Computerized Decision Aids For Flexible Benefits Decisions: The Effects of an Expert System and Decision Support System on Employee intentions and Satisfaction with Benefits

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Review chapters and case descriptions suggest that expert systems and decision support systems are useful decision aids in human resource management. Our study examines this belief by exploring the effects of two such systems on the quality of employees' desired benefit choices and satisfaction with benefits in a flexible benefits environment. Results show that employees' current benefit choices and desired benefit changes are related to satisfaction with benefits. Those using both computerized decision aids signaled benefit choice intentions that more closely corresponded to expert system recommendations than those not using a decision aid, but those using the expert system desired to make more expert-like decisions than those using the decision support system. In addition, those using the expert system had greater satisfaction with benefits than those not using a decision aid and those using the decision support system. These results suggest that expert systems have potential for improving decision making and influencing employees' attitudes for human resource problems.

Much of the human resource management literature that deals with computerized decision aids focuses on descriptions of system features (Broderick & Boudreau, 1991; Lawler, 1992) or examples of alternative applications (e.g., Briggs & Doney, 1989; Kavanagh, Gueutal, & Tannenbaum, 1990; Kirrane & Kirrane, 1990). In a recent review of information systems in human resources, Lawler (1992) called for research to move beyond descriptions of systems to examine the effects of decision aids on employees' attitudes and behaviors. Our study is one of the few field experiments in human resources to explore the effects of multiple decision aids on user decisions and attitudes.

We examine two types of decision aids that are increasingly relevant for human resource problems: Decision Support Systems (DSS) and Expert Systems (ES) (Broderick & Boudreau, 1991). Briefly, DSSs are interactive computer programs designed to (a) provide relevant information and (b)

help answer "what if f questions (Kavanagh et al., 1990). These systems are designed to help users solve problems, but do not actually solve problems themselves (Thierauf, 1991).

Alternatively, ESs are programs designed to model experts' knowledge into logical structures, translate their heuristics into formal rules, and use these rules to provide expert quality solutions to users (Al-Attar, 1990; Rich & Knight, 1991; Stefik, 1990). ESs differ from conventional DSSs in that they model the human decision-making process rather than utilizing rigid, process-based algorithms (Edwards, 1992). On the other hand, because their logic is not built from a learning algorithm, ESs differ from other artificial intelligence programs (Weiss & Kulikowski, 1991). ESs are intended to mimic experts' problem-solving processes by combining, organizing, and applying the questions and heuristics used by domain experts. This study examines how these two different types of decision aids, a DDS and an ES, help employees make their decisions in a flexible benefits setting. This study also compares these two decision aids to unaided decision making. Three specific questions are examined: (a) Are employees' benefit choices (current or desired) related to their level of satisfaction with benefits? (b) How do different benefit decision aids (DSS and ES) affect employees' desired benefit choices? (c) How do different decision aids (DSS and ES) affect employees' satisfaction with benefits? Before presenting our specific hypotheses, we first review the three methods used in this study to make benefits decisions (ES, DSS, and no decision aid) and discuss the flexible benefits decision-making problem.

Decision Aids

Expert Systems

ESs share several features that distinguish them from other decision aids. Specifically, ESs capture and combine the knowledge of one or more subject matter experts and use this knowledge to recommend a solution for the user (Lawler, 1992). In addition, ESs often provide the user with the rationale behind their recommendations (Moffitt, 1994).

ESs are particularly relevant to human resources because they offer the potential to preserve human expertise, enhance the productivity of employees by providing them with expertise, provide personalized and expert quality training to a large number of employees, and enable experts to devote their time to more complex tasks (Krebs & Parish, 1986; Rufflo, 1990). Thus, ESs offer a number of potential means of improving employee productivity. Accordingly, ES use in human resource management appears to be on the increase (Lawler & Elliot, 1996). ESs are discussed in reviews highlighting emerging human resource information technologies (Broderick & Boudreau, 1991; Lawler, 1992), and the professional literature reports a number of ES applications, including systems for

employee selection (Mau & Smeltzer, 1989), job analysis (Green, 1987), scheduling (McMillan, 1989), performance appraisal (Roberts, 1988), and compensation (Roberts, 1988). Unfortunately, virtually all the research on ESs in the field of human resources is limited to aspects of system design rather than system use. For instance, a special issue of *Organizational Behavior and Human Decision Processes* that was devoted to experts and ES research in organizations (Shanteau & Stewart, 1992) focused primarily on expertise and design-related issues, not the consequences of ES use.

Not surprisingly, outside of the professional press, most of the ES research is reported in the management information system and computer science literatures. These studies focus on analyses of ES feasibility (Goul & long, 1987), case studies of applications (Sviokla, 1990), issues related to ease of use (Lamberti & Wallace, 1990), and evaluations of alternative methods of knowledge acquisition and representation (Hoffman, Shadbolt, Burton, & Klein, 1995; Lenk & Floyd, 1988; Liang, 1992; Tou, 1985; Wright & Ayton, 1987). Research into the effects of ESs on users reports that ESs generally improve individual performance and learning (Fedorowicz, Oz, & Berger, 1992; Lamberti & Wallace, 1990; Moffitt, 1994; Sviokla, 1990). Aside from measuring user satisfaction with the ES itself, however, little is known about the effects of ESs on other attitudinal measures. In addition, there has been no research comparing the effects of ESs with other computerized decision aids, such as DSSs, which have a longer history and are more widely used.

One notable exception to the lack of studies on the effects of ESs in human resources is an article by Lawler and Elliot (1996), who describe an experiment where an ES is compared to a paper and pencil system for job analysis. In their study, intended users of the job analysis ES were randomly assigned to treatment groups that varied on the method of decision making (ES versus paper and pencil) and complexity (low, medium, or high). The results of the study showed that the main performance and attitudinal effects for the ES were not significantly different from those of the paper and pencil system. Further, the system often yielded worse outcomes (e.g., lower accuracy) for more complex tasks. Nonetheless, their study illustrates the feasibility of constructing an ES in a human resource context and demonstrates how one can be examined in an experimental study.

