PFPS - Personal Financial Planning System

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Abstract

PFPS is an expert system developed over the last five years at Chase Lincoln First Bank, N.A., to provide objective, affordable expert financial advice to individuals with household incomes ranging from $25,000 to $150,000, and up. PFPS is an integrated personal financial planning system encompassing the following areas of financial expertise: investment planning; debt planning; retirement savings and settlement of retirement plans; education and other children's goal funding; life insurance planning; disability insurance planning; budget recommendations; income tax planning and savings for achievement of miscellaneous major financial goals (purchase of house, extended travel, etc.). PFPS has supported the personal financial planning service of Chase Lincoln First in upstate New York since late 1987. The PFPS system components are implemented as an embedded system on an IBM 4300 series mainframe under VM/CMS and on a Symbolics 3600 series LISP processor. The Symbolics system is connected to the IBM mainframe in a master/slave relationship using an application-level protocol defined on top of RS232C. All of the inferencing and planning is done on the Symbolics 36xx using a system architecture based on a blackboard framework, an object-oriented data base, and a goal-directed generate-and-test search paradigm with extensive search-space pruning.

The Nature of The Problem and The Solution

"How can I achieve, as closely as possible, my lifetime financial goals given my limited resources?" is the problem, defined from the client's perspective, that the Chase Lincoln First Bank Personal Financial Planning System (PFPS) was designed to solve. This system was developed to supplement the use of high-cost bank personnel in the strategically important, but heretofore unprofitable, area of personal financial planning services.

The system is of strategic importance to the bank. Relationships developed with customers through the planning process often lead to the development of additional bank business related to implementation of the planning recommendations. The incremental cost of producing a plan using PFPS is more than recovered as a client fee. Thus, what has generally been for banks a loss leader for upscale clients has become, using PFPS, a cost-effective opportunity to serve a much wider client base.

The planning system eliminates the individual biases of the human planner and exceeds by far their ability to take into account the wide range of information that might, and should, affect a financial decision. PFPS integrates planning modules having expertise in the following areas: investments; debts ; retirement savings and settlement of retirement plans; education and other children's goal funding; life insurance; disability insurance; budget recommendations; income tax planning; savings for achievement of miscellaneous major financial goals

PFPS develops a set of strategies that enables the client either to attain their goals or make reasonable concessions that trade off among conflicting goals based on client priorities and the timing and amounts of any shortfalls. For example, age of retirement may conflict with post-retirement standard of living. One, or a combination of both of these goals may be modified, depending on the amount of the shortfall and the client provided priorities.

Strategies may include the use of alternative savings and investment options such as custodial accounts, company-sponsored retirement plans, individual retirement accounts (IRAs), tax-exempt investments, and where necessary, debt. The system maintains a balanced cash flow while optimizing investment returns and the tax consequences of selected strategies.

The client provides data regarding his or her sources of income, level of expenses, assets, liabilities, insurance coverage, employee benefits (retirement and insurance), risk tolerance and lifetime goals, ranked according to priority, through an extensive questionaire and an interview with a financial planner. Goals may

include standard of living now and during retirement, age of retirement, adequate levels of insurance protection, college or other goal funding for the children (wedding, home downpayment, etc.), and provision for miscellaneous major goals. The system determines what level of these goals can be achieved and develops a customized strategy for their achievement.

The system is driven by the client-supplied data together with a set of parameters that describes the external environment; for example, types of investments available, types of loans available, rates for general inflation, education inflation and real estate inflation and insurance costs. This planning parameter file contains on the order of 15,000 pieces of data.

Candidate solutions are generated and examined by PFPS to make certain that all aspects of the client's cash flow and asset levels are in balance over the entire planning period. The planning period often covers 50 years and is selected to ensure that less than 5% of the clients will outlive the plan.

The output from the system is a final report for the client ranging in size from 75 to 100 or more pages with text, tables, and graphs which clearly explain the recommendations and the advantages of these strategies. The final report is divided into three sections: specific action items for the next year or two; recommendations for the next three to five years; and an appendix containing recommendations and supporting charts for the balance of the client's life. Figures 1 and 2 show two pages of output from a typical client plan.

Generic recommendations that leave the client wondering what to do are avoided. Instead, yearly recommendations are provided which are specific to the client situation. For example, rather than describing the general benefits of participating in defined contribution plans, the plan might recommend that the client contribute 6% to their company's 401(k) plan starting in May of 1989 and increase it to 10% in January 1990. All recommendations are fully supported by charts showing detailed sources and uses of cash for the first five years of the plan and summary charts covering the client's entire life.

