

EXPERT SYSTEMS FOR PERSONAL FINANCIAL PLANNING

by Carol E. Brown, Norma L. Nielson, and Mary Ellen Phillips

Computer capability is expanding to provide users access to the judgments of the best experts in a given field, including personal financial planning, through computer programs called expert systems. Personal financial planning expert systems can be classified as either integrated systems, which provide solutions to all aspects of financial planning, or specialized systems, which focus on a smaller knowledge domain. This article discusses the various integrated personal financial planning expert systems in use. The article also discusses financial planning expert systems based on the approach used in their development and the characteristics that should be considered in selecting a system.

The role of computer systems is expanding exponentially within the financial services industry. Today's databases and spreadsheets are increasingly sophisticated, and more control of report generation is available to the

individual computer user. Computer capability also is expanding to provide access to the judgments of the best experts in a given field through computer programs called expert systems. Expert systems in personal financial planning have existed for several years, but with the complexity of personal financial planning surpassing what a single individual can master, the need and demand for expert systems is greater than ever.

In general terms, an expert system is a computer program that solves problems usually solved by a human expert. An expert system differs from other computer programs because it addresses problems, such as personal financial planning, that have no unique, step-by-step solution procedure, and no unique solution. Experts in the field explain the reasoning they use in arriving at their solutions to specific situations. The system developers represent symbolically the experts' knowledge in the expert system's

knowledge base. Then the system users, with less experience and expertise than "experts," use the expert system to solve similar problems.

Features of an Expert System

Most expert systems use two important artificial intelligence techniques: heuristics, and the separation of knowledge and control. These techniques are crucial in the development and maintenance of expert systems.

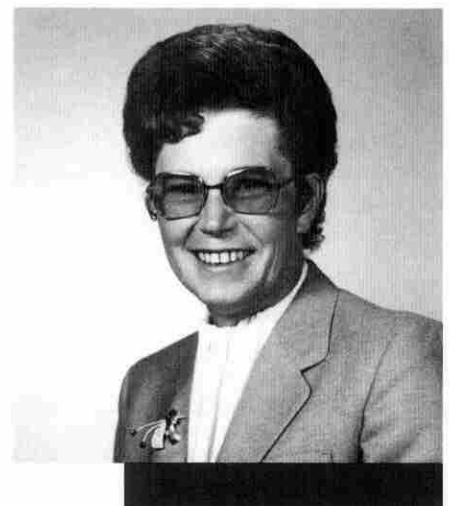
A heuristic is simply a "rule of thumb" that usually results in a correct solution to the problem, but that cannot be proved to be correct. Heuristics help the system operate at maximum efficiency by looking in the most likely place first. For example, most personal financial planners would agree on the rule of thumb that planning usually is needed to provide liquid assets for the payment of estate taxes when an individual's net worth exceeds \$600,000. In fields that use expert systems, so many



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factors are involved that only a few of the possible combinations of all the factors can be considered in the time allotted to a human expert. A heuristic determines the path, out of numerous choices available, that is most apt to quickly lead to a solution. The solution then can be verified independently from the heuristic, either within the system or by humans overseeing its use.

An expert system is most commonly and most effectively used as an advisor to a human decision maker. The expert system provides the technical knowledge and the user provides the common sense and creative responses to unusual situations.

The second expert systems technique is the separation of the experts' domain knowledge (knowledge base) from the control structure (inference engine) of the program. Separating knowledge and control creates several desirable features in expert systems. A program can be developed in stages more easily because only one element of the program must be changed to incorporate improvements in solution techniques. Developers test the system's ability to perform the desired functions, based on feedback from users, and then improve the system.

In addition, people deal best with explicitly expressed knowledge. An expert system is more easily understood by its developers and users because knowledge is expressed in forms more readily understood than when expressed as computer code. The most common expression is through a set of rules, but other methods, such as blackboard systems, frame-based systems, and combination systems, also are used.

