

Using Expert Systems to Aid Employees' Flexible Benefits Decisions

By George T. Milkovich, Ph.D., Michael C. Sturman and John M. Hannon, Ph.D.

As organizations become more focused on customers, employees are being asked to shoulder greater responsibilities, become increasingly flexible and exercise continuous learning. As a result, employees require more access to information and expertise to help them carry out their responsibilities, manage their careers, and confront more choices and greater uncertainty in the new workplace. If empowerment is to be successful, access to expertise and information is fundamental. In this context, expert systems can serve as tools to transfer expertise to employees, and have the potential to become decision aids that serve employees and managers.

Much of the attention devoted to expert systems in human resources management and employee compen-

sation has focused on a variety of applications and case studies (Briggs and Doney 1989; Hannon, Milkovich and Sturman 1990; Roberts 1988; Krebs 1988). However, little research to date extends beyond description and conjecture. Little has been reported about the effects of expert systems on the people and organizations that are using them, the costs of design and development, or the potential payoffs.

The authors have conducted one of the few field studies designed to investigate the effects of an expert system on users' attitudes and decisions. It is the first study of the impact of expert systems in which employee benefits and employees are the subjects. Costs of design and development have been examined to offer a sense of what similar applications may cost.

Expert Systems

Expert systems is a branch of artificial intelligence. The professional knowledge of a person recognized as an expert is transferred to a computer program. Nonexpert users of the program then are able to tap into the expert's knowledge to aid in making decisions about complex problems. The expert system usually explains the logic behind its conclusions so users are able to understand how experts diagnose and solve a problem.

Early expert systems were used mainly for medical diagnoses, geological prospecting and trial-jury selection (Stefik 1990). With growing success, expert-system specialists expanded their scope to take advantage of the technology's wider potential. In manage-

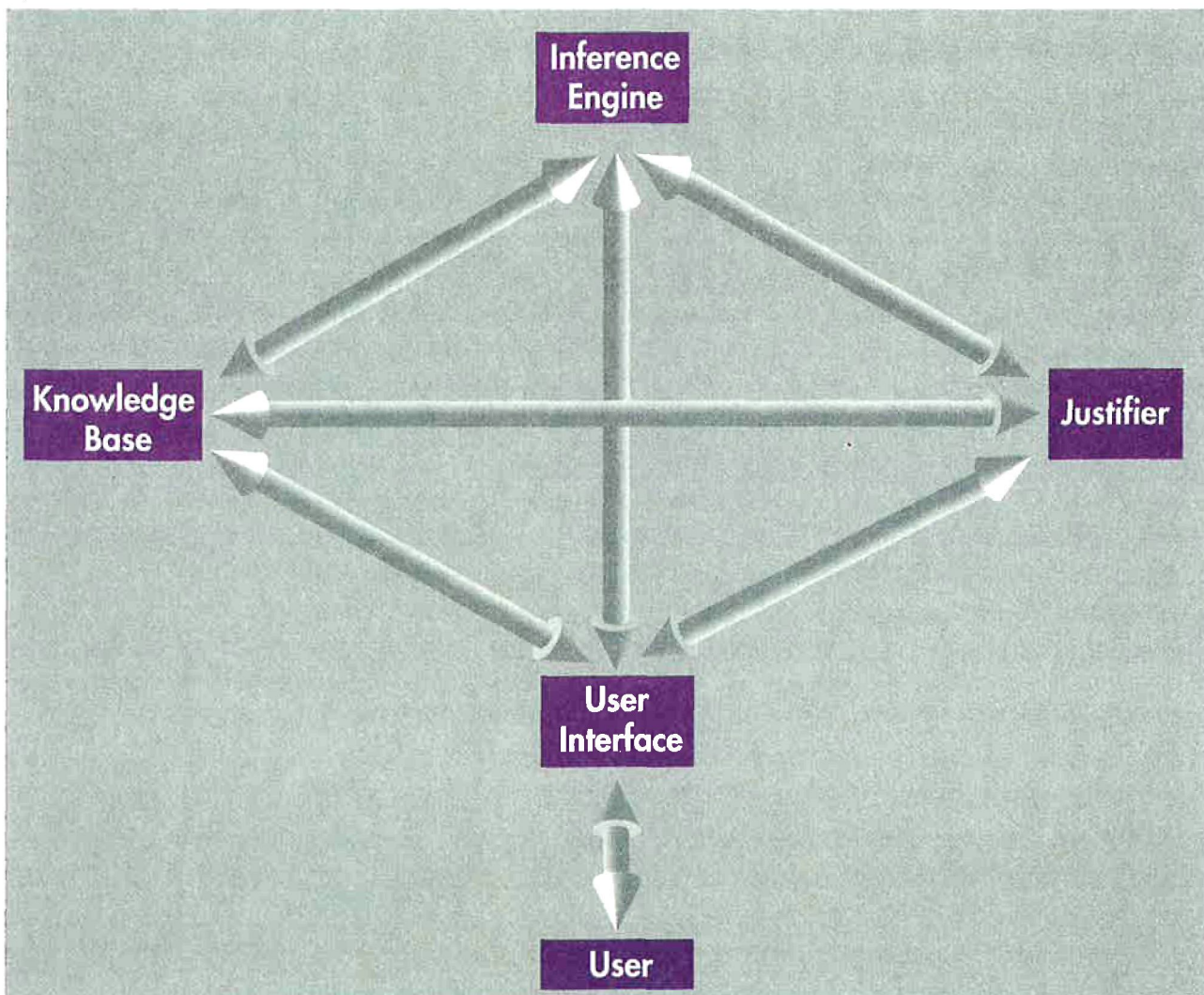
ment, systems for manufacturing, inventory control and financial investments were designed.