Decision Support Systems

Generally speaking, DSSs are designed to help users derive numerical solutions for a wide range of problems (Thierauf, 1991). DSS features often include statistical capabilities, linear programming options, database management features, and simulation abilities (Lawler, 1992). The one feature they all share is their ability to allow a user to ask "what if type questions (Kavanagh et al., 1990; Lawler,

1992). Of course, these systems vary dramatically as to how they permit users to ask this question, but they virtually always provide users with a means to estimate the effects of various decisions on the variables of interest.

Similar to research on ESs, DSS research has focused on design and development issues (Sharda, Barr, & McDonnell, 1988). A few case and field studies show improved decision-making performance (for a review, see Sharda et al., 1988). Yet, the comparative advantages of ESs and DSSs remain to be adequately explored.

No Decision Aid

Unaided decision making probably remains the most common approach for decision makers, especially in the realm of human resource management. For most situations, decision aids simply have not been developed, and when alternative decision strategies are available, decision makers may choose not to use them (Beach & Mitchell, 1978). Therefore, because decision aids are usually introduced to aid decision making in a previously unaided environment, using a "no decision aid" group is a logical comparison group for studying the effects of ESs or DSSs.

Some research suggests that people react adversely to the introduction of DSSs (Peterson & Peterson, 1988). For instance, Kotteman and Davis (1991) reported that subjects often avoid computer-based aids in favor of simpler, but less accurate, approaches. On the other hand, others have found that people prefer to use computerized decision aids (Bronner & De Hoog, 1983), are more satisfied with such a process, and prefer the choices they arrive at when compared to unaided decisions they made (Aldag & Power, 1986).

Essentially, the effects and desirability of a decision aid (versus not using a decision aid) depend on the characteristics of the decision maker, the type of problem, and the environment (Beach & Mitchell, 1978). Thus, before being able to make any specific predictions on the effects of using an ES, DSS, or not using a decision aid, the decision environment must be examined.

The Setting: Flexible Benefits Choices

As noted, potential applications for both DSSs and ESs have attracted attention in human resource management (e.g., Briggs & Doney, 1989; Lawler & Elliot, 1996; Mau & Smeltzer, 1989; Whaley, 1989). One human resource process, selecting flexible benefits, lends itself to DSS and ES applications because of its complexity, scope, and effect on a large number of people (Besser & Frank, 1989).

For over 25 years, E. Lawler (1971) and others have espoused the merits of flexible benefits. Essentially, they argue that allowing individuals to choose their own benefits heightens employees' knowledge of their benefits options and makes them better informed about the costs and values of their choices. A basic premise is that offering employees a choice improves the likelihood that the benefits selected will meet the individual's needs and preferences better than an employer-determined, one-size-fits-all benefit program. Indeed, there is long-standing evidence that significant individual differences in benefit preferences exist (Davis, Giles & Field, 1985, 1988; Huseman, Hatfield & Robinson, 1978; Nealey, 1963). Therefore, if flexible benefits plans improve the fit between what employees prefer and what they receive, then discrepancy theory (Locke, 1969) predicts that flexible benefit plans should increase employees' satisfaction with benefits.

Over the past 2 decades, the proliferation of flexible benefit plans has increased dramatically. In 1981, only 17 major employers offered them. By 1983, 99 major employers offered them, and by 1992 over 1,400 such plans had been implemented (Hewitt Associates, 1993a). The design of these plans varies extensively (Hewitt Associates, 1992). The simplest plans give employees the opportunity to contribute pre-tax income into a flexible reimbursement account (e.g., flexible spending accounts) that may be used to pay expenses for benefits such as dependent care, uncovered medical expenses, and dental care. More complex plans allow employees to select from several different benefit categories (e.g., medical care, dental care, life insurance) and different levels of coverage within these categories. According to Hewitt Associates (1993b), in a study of 1,034 major U.S. employers, almost 80% offered some sort of choice in the benefits process, with health care spending accounts (69%), dependent care spending accounts (73%), and health care plan choice (53%) being the most common features.

Employee benefits have grown to about 41 % of payroll costs in 1994 from 20% in 1955 (US Chamber of Commerce, 1994). Scholarly research on benefits has also increased, although most of it has been directed at measuring satisfaction with benefits. There have also been attempts to develop theoretical models of benefits satisfaction, its antecedents, and consequences (e.g., Miceli & Lane, 1991). Questions about the different facets of satisfaction with benefits (Heneman & Schwab, 1979, 1985; Judge, 1993), the robustness of these facets among employees in different occupations (Scarpello, Huber, & Vandenberg, 1988), and the independence of benefits and pay satisfaction (Dreher, Ash, & Bretz, 1988; Heneman & Schwab, 1985) have also been examined. Research into the antecedents and consequences associated with the implementation of flexible benefits plans has been more limited.

Miceli and Lane (1991) and Williams and MacDermid (1994) suggested that individuals' need for control may yield higher satisfaction with benefits under flexible benefits plans. In one of the few

studies of its effects, Barber, Dunham, and Formisano (1992) reported that the introduction of a flexible plan was positively related to increased satisfaction with benefits.

Others are less sanguine about the relationship between flexible benefits plans and satisfaction. Writers of benefits administration texts and articles note that choosing benefits in a flexible benefits plan is a highly complex task (Besser & Frank, 1989; Mamorsky, 1990; McCaffery, 1992; Rosenbloom & Hallman, 1981). They note that this complexity may be a source of confusion, poor decisions, and, eventually, dissatisfaction (Rosenbloom & Hallman, 1981).

The Case at Hand: The Personal Choice Flexible Benefits Plan

Personal Choice is the name of the corporate flexible benefits plan studied here. Like many flexible benefit plans, under Personal Choice, employees are granted a predetermined number of benefits "credits" to allocate across different benefit categories. In general, the number of credits employees receive is a function of their salary, number of dependents, and years of service. These credits, roughly equivalent to real dollars, are then used to purchase various benefits. Employees who want more coverage have the option of supplementing their credit allowance with actual, out-of-pocket dollars, which are deducted from their pay (usually) on a pre-tax basis. Personal Choice has nine benefit categories, with two to eight options (levels) of coverage per category, and two flexible spending accounts. Thus, theoretically, employees have a choice of over 2 million benefit combinations, not including allocations to the spending accounts.