Separation of knowledge and control also is useful for domains where the environment frequently changes. For example, if tax knowledge is embedded in computer code in a conventional program that calculates income taxes, that computer code needs to be modified each time the tax law changes. However, if the tax knowledge is stored separately in a manner similar to a database, only the information or "rules" must be updated. If knowledge and control are separated, the perceived complexity decreases, allowing computer users to tackle increasingly complex problems.

Advantages and Disadvantages of Expert Systems

Expert systems are used for solving ill-

defined problems and well-defined problems that cannot be solved efficiently with algorithms. These systems have many advantages over human experts. One advantage is permanence of expertise: once programmed, expert systems do not forget, but human experts may. Another advantage is that many copies of an expert system can easily be produced, but training new human experts is time consuming

and expensive. Because the results are reproducible, expert systems also are consistent in their behavior, while the performance of human experts may vary a great deal.

Although expert systems are expensive to build and maintain, they are inexpensive to operate. The development and maintenance costs can be spread over many users, so the cost per user is reasonable compared to expensive and scarce human experts. A computerized system also allows the user to track demographic characteristics of the client base using it.

Expert systems also have some disadvantages when compared to human experts. In addition to their extensive technical knowledge, human experts have common sense. Developers do not know how to give expert systems common sense. Human experts can respond creatively to unusual situations; expert systems cannot respond except in a prescribed way to known situations. Human experts automatically adapt to changes in the environment, while expert systems must be explicitly updated (machine learning, however, is an active area of research in computer science). Human experts have available to them a wide range of sensory experiences, while most current expert systems are dependent on symbolic input. Expert systems are not good at recognizing when a problem is outside their area of expertise and may not recognize when a problem is insoluble.

Because of this combination of advantages and disadvantages, an expert system is most commonly and most effectively used as an advisor to a human decision maker. The expert system provides the technical knowledge and the user pro-

vides the common sense and creative responses to unusual situations!

Personal Financial Planning Expert Systems

Personal financial planning expert systems can be classified as either integrated systems, which provide solutions to all aspects of financial planning, or specialized systems, which focus on a smaller knowledge domain. Table 1 provides the domain, the producer, references, and the stage of development for the integrated systems. A discussion of each of the integrated systems follows. Some specialized systems are described briefly in a subsequent table.

This section includes a discussion of the various integrated personal financial planning expert systems in use, including the major features that differentiate these systems. These systems are representative of the various approaches currently available for developing expert systems. Comprehension of their features allows the potential purchaser to understand which features are important and unimportant in the selection of a system.

PlanPower — Applied Expert Systems (APEX)

The development of PlanPower began in 1982 and the system was first shipped commercially in April 1986. Until 1987, the knowledge base was updated every three to six months to incorporate tax law and other environmental changes. PlanPower uses data provided by the financial-institution representative to generate the client's report. PlanPower has "what if" capability. In 1987, APEX shifted their marketing to Client Profiling System.

Client Profiling System — Applied Expert Systems (APEX)

The development of Client Profiling System for financial institutions began in 1986, and the system was in use by 1987. Currently, more than twelve insurance companies, major banks, and brokerage firms use the system, including firms both inside and outside the United States. The APEX system has a licensing fee of \$100,000 or more per year.

Client Profiling is intended for middle-income customers. The system uses a client questionnaire prepared with the assistance of the financial institution representative. The questionnaire requires financial data and focuses on the customer's goals. The system generates a 15-20 page client report and a second