As shown in Figure 1, computer science literature shows expert systems as having four key components: a knowledge base, an inference engine (the software and program), a justifier and a user interface (Feigenbaum, McCormick and Nil 1988):

- The *knowledge base* is derived from the expert's information knowledge and expertise.
- The *inference engine* is the "brain" of the expert system. It is a computer program that captures the expert's knowledge and experience. It specifies data to collect, translates the data into information, interprets it and draws conclusions.

Figure 1

BASIC COMPONENTS OF AN EXPERT SYSTEM



- The *justifier* explains the system to users, answers questions and explains the conclusions.
- The *user interface* is the system component that communicates with the user. It conducts a dialogue with the user by asking questions to gather data, and offering advice and logic (J.J. Lawler 1992).

Not all problems are appropriate for expert systems; some are too simple or too complex. Processing payroll, calculating labor costs, generating alternative budgets for merit and variable pay programs, and calculating total benefits credits used under flexible benefits plans are tasks that are served adequately using conventional spreadsheet software. Other decisions that require creativity, discovery or innovation – designing new variable pay programs, selecting the optimal health care program for an organization or choosing the principles underlying a total compensation strategy – may be too involved for expert systems. Some advocates argue, however, that if experts can be identified and if they are willing to share their knowledge, then an expert system can be designed.

The types of decisions that best lend themselves to expert systems are those for which experts are not always available or are expensive. For example, expert systems can offer advice on managing stock options, diagnosing turnover or employee satisfaction, performing job and skill evaluations, making hiring decisions, and handling employee relations matters. These systems work best and are most cost-effective if expert knowledge is available but relatively scarce or expensive, and if experts are willing to share it. There are some classic accounts where large sums of money were expended on attempts that fell short of capturing an expert's knowledge and experience. Perhaps the experts, realizing that an expert system could diminish their value, felt little incentive to share their expertise.

Choosing Flexible Benefits

This study is part of a broader research initiative at the Center for Advanced Human Resource Studies at Cornell University to explore issues related to human resources information and artificial intelligence (Broderick and Boudreau 1992). Employees were offered the use of an expert system that was designed to aid them in making choices under a flexible benefits

plan. The system was based on experts' knowledge about the appropriate choices individuals should make given their unique personal situations. The flexible benefits decision was chosen because it has many of the ideal features for an expert system. The decision mattered both to employees and employers, expertise was scarce and expensive, and the experts were willing to share their knowledge.

Under flexible benefits plans, the task of choosing benefits options is complex. Figure 2 illustrates some of the benefits forms typically available as well as the coverage for a relatively simple flex plan. The illustration includes a number of health care, disability and insurance plans. Even under this simplified plan, employees face an array of options. In an attempt to aid employees, benefits managers often provide booklets, informational newsletters, memos, posters and benefits counselors. All these aids are informational; none of them recommends the benefits choices that are most appropriate in light of specific personal circumstances.