The DSS Aid—Choice Maker

In light of this complexity, the company being studied, like many others, developed a decision aid for its employees. Their DSS, known as Choice Maker, combines information on benefit types, costs, and regulations. It also incorporates decision assisting features such as menus and error checking. Choice Maker helps employees make benefits decisions by simplifying the mathematical task of calculating the costs of their selections. The program computes the cost of each choice and deducts this from the total credits provided to the employee. The system also prevents employees from making illogical choices (e.g., choosing spouse life insurance when the employee is single). Although the system provides the user with access to a wide array of benefit information and enforces various enrollment rules, it does not provide any specific recommendations to the decision maker.

The ES Aid—Personal Choice Expert

In conjunction with the authors, the company developed Personal Choice Expert (PCE).[1] This is a customized ES that generates recommendations for each of the nine benefit categories and two spending accounts. This system, written using the ES shell Knowledge Pro (Knowledge Garden, 1991), was designed and developed in accordance with conventional knowledge engineering procedures (e.g., Parsaye & Chignell, 1988; Rich & Knight, 1991 Stefik, 1990).

Specifically, this ES was designed using the expertise of company benefits experts. First, independent interviews were conducted with three experts to obtain the decision rules used by each expert. The interviews primarily entailed working through example cases with each expert and asking him or her to explain the reasoning behind each recommendation. Second, based on the results of the interviews, a prototype was developed. The logic of the prototype was evaluated by the three experts and differences in the decision logic were resolved by the experts A copy of PCE is available from the authors to any researchers interested in replicating or extending our study. as a team. The prototype was also pilot tested on eight employees (Hannon, Milkovich, & Sturman, 1990), which led to slight alterations of the user interface.

To validate the system, ES recommendations were in part compared to those of other company experts. The company identified 16 benefits experts from throughout the country. A questionnaire, consisting of 10 employee scenarios, was distributed to the 13 experts who did not participate in the system design. Eight experts completed the questionnaire for the validation study. The validation study showed that the system exhibits criterion-related validity in that its recommendations and those given by independent experts do not differ significantly. Moreover, a sample of non-experts did not consistently provide recommendations of the same quality as the ES. In other words, PCE successfully mimics the decision processes used by the company's benefit experts. For more information on the validation study, see Sturman and Milkovich (1995).

A typical user session with PCE consists of four phases: introduction, questioning, recommendation, and modification. The introduction phase provides an on-line help screen informing the user about what the system does and how to proceed.

In the questioning phase, illustrated in Figure 1, users move through a decision tree to answer a series of questions (up to 25) pertaining to their individual demographics and personal circumstances. These questions are used to capture and incorporate information on the employee (e.g., age, sex,

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[1] A copy of PCE is available from the authors to any researchers interested in replicating or extending our study.

income) and the employee's family (e.g., marital status, spouse income, number of children, spending habits, alternative sources of health and life insurance).[2]

In the recommendation phase, the ES combines the individual's inputs and the decision schemes embedded in the system to generate a set of recommended decisions. These outcomes are then displayed on the screen and via a printout (see Figure 2). This printout replicates the company's actual benefit enrollment form. When finished, employees could conceivably print, sign, and submit this form to register their flexible benefit choices.