TABLE 1
Integrated Personal Financial Planning Expert Systems

Name	Domain/Company/References	Stage/Date
PlanPower	Personal financial planning for individuals with incomes over \$75,000. APEX (Applied Expert Systems) [Applied Expert Systems 1987], [Standfield & Greenfeld 1987], [Behan & Lecot 1987], [Humpert & Holly 1988], [Mowatt 1989]	In Use 1986-1988
Client Profiling System	Personal financial planning for individuals with incomes between \$25,000 and \$200,000. APEX (Applied Expert Systems) [Applied Expert Systems 1987], [Vandegrift 1990]	In Use 1987
Objective Financial Systems	Personal financial planning for all income ranges. Through financial institutions with per-use charge. Objective Financial Systems, Inc. [Behan & Lecot 1987], [Niswander 1989-1990]	In Use 1987
PFPS	Personal Financial Planning System. Prepares a financial plan for people with incomes between \$25,000 and \$150,000. Arthur D. Little, Inc. and Chase Lincoln First Bank [Kindle, et al. 1988], [Martin 1988], [Behan & Lecot 1987], [Cann 1989-1990]	In Use 1987
Personal Financial Analysis	Integrated personal financial planning system with 4-5 imbedded expert systems modules. Price Waterhouse [Laube 1988], [Price Waterhouse 1988], [Barber, 1989-1990]	In Use 1987
PLANMAN	Personal financial planning. Sterling Wentworth Corporation [McKell and Jenkins 1988], [McKell, et al. 1988], [Behan & Lecot 1987], [Sterling Wentworth 1989], [Whittenberg 1989-1990]	In Use 1986
AAFINPLAN	All income ranges, modification of PLANMAN. Arthur Andersen & Co. [Head 1989-1990]	In Use 1989
STEPI	Sales-oriented personal financial planning. Sterling Wentworth Corporation [Whittenberg 1989-1990], [Sterling Wentworth 1989]	In Use 1989

report for the financial institution representative that recommends specific products and describes selling points tailored to the client. In 1989, APEX began offering the system on a per-use basis to individual financial planners.

Objective Financial Systems — Objective Financial Systems, Inc.

Objective Financial Systems has been available commercially for three years. Mini-computer based, Objective Financial Systems links to other systems that track market and rate-of-return trends, and integrates that information into its analysis and recommendations. The

system uses client-profile information as well as financial information in preparing its report. Modeling is based on available funds and available investments. The system produces either a comprehensive financial plan or separate modules addressing retirement planning, education funding, debt management, insurance and risk management, life-insurance planning, estate planning, dwelling management, cash flow and budgeting, and investments. The final report is produced using a computer-controlled word processor.

Objective Financial Systems is marketed on a per-use basis primarily

through banks, savings and loans, and credit unions. The charge per use ranges from \$15 to \$500. The charge to the user's customer ranges from \$500 to \$5,000, depending on how the product fits the marketing strategy of the financial institution and whether the request is for a comprehensive plan or for a single module. The system is designed to be appropriate for all income levels. In practice, however, the single-module runs are for clients with incomes from \$20,000 to \$70,000, and requests for comprehensive plans begin with income levels of \$50,000 or net worth of \$100,000.

PFPS — Personal Financial Planning System — Chase Lincoln First Bank

PFPS, in use since 1987 by Chase Lincoln First Bank, was developed over five years by Chase in conjunction with the international consulting firm Arthur D. Little, Inc. PFPS covers investment planning, debt planning, retirement planning, education planning, life-insurance planning, budget recommendations, income-tax planning, and savings achievement for other major financial goals.

The system provides detailed financial planning reports for individuals with median incomes (\$25,000 — \$150,000 and up). Reports are provided to clients on a fee basis and cost as little as \$300. Chase is considering reselling the system to financial planners and other banks.

Personal Financial Analysis — Price Waterhouse

Personal Financial Analysis is a package of services available to employers who are clients of Price Waterhouse. Client companies purchase the service to provide financial guidance to their employees. Through this three-step approach, results are tailored to the client company's benefit plan.

First, the employee fills out a brief, confidential questionnaire focusing on his or her economic and family situation: income, taxes, investments, employee benefits, marital status, number of dependents, and any special financial goals such as financing retirement or children's education. The questionnaire serves as the basis for a 40-50 page report that provides suggestions for asset management, investment strategies, tax-saving strategies, planning for education savings, life-insurance needs, and retirement savings. The report is prepared using a combination of human analysis and expert systems. The report includes financial

action checklists to assist the employee in implementing the plan.