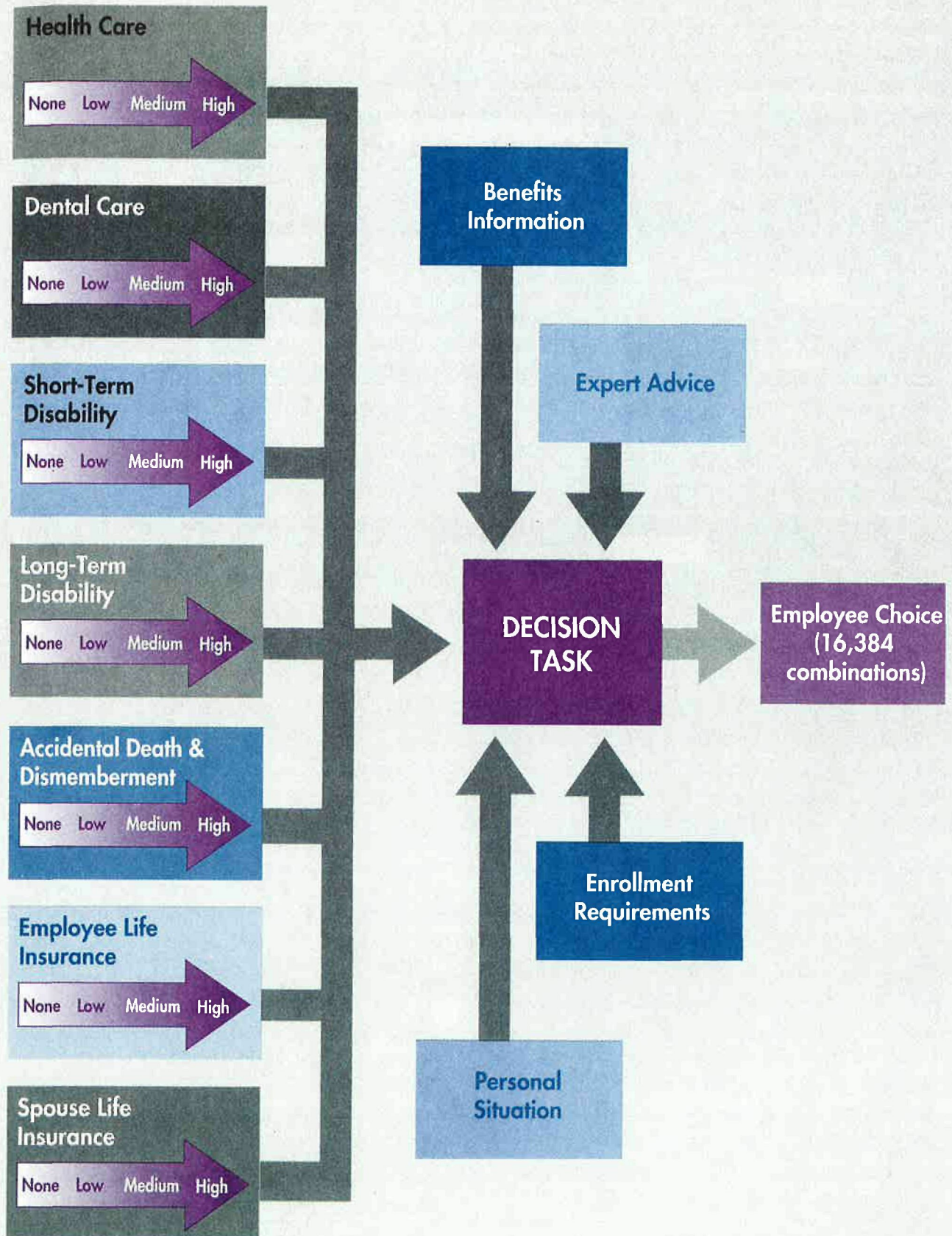
The merits of flex plans were espoused more than 20 years ago by Edward E. Lawler III, Ph.D. (Lawler 1971). He argued that allowing employees to choose their own benefits heightens their knowledge of coverage and costs. Additionally, flex plans increase the likelihood that benefits fit the needs of an increasingly diverse work force. While this line of reasoning depends on employees making well-informed choices, it is not at all clear that individuals who are empowered to make benefits choices possess the expertise required to make well-informed decisions. If employees are not well informed, incorrect decisions may leave them vulnerable, financially at risk or unsatisfied.