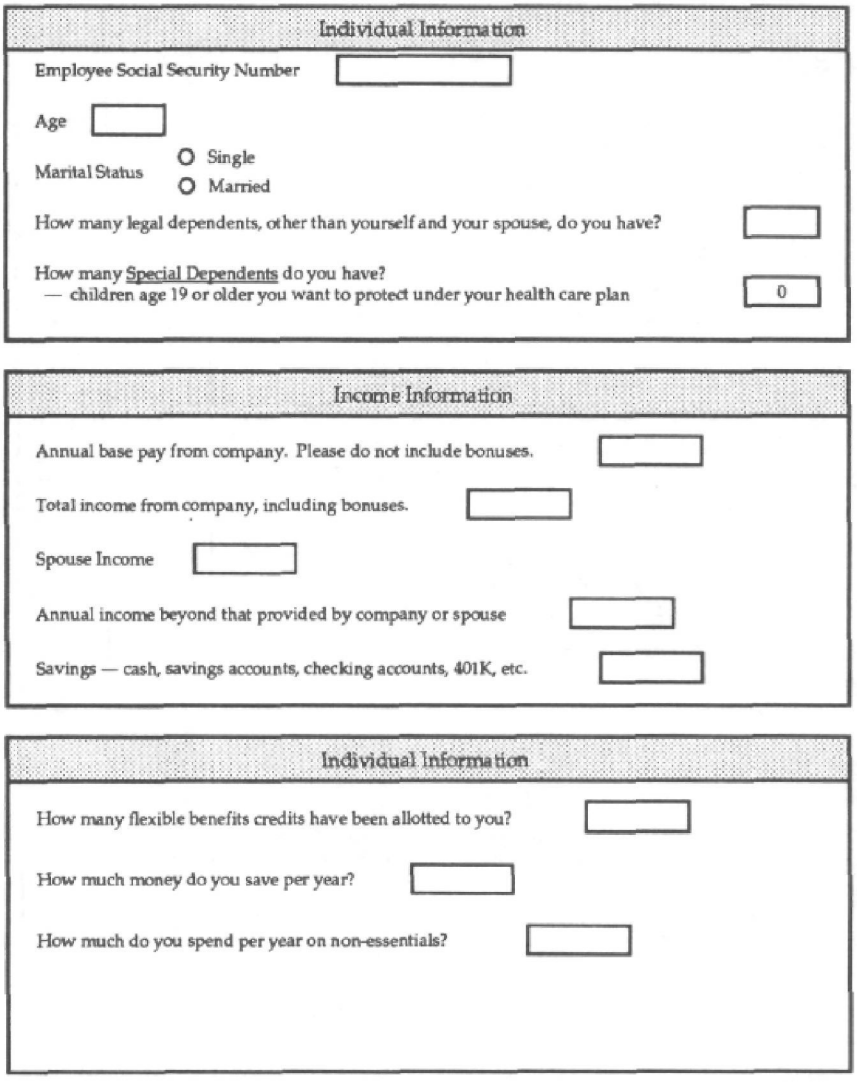
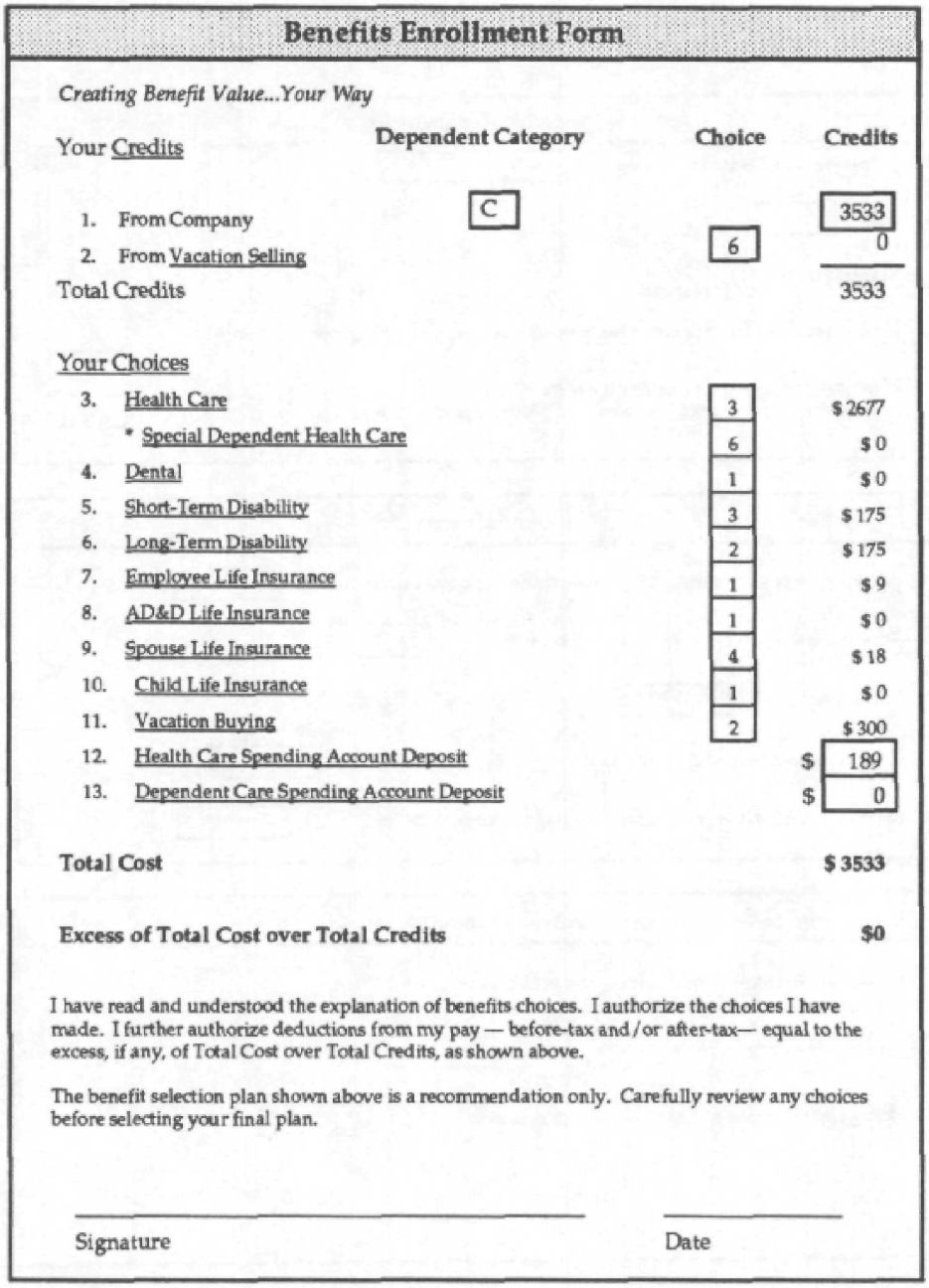


Figure 1: **Expert system screens from the questioning phase (3 of 7 screens shown)**

[2] A complete list of the variables are reported in the system's validation study (Sturman & Milkovich, 1995).

In the modification phase, the system also allows the user to return to the questioning phase or modify personal information (e.g., add more dependents, change one's level of savings). Thereafter, the system generates a new set of recommendations. In addition, this phase provides the user with DSS features. Once recommendations are provided, the system permits the user to override the ES and make different benefit choices. The system then recomputes the costs and updates the enrollment form. In effect, the system allows users to ask "what if" questions and obtain information on benefits types and enrollment rules. The DSS aspect also includes error checking. Thus, the ES enhances, and in no way erodes, the decision-making support for the user when compared to the DSS.

Note that the ES was also equipped with a hypertext feature. Key words and phrases were underlined, and at any phase users could click on one of these underlined phrases and the system would provide more in-depth information. This information, taken from employee benefit manuals, pamphlets, and booklets, is presented on the screen. The user could thus acquire more information on the questions being asked (e.g., what is a "special dependent"?) or the recommendations (e.g., What are the different health care plans, their varying levels of coverage, and their costs?). This feature allowed the ES to present as much information to the user as he or she desired. However, it is presented in such a way that the user only views the pertinent, desired information and is not overwhelmed with pages of confusing or unrelated information.



Benefits Enrollment Form

Creating Benefit Value...Your Way

Your Credits	Dependent Category	Choice	Credits
1. From Company	C		3533
2. From Vacation Selling		6	0
Total Credits			3533

Your Choices

3.	Health Care	3	$ 2677
	* Special Dependent Health Care	6	$ 0
4.	Dental	1	$ 0
5.	Short-Term Disability	3	$ 175
6.	Long-Term Disability	2	$ 175
7.	Employee Life Insurance	1	$ 9
8.	AD&D Life Insurance	1	$ 0
9.	Spouse Life Insurance	4	$ 18
10.	Child Life Insurance	1	$ 0
11.	Vacation Buying	2	$ 300
12.	Health Care Spending Account Deposit		$ 189
13.	Dependent Care Spending Account Deposit		$ 0

Total Cost **$ 3533**

Excess of Total Cost over Total Credits **$0**

I have read and understood the explanation of benefits choices. I authorize the choices I have made. I further authorize deductions from my pay — before-tax and/or after-tax— equal to the excess, if any, of Total Cost over Total Credits, as shown above.