PLANMAN — *Sterling Wentworth Corporation*

PLANMAN is a personal financial planning expert system for professional financial planners. Quantitative and qualitative personal data about the client is collected on preprinted fact finders. The client information is checked and analyzed by over 7,500 decision rules in the system. The system generates comprehensive or modular plans with an option to create a pro forma report. The use of planning parameters allows the system to base its conclusions and recommendations on the individual planner's philosophy as well as the client's data. Conclusions and recommendations tailored to the client are used to select appropriate paragraphs of information which are merged and customized, using client data, into a report.

With the pro forma option, the financial planner can use the system to project the long-term impact of the system's recommendations on the financial condition of the client and to do "what if" analysis.

PLANMAN includes the following planning modules: income tax and cash flow, investment and portfolio, life insurance, disability income, retirement, education funding, and estate. The user can use one or a combination of several of these modules, or the entire expert system. The system provides the financial planner with extensive report-writing and graphics capabilities. PLANMAN has been in use for several years and recommendations of users for improvements have been included continuously in the system.

AAFINPLAN — *Arthur Andersen & Co.*

AAFINPLAN is a modified version of PLANMAN that Arthur Andersen & Co. developed with Sterling Wentworth Corporation. The knowledge base received minor modifications and the text of the recommendations had extensive modifications. Arthur Andersen's approach is to include consultation with its personal financial planning professionals, together with the expert-system-produced plan. AAFINPLAN is available to companies who are Arthur Andersen's clients in a package of services similar to that described above for Personal Financial Analysis.

STEPI — *Sterling Wentworth Corporation*

STEPI is designed as a sales tool for a

Name	Domain/Company/References	Stage/Date
PEAT/1040	Projection and Expert Analysis Tools for 1040 tax return preparation and tax planning. KPMG Peat Marwick [Goldberg 1988], [KPMG Peat Marwick 1988], [Brown 1988]	In Use 1987
PEAT/QPD	Qualified Plan Distribution Planning System Designed to assist in determining optimal elections and distributions for multiple qualified plans. KPMG Peat Marwick [Goldberg 1989]	In Use 1989
INVEST	Advises about specific securities to meet short-term objectives. Volksband Muenster and Westdeutsche Genossenschafts-Zentral Muenster [Heuer, et al 1988]	In Use 1988
Andrew Tobias' TaxCut	Assists taxpayers in preparation of Form 1040. MECA Ventures, Inc. Previously marketed as "Ask Dan About Your Taxes." [Caine 1988], [Legal Knowledge Systems 1988], [Port 1988], [Brown 1988]	In Use 1988 and 1989
TaxPoint	Assists taxpayers in selecting proper tax forms. TASO Inc. [Taso 1988]	In Use 1989

financial planner. STEPI, like PLANMAN, contains modules that can be used alone, or in combination, to produce reports. In addition, the planner can use the entire expert system through a capstone module. Information is supplied to the system via a fact finder that can be completed by the client. The financial planner can modify the input data required and the report format by changing the planning parameters that incorporate the planner's individual style, attitude, and insights. The system permits modification of the input data and the report format to fit the individual client.

A word processing file allows for customizing the financial plan. The format of the financial plan is designed to assist the planner with sales presentations. STEPI also produces a sales report that provides background information on the client, educational information for the planner, and explanations of the calculations.

Some expert systems deal only with a portion of the financial planning knowledge domain. Table 2 contains a summary of some of the specialized systems in use. The table provides the domain, the developer, references, and the stage of development for these systems.

Types of Personal Financial Planning Expert Systems

Developers have used four basic approaches for financial planning expert systems. The best approach for a particular user depends upon the organization's size and the characteristics desired by the user. The approaches are:

- Develop a customized system
- Custom modify an existing expert system to fit the particular needs of the user
- Contract to use the expert system of a developer who operates a service bureau
- Purchase or license a generic system for in-house use with periodic updates provided by the developer

A large institutional user could elect any of these four approaches to expert systems technology. A customized system or custom modification is too costly for an individual financial planner and, therefore, would be appropriate only for medium and large users.