Personal Choice, Choice Maker and Personal Choice Expert

The NCR Corp.–AT&T flexible benefits plan "Personal Choice" was used in this study to design an expert system. The plan is typical in that all NCR employees receive benefits credits based generally on their dependent situation, salary level and years of NCR service. These credits may be allocated or "spent" on various forms of benefits, each with optional levels of coverage.

Figure 2

ILLUSTRATION OF A FLEXIBLE BENEFITS DECISION



"Choice Maker," NCR's current software program, is a conventional spreadsheet application with several advanced features such as error-checking. Its purpose is to enable an employee to conduct "what if" analyses by altering benefits decisions. Choice Maker calculates the benefits credit costs of each set of choices and compares the result to the total benefits credits available to the employee. It is a convenient calculator and decision-support system, but it does not provide any recommendations or expert information to aid the employee's decision making.

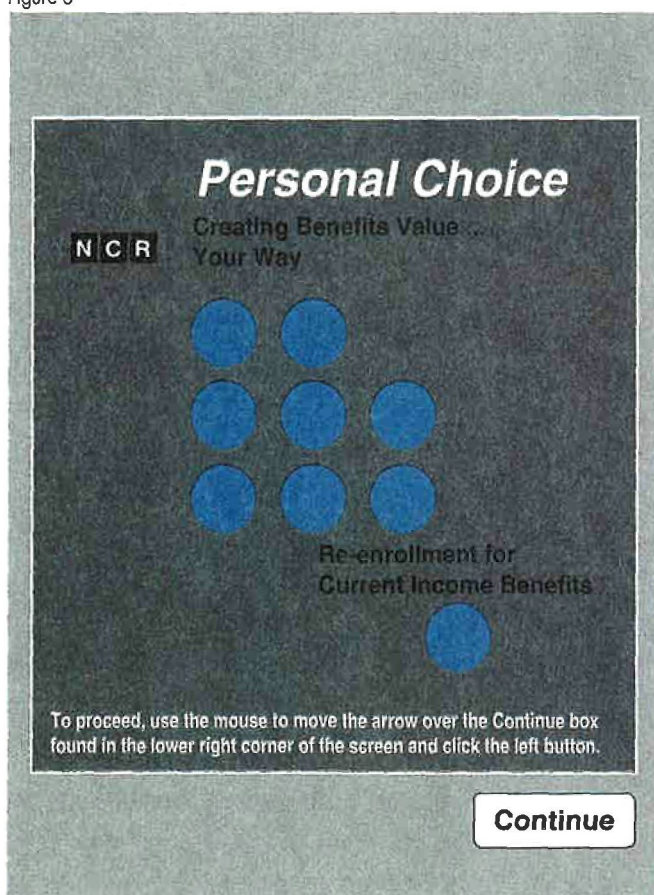
In this study, "Choice Maker" was compared to "Personal Choice Expert" (PC Expert), an expert system the authors designed at NCR. PC Expert generates specific recommendations for the various benefits forms and coverage options offered to employees. The system, which uses the expert-system shell "Knowledge Pro," was designed and developed in accordance with conventional knowledge-engineering procedures. PC Expert is based on NCR benefits managers' expertise, supple-

mented by information provided by its benefits consultants (e.g., booklets and comparative data).

A typical session with PC Expert involves three phases: introduction, questioning and recommendation. The introduction phase uses information screens to inform the user about what the program does and how to use it. Figures 3 and 4 illustrate these screens. During the questioning phase, illustrated in Figure 5, employees answer a series of as many as 28 questions on a number of information screens pertaining to their personal situation (e.g., financial status, spousal income, number of dependents, savings and other income). These questions are the key variables on which benefits experts tailor their recommendations for individual employees, and they were solicited from experts during the design of PC Expert. During the recommendation phase, PC Expert generates the recommended decisions on a screen along with a printout, shown in Figure 6, on page 24, that mimics the actual benefits enrollment form that employees must complete.