The benefit selection plan shown above is a recommendation only. Carefully review any choices before selecting your final plan.

Signature Date

The Effects of Decision Aids on Flexible Benefits Decisions

There have been few attempts to understand the effects of decision aids on performance, fewer efforts to study the effects of decision aids on other outcomes (e.g., learning), and virtually no attempts to compare different types of decision aids in an experimental or field setting. Recall that in Beach and Mitchell's (1978) conceptual model, the value individuals ascribe to different decision aids varies depending on the person and the type of problem. However, their model, although valuable for

predicting decision aid use, is silent about the consequences of different decision aids. For example, aside from the basic assumption that more sophisticated models yield higher quality decisions, their model does not describe how different decision strategies influence decisions or user attitudes. In this experiment, actual employees were randomly assigned to either an ES, DSS, or no aid group and asked to make hypothetical re-enrollment benefits decisions. This allowed us to explore how desired benefit choices and satisfaction with benefits for those using an ES differed from those using a DSS and those not using a decision aid.

The Relationship between Decision Quality and Employee Attitudes

One fundamental premise of this ES, and indeed of the entire flexible benefits literature, is that some benefits are "better" than others in certain circumstances. Although PCE was validated against expert recommendations (Sturman & Milkovich, 1995), the validation study did not investigate user reactions to the system's recommendations. We expect that the quality of benefits choices influences satisfaction with benefits.

A fundamental problem of ascertaining the "quality" of decision making, especially for flexible benefits decisions, is its definition and measurement. Because an objective, optimal solution usually does not exist, recommendations from one or more subject matter experts would be desirable to serve as the standard. Obtaining such recommendations for all the subjects in this study, though, was highly impractical. Indeed, the difficulties associated with obtaining expert recommendations for large samples of employees was the primary impetus for the development of this ES in the first place. As noted earlier, this ES exhibited criterion validity. Therefore, we operationalize decision "quality" here as agreement between the employees' decisions and those recommended by the ES: If the individual chose the same benefit options as the ES, then the choice was considered to be an expert quality decision. As will be described below, the requisite information for the ES to render recommendations was gathered from all subjects (regardless of whether they used the ES, the DSS, or no aid), and ES recommendations were generated for all the subjects in this study.

For each subject, decision quality is a measure of the agreement between the employee's decisions and ES's recommendations for that employee. If this measure is valid, and if employees are at least somewhat sensitive to their decision quality, we expect that higher quality employee decisions will be associated with higher satisfaction with benefits. Thus, we would expect:

Hypothesis 1: Decision quality of an employee's current benefit selections (i.e., the frequency with which an employee's selections match those of the ES) is positively related to employee satisfaction with benefits.

The Effect of Two Decision Aids on the Quality of Desire Choices

Research on both DSSs (Bass, 1983; Ferguson & Jones, 1969; Sharda et al., 1988; Simon, 1977) and ESs (Fedorowicz et al., 1992; Lamberti & Wallace, 1990; Moffitt, 1994; Sviokla, 1990) has shown that these systems generally improve the performance of decision makers. These findings are not conclusive, though, as other studies on decision aids have not found significant performance improvements (Aldag & Power, 1986; Goslar, Green, & Hughes, 1986; Joyner & Tunstall, 1970; King & Rodriguez, 1978; Lawler & Elliot, 1996).

Using ES recommendations as a quality standard, it is possible to generate hypotheses regarding the effects that decision aids will have on decision performance. Both of the decision aids, the DSS and the ES, facilitate a more sophisticated decision strategy, and decision strategy sophistication is expected to lead to improved decision-making performance (Beach & Mitchell, 1978). Although employees did not actually make re-enrollment decisions in this experiment, we did ask them to indicate what benefits they would choose if they could re-enroll at that time. Thus, we hypothesize:

Hypothesis 2: Decision quality of employees' desired benefits selections will be higher for those using a decision aid (ES or DSS) than for those not using a decision aid.

Because the ES makes specific recommendations to the decision maker, and since these recommendations reflect the knowledge and expertise of a group of domain experts and serve as the standard for decision quality, we also predict:

Hypothesis 3: Decision quality of employees' desired benefits selections will be higher for those using the ES than for those using the DSS.

Note that this hypothesis will be supported if (a) subjects in the ES group simply accept the recommendations from the system, and (b) subjects in the other conditions do not come up with the expert recommendations on their own. Yet, for Hypothesis 2 to be supported, those in the DSS group must come up with the ES recommendations more often than those in the no-decision aid group.

The Effect of Desiring to Make Benefits Changes on Satisfaction with Benefits

Although employees were not making actual benefit selections, this experiment does capture their intentions. As such, we can make predictions about the relationship between these intentions and satisfaction with benefits. Discrepancy theory, which has frequently been used to explain compensation satisfaction (e.g., Heneman, 1985; Lawler, 1971; Miceli & Lane, 1991), sheds some light on how these desired changes affect satisfaction with benefits. Discrepancy theory posits that the difference between what a person wants and what is received explains satisfaction, or the lack thereof (Locke, 1969). For

our study, a post-hoc desire to change an existing benefit selection is evidence of a discrepancy. Thus, we hypothesize:

Hypothesis 4: The frequency with which a person desires to change existing benefits is negatively related to satisfaction with benefits.

The Effect of an Expert System on Employee Attitudes

One of the advantages of ESs is that they communicate information to employees (Broderick & Boudreau, 1991; Lawler, 1992). For this study, the ES might increase employees' understanding of their benefits plan or clarify aspects of their current choices. Thus, much like a benefits communication intervention may improve satisfaction with benefits even though the benefits package is not being changed, the ES in this study may affect the subjects' satisfaction with benefits even though the employees are not choosing new benefits.