Customized System or Customized Modification

A customized system or a custom modification provides the user with exactly the

system specified. This requires the buyer to have an excellent understanding of his or her needs and potential future uses, as well as access to programmers skilled in expert-system development. These approaches command high development costs (whether developed internally or by an outside consultant), and a long lead time before a working system is on line. The buyer of a customized system or a custom modification also will incur high maintenance costs to update the system's knowledge base. The more frequent the updates, the larger the cost. Therefore, only an institution that expects a high volume of use would want either a customized system or a custom modification. Because the development of an expert system for personal financial planning is a very large, expensive, and time-consuming task, even large companies should approach the decision with great care.

A Service Bureau

A developer who operates a service bureau may charge a flat fee for unlimited usage or may charge the user for each client report. A financial planner who uses a service bureau need not incur either the investment or the maintenance costs for computer capacity to operate the expert system. Another organization might lack staff skilled in financial planning and find a service bureau less expensive than adding personnel.

In addition, the service bureau operator is completely responsible for keeping the system operational and current (updating the system). Whether a proprietary fee or a per-use fee, or both, is paid depends on the volume of the buyer and the buyer's ability to pass the costs of using the expert system on to its clients. The service bureau

tages of being available in-house and does not depend on rapid and accurate data transfer to a processing center. Many users find that the accessibility of an in-house system encourages sensitivity analysis. This type of system will not provide access to real-time data on market rates and other information that can be built into either custom or service-bureau systems. Inevitably, then, the timeliness of some information within the system may be less uniform than that of another type of system.

The user must acquire the computer capability to run an in-house system. The less a user is willing to invest in hardware, the more restrictive are the choices among systems. The minimum equipment specified for a particular system generally will provide output at slow speeds. Tradeoffs between the sophistication of the expert system and the cost and speed of the target hardware are inevitable.

Criteria for Selecting an Expert System

The purpose of financial planning expert system is different, and the criteria used to select such a system should differ as well. Selection criteria should match the buyer's objectives for the system. The importance of a particular feature may depend on whether the financial planner is providing both planning services and products, or simply selling advice. In other cases, the importance of a feature may simply be a matter of personal preference.

Whether the planner uses a service bureau or acquires a generic system, the selection criteria for a personal financial planning expert system can be divided into the following categories: reliability, flexibility, user friendliness, output usability, and operating time and cost.

If the system truly represents domain expertise, then reports generated by a financial planner using the expert system should be superior to reports created by the planner if he or she does not use the expert system.

may allow the user to set some parameters for the plan being produced, thus allowing the user some customizing of the report. Most vendors provide assistance to the user in learning to use the system, in choosing parameters, and understanding the system's output.

A Generic System

A generic system that is updated periodically by the developer has the advan-

Reliability of the System

If the system truly represents domain expertise, then reports generated by a financial planner using the expert system should be superior to reports created by the planner if he or she does not use the expert system. Regardless of the computer programming and the other beneficial features of the system, if the developer is not an expert in the domain, the reports

generated by the system will be inferior. Consequently, determining the expertise of the developer is critical in selecting an expert system.

In addition to reviewing sample reports provided by the developer, a prospective buyer should carefully evaluate the system by running test cases and studying the results. The buyer also needs to examine the detail and the rationale used by the expert system in making its choices and arriving at its recommendations. Without these tools, the financial planner may have difficulty assessing the thoroughness and correctness of the system's recommendations, and explaining reports to his or her clients. Because expert systems are fallible, the ability to review the rationale for major decisions is vital. The financial planning professional is morally and legally responsible for the quality of the final report — regardless of whether the planner used an expert system.

The advantages of a financial planning expert system will rapidly disappear unless the knowledge base is constantly updated by the developer for changes in the environment. The pace of new product introductions by financial institutions and the frequency of modifications to the Internal Revenue Code make periodic updates to an expert system's knowledge base crucial. To be reasonably certain the developer will make timely and adequate updates, the buyer should determine if the developer is stable, financially sound, and committed to the product.