EXPERT SYSTEM SAMPLE INTRODUCTORY SCREEN

Figure 3



EXPERT SYSTEM SAMPLE DIRECTION SCREEN

Figure 4

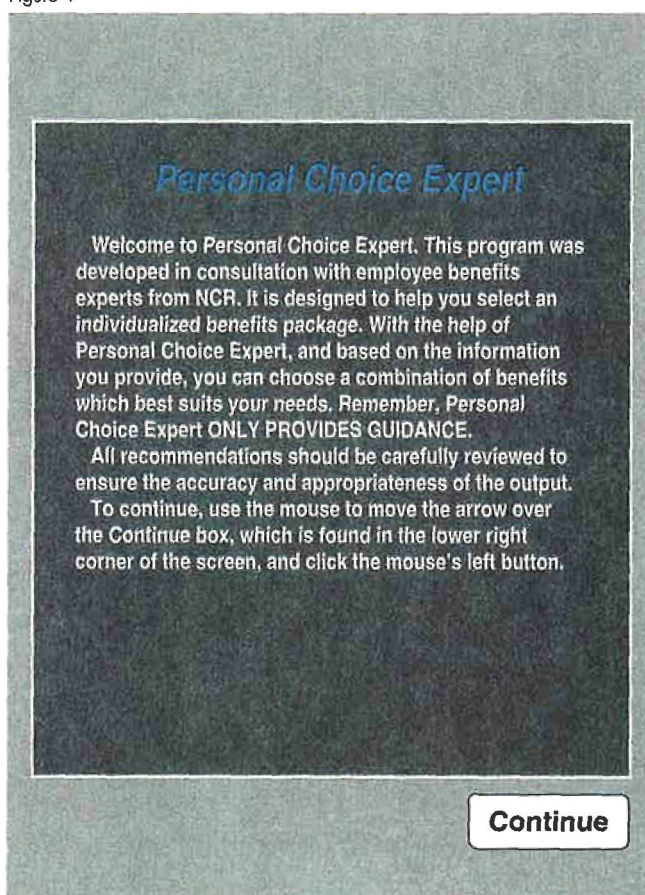


Figure 5

EXPERT SYSTEM SAMPLE PERSONAL AND DEMOGRAPHIC SCREENS

Individual Information

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User Information

Employee Social Security number :

Age :

Marital Status : ☐ Single
☐ Married

How many legal dependents, other than yourself and your spouse, do you have?

How many Special Dependents do you have?
 – children age 19 and older you want to protect under your health care plan –

Income Information

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User Information

Annual base pay from NCR. Please do not include bonuses :

Total income from NCR, including bonuses :

Annual income beyond that provided by NCR :

Savings – i.e., cash, savings accounts, checking accounts, 401k, etc. – :

Income Use Information

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User Information

How many flexible benefits credits have been allotted to you?

How much money do you save per year?

How much do you spend per year on non-essentials?

SAMPLE OUTPUT SCREEN

Benefits Enrollment Form			
Creating Benefit Value ... Your Way			
Your Credits	Dependent Category	Choice	Credits
1. From NCR	<input type="text" value="C"/>		<input type="text" value="3533"/>
2. From Vacation Selling		<input type="text" value="6"/>	<input type="text" value="0"/>
Total Credits			<u><input type="text" value="3533"/></u>
Your Choices		Choice	Price
3. <u>Health Care</u>		<input type="text" value="3"/>	<input type="text" value="\$ 2667"/>
* <u>Special Dependent Care</u>		<input type="text" value="6"/>	<input type="text" value="\$ 0"/>
4. <u>Dental</u>		<input type="text" value="1"/>	<input type="text" value="\$ 0"/>
5. <u>Short-Term Disability</u>		<input type="text" value="3"/>	<input type="text" value="\$ 175"/>
6. <u>Long-Term Disability</u>		<input type="text" value="2"/>	<input type="text" value="\$ 175"/>
7. <u>Employee Life insurance</u>		<input type="text" value="1"/>	<input type="text" value="\$ 9"/>
8. <u>AD & D Insurance</u>		<input type="text" value="1"/>	<input type="text" value="\$ 0"/>
9. <u>Spouse Life Insurance</u>		<input type="text" value="4"/>	<input type="text" value="\$ 18"/>
10. <u>Child Life Insurance</u>		<input type="text" value="1"/>	<input type="text" value="\$ 0"/>
11. <u>Vacation Buying</u>		<input type="text" value="2"/>	<input type="text" value="\$ 300"/>
12. <u>Health Care Spending Account Deposit</u>			<input type="text" value="\$ 189"/>
13. <u>Dependent Care Spending Account Deposit</u>			<input type="text" value="\$ 0"/>
Total Cost			<input type="text" value="\$ 3533"/>
<u>Excess of Total Cost over Total Credits, if any</u>			<input type="text" value="\$ 0"/>
<p>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.</p> <p>The benefits selection plan shown above is a recommendation only. Carefully review any choices before selecting your final plan.</p>			
Signature _____		Date _____	

Options

The Field Study

This study, a conventional four-group field experiment, represents one of the few field studies to investigate the effects of an expert system on users' decisions and attitudes. The four groups consisted of

- a group that took a pretest, used PC Expert and took a post-test
- a group that used PC Expert and took a post-test
- a group that received a pretest; used the spreadsheet program, Choice Maker; and completed a post-test
- a group that used Choice Maker and completed a post-test.