FINANCIAL STRATEGIES FOR JOHN & MARY RIGHT

CHASE LINCOLN FIRST BANK, N.A. *November/1988*

Your Goals

Our projections of the achievable level of each of your goals, based on following all of the recommendations in this plan, are outlined in the following table.

Your Goals for Personal Financial Planning (1988 Dollars)

Priority Rank	Goal	Desired Objective	Projected Achievement Based on Plan	Percent Achievement Based on Plan
1.	Retirement Age/Year			
	John	57/2002	57/2002	100%
	Mary	56/2002	56/2002	100%
2.	Funds for Retirement Living Expenses (annual after-tax)	$ 30,565	$ 30,565	100%
3.	Maintain Standard of Living - Current Budget	$ 24,440	$ 23,218	95%
4.	Annual Income if Disabled*			
	John	$ 30,530	$ 30,530	100%
5.	Funds for Children	$ 82,000	$ 69,700	85%
6.	Annual Income for Survivors			
	Mary	$ 19,624	$ 17,662	90%
	John	$ 19,624	$ 19,624	100%
7.	Boat (1990)	$ 25,000	$ 20,000	80%

*For Other Protection, see "Other Insurance" section of Plan.

Figure 1. Sample report page showing goal achievement.

FINANCIAL STRATEGIES FOR JOHN & MARY RIGHT
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Recommended Risk and Return Projections

The next graph shows the expected performance of the investments we recommend. We have factored in a risk level that is consistent with your stated tolerance for risk, and the performance reflects a rate of return consistent with our recommendations. The table on page A.51 of the Appendix has the actual numbers which support these projections.

Recommended Portfolio Risk and Return Projections
Investment Assets After-Tax
(1988 $000)

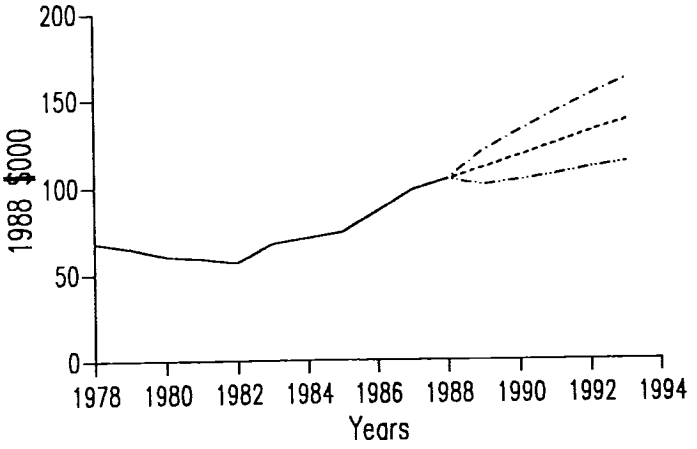

Figure 9. Recommended Portfolio Risk and Return Projections: Historical Value (solid line), High Range (dash-dotted line), Low Range (dashed and dots line), Expected Value (dashed line)

Figure 2. Sample report page showing risk/return envelope for recommended client portfolio.

Development History

PFPS and the personal financial planning service have been under development for the past five years at a cost to Chase Lincoln First of close to five million dollars for system development, product development and marketing promotion. The architecture and initial version of the system were developed by Martin, Kindle and others at the Arthur D. Little AI Center between 1983 and 1985 under Cann's supervision at Chase Lincoln First.

The initial version of the system, written in PROLOG, used a simple form of generate-and-test to construct, evaluate and dismiss trial solutions. PFPS was then redesigned and written in ZetaLISP to enable the creation of a full-scale real-world solution.

Between 1985 and initial market testing in late 1987, Cann, Kindle and Craig completed the implementation of the planning modules which deal with the individual areas of financial planning expertise. Additional work was also undertaken at Chase Lincoln First to enhance the goal modification process and permit larger areas of the search space to be pruned to acheive substantial run-time improvements for client plans requiring goal reductions.

Controlled market and product testing continued through early 1988 and personal financial planning was rolled out on a limited basis in the Rochester area in September 1988. Preliminary market studies indicate a very high level of satisfaction among those people who have received financial plans. In a recent survey of plan recipients, an astonishing 100% indicated that they would be willing to recommend the planning service to a friend.