The complexity associated with making flexible benefits decisions may constrain employees' abilities to choose options that best fit their needs (Besser & Frank, 1989; Mamorsky, 1990; McCaffery, 1992). This could lead to decreased satisfaction with benefits. For ill-defined and complex problems, such as making flexible benefits decisions, Lovata (1987) suggests that the garbage can model (Cohen, March, & Olsen, 1972) can help to explain how a decision aid affects satisfaction with the resultant outcomes. This model "stresses the importance of limiting data to that which is useful and relevant to a decision" (Lovata, 1987, p. 148). Therefore, decision aids that minimize extraneous information are likely to lead to greater satisfaction with both the decision process and its outcomes.

As described previously, in addition to recommendations, the ES includes information from the employee benefits manual linked through a hypertext format. With a click of their mouse, employees are presented with information on the screen that is pertinent to the questions they were being asked or the benefit category they were evaluating. In addition, simply using the ES may make employees more comfortable with their benefits plan or specific selections. This proposition is somewhat supported by previous research in that ESs have been shown to enhance learning in the user (Fedorowicz et al., 1992; Moffitt, 1994); for flexible benefit decision making, enhanced learning may reduce the confusion associated with flexible benefits plans, and thus may make those using the ES more satisfied with the benefits plan provided by their employer. On the other hand, those not using the ES would not have this information available. Nor would they have a tool to help present and organize information that could address their immediate concerns. Thus, we hypothesize:

Hypothesis 5: Those using the ES will have higher satisfaction with benefits than those using the DSS or no decision aid.

Methods

Subjects and Design

The study follows an experimental design, implemented in a field setting. The site was a manufacturing and assembly facility of a Fortune 500 company, located in the Northeast. The employer is generally viewed as a market leader regarding its pay and benefits to its employees. One hundred sixty exempt workers at the facility were covered by the flexible benefit plan described previously. A sample of 80 employees volunteered to participate in the study. The employees were told that the study was about the flexible benefits program and their benefit selections. Subjects were also informed that participation in the study would require no more than 2 hours of their time.

Subjects were randomly assigned into one of three groups: Group A used the ES; Group B used the DSS; and Group C used no decision aid. The ES and DSS groups each had 20 subjects in them; the no-aid had 40. Participation was voluntary and people were given the opportunity to withdraw at any time. No one did. Subjects were notified via e-mail with regard to the time and place of the study. This was followed up with personal calls and inter-office mailings. To minimize researcher effects and maintain consistency, three research assistants were trained in advance to introduce the study and monitor the use of the decision aids.

Subjects were brought into a conference room in groups of five (all of whom were to receive the same treatment) where they were read a scripted set of directions thanking them for their participation and introducing the study. If the subjects were in the no decision aid group, they were then provided with a questionnaire. Subjects from the other two groups were brought to a second conference room where computers loaded with the appropriate treatment (ES or DSS) were located. Here, subjects received scripted instructions regarding how to use the decision aid. After the computer session, which lasted approximately 30 minutes for both the ES and DSS groups (no time constraint was used or enforced), subjects were brought to a third conference room where they completed a questionnaire.

Participants were mostly male (71%), married (76%), with a mean age of 38.5 years, and had on average one child. Subjects earned an average of $46,000. Of those married, 77% reported that their spouses were employed, and the spousal income for these subjects averaged $23,500. The average reported household savings was $21,000. All of the subjects were high school graduates and most were college graduates (65%). Almost half (49%) possessed a technical (engineering, computer science) degree. Their education level and technical emphasis, coupled with the job requirements associated

with the high tech manufacturing processes in the plant (the manufacture and assembly of computer components and printers), presupposes a reasonable level of computer literacy among these subjects.

Measures

We used the items from the Heneman and Schwab (1985) Pay Satisfaction Questionnaire to examine the relative effects of the decision aids on satisfaction. They include (a) satisfaction with benefits[3], (b) satisfaction with pay, (c) satisfaction with raises, and (d) satisfaction with pay structure/ administration. Information was also collected on the subjects' demographics, their personal and family characteristics, their current benefit selections, and the selections that they would make if they could re-enroll at the time of the experiment. As mentioned, the subjects in the no-aid and DSS groups provided the same information. This allowed the researchers to input the subjects' personal information into the ES, post hoc, and thus obtain ES recommendations for all 80 subjects.

Subjects were first asked to recall and note their current benefit selections. Certainly, there was no guarantee that the subjects could recall their current benefit choices. However, the subjects knew beforehand that the study was about their benefits and they had access to a list of their current benefit choices. None of the subjects mentioned any problem about recalling their benefits to the researchers administering the questionnaire. Subjects were also asked to indicate how they would change these choices if it were possible. As noted, subjects were not making actual enrollment decisions when indicating their desired benefits: They were indicating their intentions if they could re-enroll. Although it is impossible to determine if employees' signaled intentions would translate into actual decisions, all evidence during the experiment indicated that the employees took the exercise seriously.

Results

Summary statistics and correlations of the study's key variables are shown in Table 1. The correlation between the number of current choices matching ES recommendations and satisfaction with benefits is .28, which is statistically significant ($p < .05$). This supports Hypothesis 1: Decision quality is related to satisfaction with benefits.

Table 1 also reveals information that demonstrates that random assignment yielded appropriately comparable groups. There was no correlation between group assignment and number of current decisions that are of expert quality for the DSS (r = .04, n.s.) and ES groups (r = .05; n.s.). This

[3] It should be noted that the measure, satisfaction with benefits, assesses satisfaction with the benefits package as a whole and not satisfaction with the specific benefit items selected. The questions ask for the subject to rate satisfaction with the benefit package, the amount the company pays toward the benefit package, the value of the benefits, and the number of benefits received.

shows that the current benefits selections of people assigned to the ES group were no more optimal than those in the DSS or no decision aid groups.