Flexibility of the System

While flexibility within an expert system is desirable, flexibility always has a price. Increasing flexibility creates operational inefficiencies, slows performance, and adds cost. Some elements of flexibility are crucial to financial planning expert systems, while others will vary in importance to individual users.

People purchasing financial planning assistance frequently ask, "what if?" An expert system that does not allow the financial planner to quickly generate "what if?" sensitivity analysis will not truly serve the client. In addition, each financial planner possesses his or her own preferences toward certain planning strategies and products. Therefore, the ability to set parameters within the expert system to reflect these preferences may be important to the user. For example, a financial plan may recommend the purchase of life insurance. If the expert system

cannot be modified to include the planner's preference for specific insurance products, it may not help the planner, and in fact, it may be counterproductive.

The planner may need to set parameters within the expert system because the client's environment is not typical and, therefore, not considered fully by the expert system. For example, a unique state law that affects property ownership or local tax laws may not be included in the knowledge base. An expert system that cannot be modified to include these special circumstances will provide misleading reports and recommendations.

The expert system capability expands the individual planner's access to the judgments of the best experts in a given field.

Finally, customized reports with a professional appearance are important to the financial planner. An expert system that allows the planner to customize the report or integrate the report into other documents maximizes the planner's flexibility. To some planners this flexibility may be crucial, to others it may be trivial.

User Friendliness of the System

Expert systems are complex to use and provide extensive reports. Therefore, most users will want extensive, quality training in the use of the system, as well as training in interpreting the reports generated by the system. The tools provided for gathering data also are important in all systems. These are the key elements in evaluating the user friendliness of a service bureau's expert system.

Additional factors must be considered for an in-house system, where the importance of user friendliness usually depends upon the computer literacy of the person who will operate the system. The more facile user sets different standards for user friendliness. However, even the most computer-literate users desire manuals that are easy to read and use, and good help lines and support from the developer.

Usability of the Output

The planning horizon, the format and length of the reports, and their readability by clients are all important considerations. The client may pay a substantial sum for the financial planning service, and the only tangible evidence of that service is the report. If the report is not readable and professional in appearance, the finan-

cial planner is at a competitive disadvantage. The systems described in this article vary considerably in length and level of detail available in their reports. A planner, for example, who selects a system (or option of the system) that generates an 80-page report also must be willing to spend considerable time with the client examining the many issues addressed and explaining the conclusions and recommendations of the report.

Time and Cost for Product/Run

These final factors are obvious ones. The time to generate a financial plan using

an expert system ranges from a few minutes on an in-house system to several days for those systems that require data to be processed at an off-site center. Thus, the value of immediate turnaround is an important factor in choosing the right expert system.

Regarding cost, the financial planner should perform a break-even analysis to determine whether a per-use charge is more cost effective than the purchase of a flat-fee license or a freestanding system. The cost of freestanding financial planning expert systems begins at around \$5,000 (excluding the cost of equipment) and can run as high as \$500,000 or more.

Conclusion

To remain competitive in the financial planning marketplace, and to stay abreast of the rapid-fire changes that occur, the professional financial planner will need to increasingly rely on expert-systems technology. The expert system capability expands the individual planner's access to the judgments of the best experts in a given field. The use of the expert system improves the quality of the recommendations of the financial planner by adding the knowledge of experts provided by the system to the knowledge, skill, and judgment of the financial planner who uses the system.

A financial planner also may broaden his or her own skill and knowledge by observing and studying the expert system's solutions to various problems. The quality of the written report presented to the client improves because the system provides assistance with wording, format, and organization. If a financial planner

uses an expert system, less time is spent on all phases of preparing the client's report, leaving more time for direct client contact. ■

Editor's Note: This article underwent review procedures typical in academic research. The Journal publishes such articles to promote academic research in financial planning.

Footnotes

1. Excellent further discussions of expert systems can be found in these books: Waterman [1986]; Wolfram, Dear, and Galbraith [1987]; Lindsay [1988]; and Rauch-Hindin [1988]. These references are technically accurate and understandable to the potential user. See the bibliography.

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