PFPS Technical Description

System Overview

The PFPS system components are implemented as an embedded system on an IBM 4300 series mainframe under VM/CMS and on a Symbolics 3600 series LISP processor (See Figure 3). The overall system is controlled by a group of virtual machines on the IBM 43xx. Separate virtual machines exist for data entry and verification (KEYENTER), composition of the final report (COMPOSER), production supervision (PRODSUPR), control of the customer data base (DBCNTL) and finally for communication with the Symbolics 36xx (PLANNER). Additional virtual machines exist for text maintenance (MAINT) and for control of the planning parameter file (PPFMNT).

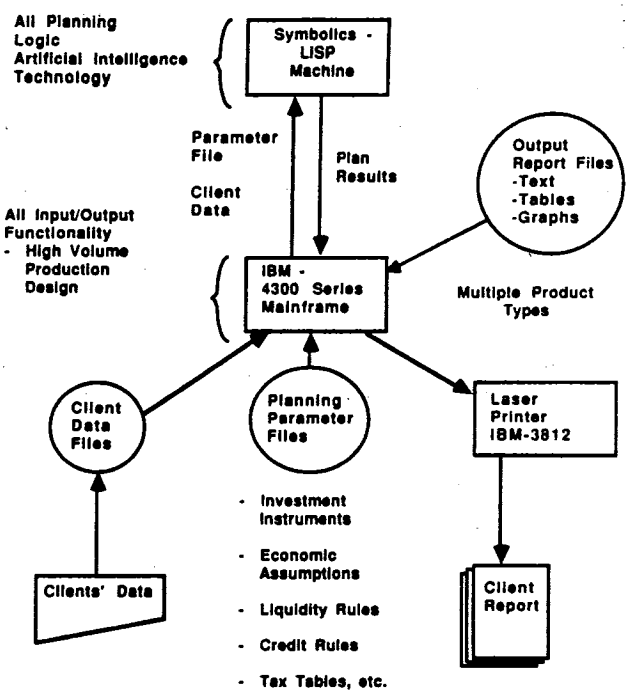

Figure 3. PFPS System Architecture Overview

The separation of duties among virtual machines on the IBM side reflects the extension of the object-oriented programming paradigm from the Symbolics into the IBM realm. In addition, a high volume production environment is made possible by this design, since any number of data-entry virtual machines can be added to the system at extremely low cost (at local or remote locations).

Data supplied by the client is keyentered and verified on KEYENTER and then put through a series of several thousand edit checks to ensure internal consistency of the data. Since the client data varies from individual to individual, anywhere from 100 to 2,000 data elements are supplied. After the client data has been approved for processing and released by PRODSUPR, it is downloaded to the Symbolics by the PLANNER virtual machine.

The Symbolics system is connected to the IBM mainframe in a master/slave relationship using an application-level protocol defined on top of RS232C. The Symbolics operates as a slave to the PLANNER vitural machine which initiates batch processing upon request. Every 30 seconds PLANNER interrogates the Symbolics about its state and transmits client data, waits for planning to be completed on the Symbolics or receives plan output files, accordingly. The Symbolics solves the plan as a single low-priority process with a high-priority process monitoring the serial communications line. The IBM system may enforce a system time-out, designed to guard against runaway plans. If the Symbolics crashes in the course of a plan, the IBM will re-boot the Symbolics and proceed to the next plan.

This innovative, direct, real-time connection antedates such well-known applications as the Authorization Assistant of American Express. The design allows the planning code to be maintained and enhanced using high-level LISP, macros and other features on the Symbolics. Rewriting the system in an IBM-supported language would have imposed far greater development and maintenance costs. From an on-going maintenance and development standpoint, PFPS must react quickly to changes in prevailing tax laws, investment types, etc. Further, this design facilitates the scaling up or down of the processing power of PFPS through inexpensive upgrades to or the addition of Symbolics workstations.

All of the inferencing and planning is performed on the Symbolics and is written entirely in LISP making extensive use of Flavors. PFPS has also been successfully ported to and run on a Texas Instruments LISP machine as part of a compatibility and performance study, although no TI machines are included in the current configuration. The planning logic includes more than 200,000 lines of LISP code and is described in greater detail later.

Upon completion of Symbolics processing, a results file is uploaded to the IBM, merged with text files, and composed using IBM's DCF/Script product for final printing of the client report on an IBM 3812 laser printer.

Object-Oriented Database

After downloading of data from the PLANNER virtual machine to the Symbolics file system, the data is loaded into an object-oriented data base that serves as the blackboard for the PFPS planning environment. The data base structure, implemented using Symbolic's Flavors, follows the theories of semantic data modeling described in Curtice and Jones (1983).