The focus of the study was to contrast the effects of a conventional spreadsheet, Choice Maker, against an expert system, PC Expert, on employees' benefits choices and their satisfaction with their benefits. The advantage of this study design was that it helped mitigate other factors (e.g., an increase in pay, downsizing) that could account for changes in employee benefits decisions or satisfaction. Without such controls in place, it only would be possible to describe the use of PC Expert and speculate about its effects on employee choices and attitudes.

The employees in this study are a representative sample of exempt managerial, professional and technical employees at an NCR facility that was covered by the flex plan. Most participants are male (71 percent) and married (76 percent), with a mean age of 38.5 years and one child (the range within the sample was one to three children). These employees earned an average of \$41,000 in 1992, and their reported spousal income averaged \$12,500. They report an average 1992 savings level of \$19,000. All are high school graduates, most are college graduates (65 percent) and almost half (49 percent) hold a technical (engineering or computer science) degree. Their education level and technical emphasis coupled with the high-tech manufacturing processes in the facility (supplying computer components and printers to NCR) suggests a reasonable level of computer literacy among these subjects. In fact, casual observations by the research team suggest that none of the subjects experienced any hesitation or difficulties in using either computer aid. With

80 employees in the study, 20 were assigned randomly to each group.

Findings

Research results are grouped into three categories:

- information describing employees' decision-making processes
- contrasts in satisfaction with benefits and pay among employees using the expert system compared to other employees
- effects of the expert system on employees' benefits decisions.

Decision-Making Process

Employees spent the most decision-making time (26.6 percent) reading NCR benefits literature. Almost as much time (24.9 percent) was spent discussing NCR benefits choices with spouses. A significant amount of time (23.7 percent) was spent using the spreadsheet benefits software. (See Figure 7.)

While employees generally expressed reluctance to share personal information (e.g., spouse's income, personal savings, spousal benefits coverage) with their employer or a benefits counselor, they readily shared it with the expert system. This type of information is essential to make recommendations and offer advice. However, even after the study, more than 82 percent of the employees indicated that they did not know all three key features of their health insurance: size of deductible, copayment amount and maximum payment level.

Employee Benefits Satisfaction

Employees who used PC Expert expressed a significant increase in satisfaction with their benefits. Satisfaction ratings among these employees rose about 20 percent, from 3.1 to 3.7 on a seven-point scale. Employees who used the spreadsheet software, Choice Maker, expressed no significant change in satisfaction with their benefits. (See Figure 8, on page 27.)

Employee Benefits Decisions

PC Expert affected employees' benefits decisions. Among employees whose benefits selections agreed

with PC Expert, 10 percent indicated they wanted to change their selections after using the software. Among employees whose selections disagreed with PC Expert, 28 percent wanted to change their selections. (See Figure 9.)

Implications

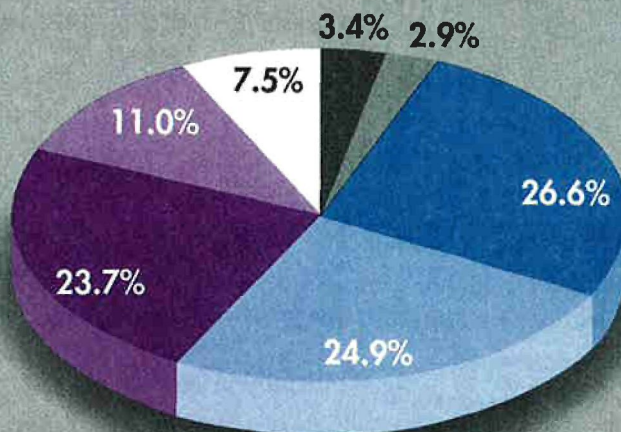
The principal conclusions from these findings are that expert systems clearly have the potential to influence employees' attitudes and decisions about their benefits. Overall, the expert-system group expressed a 20-percent improvement in benefits satisfaction, while employees using a simple spreadsheet showed no significant changes in their decisions or attitudes.

