decision Aids that Affect the Decision Maker

| Study | Type of Decision Maker | Type of Decision Aid | Task | Variables of Interest | Overview of Findings |
|---|---|---|---|---|---|
| Pei and Reneau (1990) | Accounting undergraduates (63) | Rule-based expert system | Evaluation of internal control | Problem representation of the rule-based expert system and learning | Consistency of problem representation and rule-based expert system led to increase in knowledge transfer. |
| Murphy (1990) | Upper-division accounting students (67) | Expert system and non-automated aid | Evaluate compliance with accounting standards | Presence of expert system, explanation of reasoning in expert system | Non-automated aid resulted in higher level of expertise than did expert system with explanation. |
| Eining and Dorr (1991) | Upper-division accounting students (191) | Questionnaire, expert systems | Evaluation of internal control adequacy | Level of support from decision aids, feedback content on decision accuracy and time | Use of expert systems decision aids improved performance over unaided and questionnaire. |
| Gal and Steinbart (1992) | Accounting undergraduates at two universities (93) | CAT program | Causal reasoning about relationships between internal control procedures and errors | Design of human-computer interface and content of training tasks on learning | Both interaction style and training tasks affected learning. |
| Fedorwicz et al. (1992) | Graduate and senior management students (32) | Expert system called ESRISK | The evaluation of risk in the development and implementation of financial information systems | Presence or absence of expert system during training | Novice performance was improved through training with an expert system. |
| Odom and Dorr (1994) | Accounting undergraduates (126) | Expert system | Evaluating controls over a payroll processing system | Level of elaboration provided, timing of elaboration, amount of learning | Level of elaboration and timing of elaboration affected declarative knowledge learning, not procedural knowledge. |
| Steinbart and Accola (1994) | Accounting undergraduates (78) | Expert System | Evaluation of internal control adequacy | Explanation type and user involvement | Neither explanation type nor user involvement affected the amount of knowledge transfer. |