TABLE 1

Summary Statistics and Correlations

	Mean	*SD*	1	2	3	4	5	6	7	8
1. Satisfaction with pay [1]	4.19	1.71	(.97)							
2. Satisfaction with benefits [1]	3.41	1.51	.54	(.93)						
3. Satisfaction with raises [1]	4.17	1.30	.58	.49	(.82)					
4. Satisfaction with pay structure/ administration [1]	3.67	1.08	.59	.37	.54	(.88)				
5. # Current choices matching ES recommendations [2]	3.76	2.15	.14	.28	.13	.17	–			
6. # Desired changes	1.09	1.56	–.09	–.27	–.11	–.18	.03	–		
7. # Desired choices matching ES recomendations [2]	3.00	2.28	.07	.12	.18	.23	.28	–.06	–	
8. Decision support system group	0.25	0.44	–.04	–.12	–.04	.06	.04	–.09	.17	–
9. Expert system group	0.25	0.44	.21	.29	.18	.29	.05	.08	.54	–.33

Note: N = 80. Numbers in parantheses are coefficient alpha. Correlations greater than 0.18 are significant at $p<.10$. Correlations greater than .22 are significant at $p<.05$.

[1] The compensation satisfaction measures were rated on a seven point scale, with 1 meaning low satisfaction and 7 meaning high satisfaction.

[2] Employees had a choice of 11 benefit categories.

TABLE 2

Means and Standard Deviations of Decision Quality and Satisfaction with Benefits

Group	*N*	Decision quality (# of desired choices matching ES recomendations out of possible 11)	Benefits satisfaction (1=*low*; 7=*high*)
No-aid	40	1.63	3.19
		(1.76)	(1.44)
Decision support system	20	3.65[a]	3.09
		(1.34)	(1.45)
Expert system	20	5.10[b]	4.15[c]
		(2.20)	(1.52)
F		27.90**	3.48*

Note: Table shows means with standard deviations in parentheses.

[a]The DSS group had a higher level of agreement than the no-aid group (two-tailed *t* test, $t = 4.66$, $t = p < .01$).

[b]The ES group had a higher level of agreement than the no-aid group (two-tailed *t* test, $t = 6.62$, $p < .01$) and the DSS group (two-tailed *t* test, $t = 2.62$, $p < .05$).

[c]The ES Group had a higher level of satisfaction with benefits than the no-aid group (two-tailed *t* test, $t = 2.38$, $p < .05$) and the DSS group (two-tailed *t* test, $t = 2.26$, $p < .05$).

*$p<.05$ **$p<.01$

Hypotheses 2 and 3, which examine the relationship between decision aid group and the quality of desired benefit selections, were tested using ANOVA and *t* tests, the results of which are reported in Table 2. Those using either decision aid indicated the intention of making benefit selections that were more likely to agree with the ES's recommendations than those who did not use a decision aid (p <.01). Furthermore, as predicted, those using the ES had higher expert agreement than those using the DSS (p <.05).

We used OLS regression to test the remaining hypothesis. We examined the impact of our independent variables on all four facets of pay satisfaction for two reasons: (a) to determine if the decision aids and benefits-related variables had an effect on satisfaction with benefits, and (b) to determine if the decision aids had effects specific to satisfaction with benefits and that this was not merely a spurious effect that increased all measures of satisfaction. The other dimensions of satisfaction, the frequency of current benefit choice agreement with the ES, the number of desired changes, and dummy variables representing the treatment groups, served as the independent variables. Support for the hypotheses is shown by significant beta-coefficients for the benefit-related variables when satisfaction with benefits is the dependent variable. When the other dimensions of satisfaction are the dependent variables, the independent variables introduced in this study should be devoid of any explanatory value. These results are reported in Table 3. Note that although the dimensions of

satisfaction are significantly correlated (see Table 1), the levels of correlation are not so high as to make multicollinearity an issue.

TABLE 3

Prediction of Satisfaction Measures

Variables	Satisfaction with benefits	Satisfaction with pay	Satisfaction with raises	Satisfaction with pay structure/ administration
Intercept	1.23	−0.61	1.12	1.99
	(0.63)	(0.69)	(0.55)*	(0.39)**
Control variables				
Sat. with benefits	–	.36	0.22	−0.07
		(0.12)**	(0.10)*	(0.08)
Sat. with pay	0.32	–	.21	0.26
	(0.10)**		(0.09)*	(0.07)**
Sat. with raises	0.28	0.32	–	.24
	(0.13)*	(0.14)*		(0.09)**
Sat. with pay structure/admin.	−0.14	0.60	0.37	–
	(0.17)	(0.16)**	(0.14)**	
Independent variables				
# Current choices matching ES recommendations	0.15	−0.03	−0.02	0.04
	(0.06)**	(0.07)	(0.06)	(0.05)
# Desired changes	−0.25	0.10	0.04	−0.10
	(0.09)**	(0.10)	(0.08)	(0.06)
DSS group	−0.11	−0.03	−0.05	0.17
	(0.16)	(0.17)	(0.14)	(0.11)
ES group	0.32	−0.08	−0.08	0.28
	(0.17)*	(0.19)	(0.15)	(0.12)*
R^2	.46	.52	.44	.48
F	8.84**	11.01**	8.11**	9.39**

Note: Table shows raw beta coefficients and standard errors of coefficients in parentheses. DSS = Decision support system; ES = Expert System.

* $p < .05$ ** $p < .01$

The regression using satisfaction with benefits as the dependent variable supports several propositions outlined previously. The number of current expert choices matching ES recommendations was positively related to satisfaction with benefits (β = .15; p <.01), supporting Hypothesis 1; the frequency with which a person desires to change existing benefits choices was significantly and negatively related to satisfaction with benefits (β = -.25; p <.01), supporting Hypothesis 4. The results also support Hypothesis 5. Those using the ES had higher satisfaction with benefits (β = .32; p < .05) than those using no decision aid. Hypothesis 5 is also supported by means tests, as shown in Table 2. Those in the ES group reported higher satisfaction with benefits than those in the DSS group (p <.05) and those in the decision aid group (p < .05).