These findings also illustrate problems with the fundamental beliefs underlying the value of flex plans to employees. The employees in this study were well-educated, and the organization used a variety of benefits communications media. While employees tended to get their knowledge and expertise about benefits choices from discussions with spouses and reading this literature, and they used the spreadsheet decision aid to help calculate the cost of their choices, more than 80 percent of them were unable to report all three key features of their health insurance. If the new workplace empowers employees to make decisions and manage their own careers, employees must become more knowledgeable.

Figure 7

SOURCE OF INFORMATION USED BY EMPLOYEES TO MAKE A FLEXIBLE BENEFITS DECISION

Sources of Information	Mean (Minutes)	Standard Deviation
Reading Benefits Literature	46	38.2
Talking with Spouse	43	42.2
Using Choice Maker	41	35.7
Talking with Co-workers	19	25.1
Talking with Benefits Counselor	13	19.9
Talking with Manager	6	11.9
Talking with HR Generalist	5	9.5



A basic belief underlying the promised payoffs of the new workplace is that individual choice, involvement and participation will add value. Applied specifically to flex benefits, this belief presumes that individuals in an increasingly diverse work force will choose the coverage that best fits their personal situations. However, this belief is based on the premise that individuals possess the knowledge and expertise re-

quired to make well-informed decisions. Without techniques to transfer information and expertise, individuals will seek remedies to mitigate this risk once they become aware of it – including techniques such as holding back effort and innovations, and unionizing.

Because expert systems can affect employee decisions, ethical issues surface. For instance, in an attempt to reduce health care costs, a system could be

Figure 8

SATISFACTION MEASURES

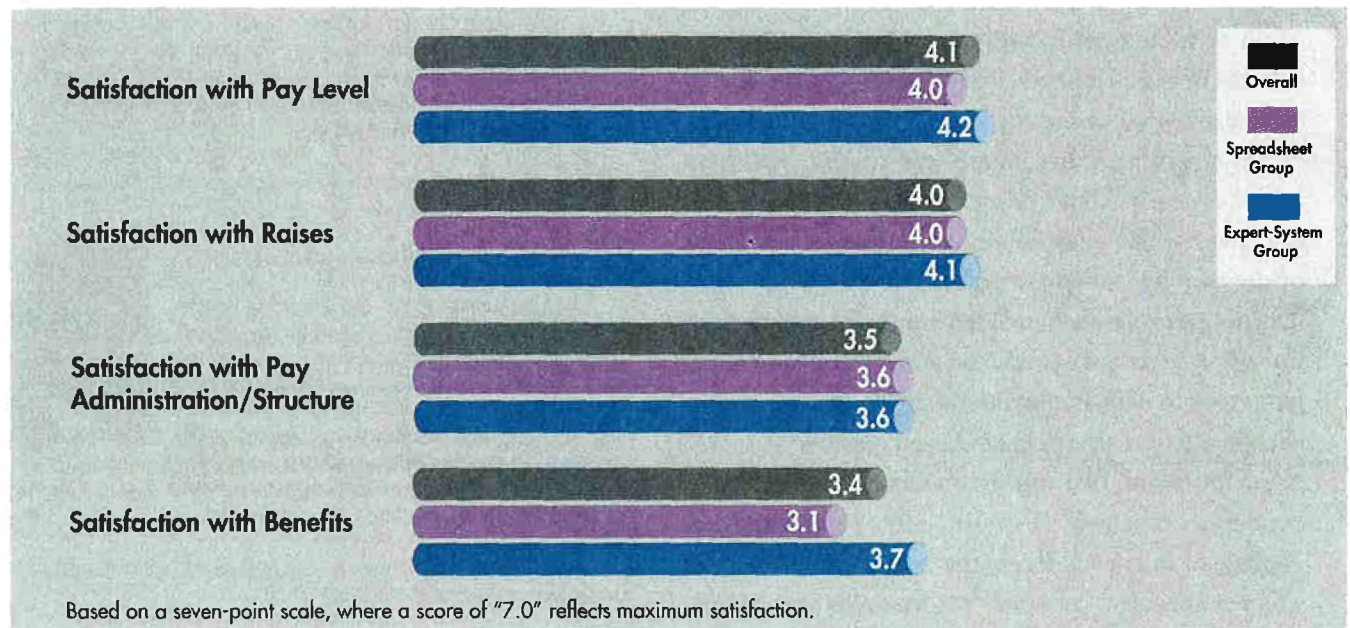
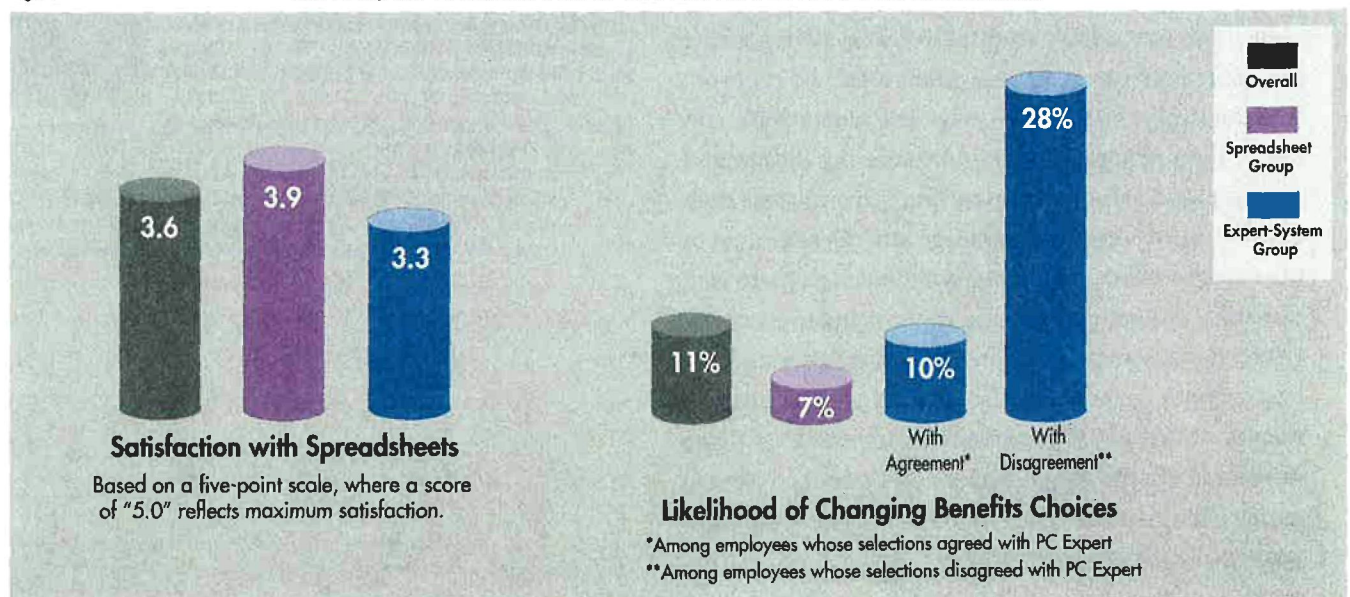