The requirements of PFPS were such that the data base of a traditional blackboard model was extended. As outlined in Weinreb et al (1987), an object-oriented data base extends the features of an object-oriented language by offering persistence, transactions, and sharing between workstations. Moon (1986) describes the approach used in the Symbolics LISP Operating System (Genera) to use the Flavors extensions to LISP for object-oriented programming.

Flavors alone, however, did not offer features generally required in the information system industry, particularly the financial community. For example, Flavor's error-checking and enforcement were weak. The authors required a method for enforcing strong typing upon objects so that project collaborators would have clear conventions by which to program. The subsequent design process produced an exhaustive record structure consisting of a determinate schema mechanism, which could embody a system data-dictionary. The schema allowed many programmers and users to see the system's data elements, which consisted of such items as the client's name, the account, the account type, yearly income statements, the client's financial goals, etc. (See Figure 4).

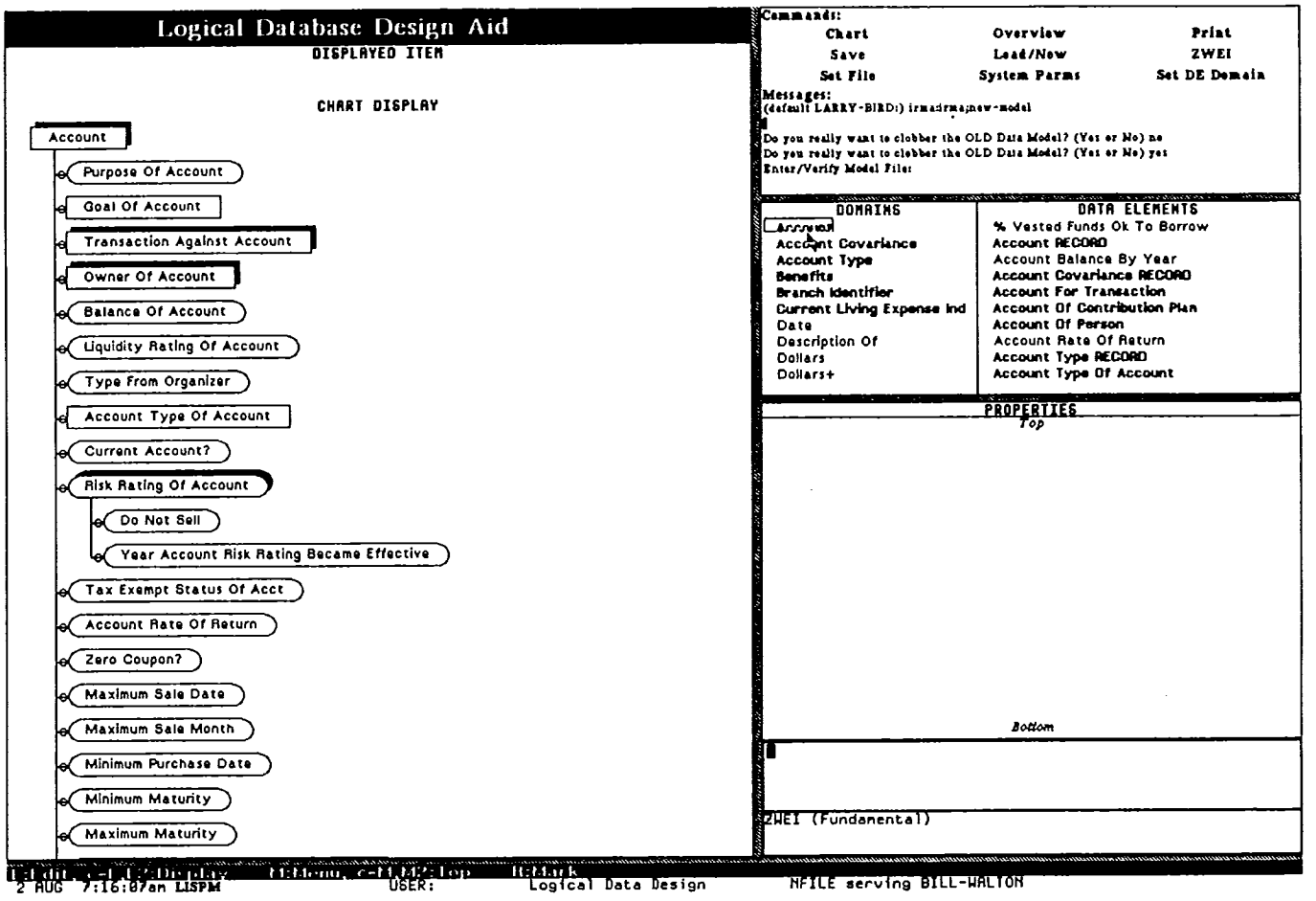

Figure 4. Account section of PFPS data base structure. Rectangles represent data records, ovals represent data elements of the record, and shaded ovals represent sub-records.