Results from the regression equations predicting other types of satisfaction largely support the notion that the effects of the benefits-related variables and interventions were limited to impacting satisfaction with benefits. There was only one exception: Exposure to the ES was also related to

satisfaction with pay structure/administration ($\beta = .28$; $p < .05$). Although this effect was not predicted a priori, it does make some sense in hindsight. First, the pay structure/administration measure includes items such as satisfaction with "Information the company gives me about pay issues of concern to me" and "How the company administers pay." If subjects perceive benefits as an important part of their total compensation, then one could see how introducing a helpful benefits decision aid could influence satisfaction with pay structure/administration.

Conclusions, Limitations, and Implications

The principal conclusion we draw from our findings is that decision aids, and particularly ESs, have the potential to influence employee decisions and attitudes. When ES recommendations are used as the standard, we find that both DSSs and ESs improve decision performance. That is, subjects' choices converged towards those the ES would have or did recommend. As expected, the desired benefits choices of those in the ES group were closest to the recommendations of the ES. In addition, those using the DSS made choices that bear a closer resemblance to the recommendations of the ES than those not exposed to any decision aid. Thus, it appears that in this context, using a decision aid influences subjects' decisions and, insofar as expert recommendations are decreed to be optimal, helps improve subjects' decision performance.

Even though this study used simulated benefits enrollment, those using the ES had higher satisfaction with benefits than those using the DSS or not using a decision aid. This supports Lovata's (1987) application of the garbage can model for information system design, which suggests that simplifying the decision process and providing employees with organized and relevant information will yield higher levels of satisfaction.

Another key finding of this study, applicable to the study of flexible benefits in general, is that benefits decision quality is related to satisfaction with benefits. The number of current choices that were of expert quality were shown to be positively related to satisfaction with benefits. This suggests that employee satisfaction with benefits in a flexible benefits environment can be improved by helping employees make better benefits decisions. This finding is further supported in that, as suggested by discrepancy theory, the number of desired benefits changes was negatively related to satisfaction with benefits. Therefore, although different aids can affect decision making differently, it is still important to consider developing decision aids to help employees make complex decisions better.

The implications of these results are that, if this ES were used by employees to make actual benefit decisions, the company would see a number of benefits. First, there would be a significant gain

in benefits satisfaction attributable to the improved clarity and communication provided by the ES. Second, satisfaction with benefits would increase because of improved benefit selection quality. Third, other facets of pay satisfaction would increase because of the increase in satisfaction with benefits. Fourth, the company would not need to devote as much of their benefits experts' time to benefits counseling.

The implications of these findings, though, are tempered by some limitations of our study. First, the study did not require employees to make actual enrollment decisions; rather, it required subjects to make simulated decisions. Although there is no reason to think that the participants did not take this situation seriously, it is still open to question whether subjects' intentions would translate into actions. In addition, we do not know if the effects on satisfaction with benefits would be sustained over time.

In our research design, subjects were randomly assigned to treatment groups that provided many methodological advantages. However, as suggested by Beach and Mitchell (1978), we might expect more pronounced effects for the various decision strategies if subjects were permitted to choose their own decision strategy. In addition, the nature of the experiment necessarily precluded subjects from talking to their spouses, friends, benefits counselors, or others. Nevertheless, the experiment did allow us to measure some behavioral "intention" effects.

Our sample was relatively educated and technical. This may limit generalizability to employees with less computer knowledge or greater apprehensions about technology. Another limitation of the study is the number of subjects. Larger, more representative samples from multiple populations would enhance generalizability. Improvements in this regard would have allowed for an even more comprehensive comparison of the effects of the various decision aids. In spite of these issues, considering that virtually no research has been reported on the effects of HR decision aids on employees' attitudes, a conservative interpretation of our findings is that they support the proposition that HR decision aids influence attitudes and behavioral intentions.

These findings and limitations highlight some concerns for decision aid research in human resource management. As previously noted, there is a need to integrate the ES, DSS, and behavioral research literatures. We know little about the signals these decision aids send to workers, whether they are managers or rank and file employees. Equally unknown is how these decision aids affect the cognitive processes that decision makers rely on. Much of the behavioral research has been in the tradition of understanding expertise and expert judgment. The relative efficiency of various linear and non-linear models is also well studied. Virtually ignored is the effect that these aids have on decision makers and the decision process itself.

In general, DSSs can provide employees with the tools and data with which to make complex decisions. Similarly, ESs offer the potential to share expert knowledge with employees, which should help them make better decisions. Although the results from this study may imply that ESs can produce substantial benefits, it is important to note that ESs have the potential for misuse. For instance, in an attempt to reduce health care costs, ESs could be designed to recommend an optimal plan only from the employer's perspective, not the employee's. Arguably, most would see the blatant diffusion of suboptimal advice as unethical. However, as there are likely to be more complex situations, the ethical issues associated with HR ESs need attention. If nothing else, this issue highlights the need for extensive validation and more research on the effects of ESs.

Employers have raised two major concerns regarding the use of decision aids for managing benefits. In a recent Conference Board report (1993), companies questioned the costs of development and implementation. Some questioned the return on investment of developing such computer software when employees may not even have access to the hardware that is needed. "During our transition to flex," noted one benefits manager, "we produced and distributed a computer disk to help employees model and map out their decisions (i.e., a DSS approach). It was great for some, like our engineers, who work with computers regularly. However, for a significant percentage of our workforce, the cost/value of the tool was not apparent" (Conference Board, 1993, p. 35). Lawler (1992) echoes this cost/benefit concern. He suggests that if little time is devoted to a decision task, or other less expensive options (e.g., training) exist, then ESs may not be justified.

Of course, this is not a study of the utility of decision aids. However, we can report that the current retail price for the ES shell is $895.00, we spent about 240 hours in the design and testing phases, and 32 hours of the experts' time was needed. Overall, the development cost for this custom system was less than $8,000. Regarding benefits, both decision aids yielded better decisions, and satisfaction with benefits was 25% higher for those using the ES. Other value added factors, such as improved knowledge, also need to be considered. In the end, these improved decisions and increase in satisfaction with benefits, all from a total investment of $8,000, suggest that employers may be well advised to begin at least exploring the relative benefits of ESs instead of just considering the costs.

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