Figure 9


EFFECTS OF DECISION AIDS ON EMPLOYEE BENEFITS DECISIONS



designed that usually recommends the lowest-cost option. This system could cause employees to choose the less expensive plan more often, regardless of its appropriateness for each employee.

Legal liability is another issue for future expert systems. Benefits counselors typically are trained to avoid recommending specific selections to employees for fear of legal liabilities. Their motto: "Describe, don't prescribe." Expert systems, however, prescribe. Concerns about liability can be mitigated by offering users a choice in their selection of experts. Rather than reflecting an employer's representative, experts could be a panel of benefits providers, benefits consultants or even employees who have experience with the organization's benefits.

In a recent Conference Board report, managers raised concerns about development and implementation costs. Some questioned the return on investment of developing computer software when employees may not have access to needed hardware. "During our transition to flex, we produced and distributed a computer disk to help employees model and map out their decisions (i.e., a spreadsheet-based approach). It was great for some, like our engineers, who work with computers regularly. However, for a significant percentage of our work force, the cost/value of the tool was not apparent," one benefits manager noted (Conference Board 1993).

If other, less expensive training options exist, then expert systems may not be justified. While this research was not a utility study of expert systems, such a project is under way. At this point, it can be reported that the expert shell, Knowledge Pro, costs \$895, and the project required about 240 hours for design and testing plus 32 hours of expert time. Overall, less than \$10,000 was devoted to the design and development of the expert system, and benefits satisfaction increased markedly (20 percent) among those using the system. Other factors such as improved knowledge and the cost of options selected also add value. The positive results of this \$10,000 investment suggest that those interested in managing benefits may be well advised to explore the relative value added by expert systems in addition to considering the costs. 

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