The memory requirements of the data base that is created on the Symbolics is very large and unpredictable in advance of a client run. Some of the complex schema, such as an individual's income statement, have several instantiations, one for each person, in each year that a plan is run. An early version of PFPS put the entire data base in a temporary area which was then flushed clean between clients. However the difficulty of keeping operating-system objects out of the temporary area made this solution unworkable.

As additional logic was added to the system, the memory requirements increased to the point where running a single plan could use up to 100 MBytes of memory, including garbage. As a result, present memory management makes use of the most extreme form of garbage collection: automatic booting of the Symbolics between client plans by command from the PLANNER virtual machine. Booting between plans takes less than five minutes and is more than offset by the reduction in planning time attained by the elimination of ordinary garbage collection during the planning run.

PFPS Inferencing Mechanism.

The Symbolics implementation is based upon a blackboard framework utilizing a group of planning modules controlled by a higher level program called the Logical Kernel. The planning modules deal with the various areas of expertises such as retirement, investment, debt, education funding, taxes, etc.

The separation of knowledge sources into planning modules whose invocation is controlled by the Logical Kernel and the object-oriented data base meet the definition of a blackboard model proposed in Engelmore et al (1988).

In this way, PFPS consists of the "many and varied sources of knowledge" described in Feiganbaum (1988), each of which contributes to the formulation of a plan for a given client. Each knowledge source contributes opportunistically to formulation of a solution, through the actions of the system Logical Kernel.

The Logical Kernel, acting as a manager, traffic cop and simulator of the passage of time, directs the year-by-year creation of recommendations, any backtracking that is required and the arbitration of client goals. Backtracking is utilized by the planning modules to try various strategies in the year-by-year processing as well as for the restart of the plan in the event of overall goal failure.

In the first round of planning, if a financial goal cannot be satisfied in a given year by any means, the shortfall is recorded and year-by-year processing continues. At the end of the planning horizon the years and amounts of shortfalls are then analyzed to develop a revised set of goals for the next round of planning. This first round of goal arbitration takes a major initial step toward the generation of a successful plan by pruning off a very large fraction of the possible search space. Of course, if all goals are satisfied on the first round, the planning ends in success and a report file is created for uploading to the IBM.

On subsequent iterations of the year-by-year planning, goal failure in a year results in immediate goal arbitration (search-space pruning). This goal arbitration is less extensive than the first-round goal arbitration since the goal levels are now much closer to an achievable set of goals. Processing continues until a set of achievable goals is attained or until the overall level of achievement falls below a system threshold.

Many of the planning modules might be considered expert systems in and of themselves if they were separated from the rest of the system. Thus, for example, the funds-acquisition module (debt and other sources of funds) has knowledge of conventional lending rules regarding debt service/income ratios, different types of debt instruments (home equity, mortgage, unsecured demand loans, etc.), tax status of various types of debt interest, IRA and defined contribution plan withdrawal regulations and tax consequences. Using this knowledge, in any year in which funds are required from sources other than normal income and assets, the funds-acquisition module searches through combinations of loans, seeking a low after-tax interest cost combination which satisfies typical liquidity rules; if necessary, retirement plan withdrawals will be brought into play.

System Deployment

The personal financial planning service based on PFPS is currently being offered in the Rochester, NY, area. The product has been available in this area since late 1987, during which time the marketing materials and approach have been extensively tested and analyzed. The quality of the plan is comparable to, if not better than, plans developed by existing traditional personal financial planning services and far surpasses any automated planning systems of which the authors are aware. Fees to a client for a PFPS-generated plan start as low as $300; plans obtained elsewhere in the market today that approach the level of quality offered can cost $10,000. The plan itself is provided on a fee basis; implementation assistance is offered to the client, but this relationship is not required.

PFPS and the personal financial planning product have been developed to fill a strategic need of the bank to provide affordable, high-quality planning to its broad base of customers. Although the standalone profitability of the operation is one key measure of success, it is being found that the relationships with customers begun through the planning process are key to the development of additional bank business. Future marketing plans are under review, but could include wider distribution through the Chase Lincoln

First market area and distribution through corporations and other institutions as an employee benefit.

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