THE BROKER’S AID:
Expert Systems and Prototype Evaluation

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An Off-Term Research Grant Proposal to The Faculty Research Review Committee

This paper is in preliminary form and should not be quoted without specific consent of the author. Comments would be appreciated.
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Figure 1: System Structure
1. ABSTRACT

This paper proposes a prototype "expert system" designed as a decision support aid to an investor and/or a stock broker. The system draws on four main elements for its functions. These elements are:

- An accounting and stock price database
- A filtering module
- A set of portfolio construction and modification rules
- A portfolio monitor module

The first element utilizes archival data from common databases. The other three main modules are built with a series of hybrid "expert derived" decision rules. The paper describes the system and attempts an a priori evaluation of system usefulness. For this purpose, (1) criteria are set for system evaluation, (2) a simulation is performed using the prototype, and (3) ex-ante conclusions are drawn on the potential of such a system and on behavioral factor related to this type of decision support.
2. PROBLEM STATEMENT

2.1. THE EXPERT SYSTEM AREA

Expert systems have evolved to the point where a series of real applications are being successful and/or present great potential for business applications. (Davis & Lenat, 1982) The major obstacle however, is the absence of methodologies for the early evaluation of decision system potential. Efforts in Artificial Intelligence and its subfields of Natural Languages and Expert Systems have been generating substantial interest by accounting researchers and practitioners. The Peat Marwick and Mitchell Foundation sponsored two expert systems projects in its ROA program. The School of Accountancy of the University of Southern California and Deloitte, Haskins and Sells supported an audit conference that stressed expert systems as a means for decision support.

However, only a few limited research efforts are currently noteworthy. Among these work in progress at the University of Florida (Messier and Hansen, in audit), University of Minnesota (Bailey et al., internal control evaluation) and University of Illinois (Chandler, allowance for bad debts).

The objectives of this research proposal are threefold:

- Development of a prototype system to use structured accounting data and rules gathered from experts in the assistance of investors and/or brokers.
- Development of a methodology of ex-ante evaluation of decision support systems utilizing software prototyping.
- Assessment and insight into accounting data usage (information utilization), heuristic development and reevaluation (association, learning and feedback) and, data user personality characteristics (cognitive style, background factors).

2.2. BACKGROUND - RELATION TO PREVIOUS WORK

Knowledge-based expert systems have been constructed, typically, from two loosely coupled modules, collectively forming the problem-solving engine.

The knowledge-base contains all the relevant domain-specific information permitting the program to behave as a specialized, intelligent problem solver.

.... The inference engine is that component of the system which controls the deductive process.

(Stolfo and Vesonder, 1982, p.6)

Large portions of the accounting literature deal with the issues of market efficiency and the MACRO behavior of the markets. A smaller sector of the literature deal in the Human Information Processing area attempting to explain how humans react in a MICRO sense leading to the observed behavior. This literature is extensive and has presented low real explanation to
the observed phenomena (Ashton, 1981; Mock and Vasarhelyi, 1984)

The expert system approach may provide a fresh way to look into these types of micro issues from two basic standpoints: (1) the nature of the identified heuristics from the experts and (2) the ways that the "critic" module can improve on existing heuristics and probability assessments.

2.3. SIGNIFICANCE OF THE WORK

It is difficult to assess the significance of this work at this early stage. Expert systems have been developed successfully for applications in Medicine (Dialog, Poppel et al., 1975 ; Mycin, Shortliffe, 1976), Mineral Exploration (Prospector, Duda & Gashing, 1981), Petroleum Exploration pattern analysis, Computer Configuration (RI, McDermott, 1980) and many other proprietary applications. Despite "successful" development, which entails the completion of a working model, some applications are still not of widespread usage. Nevertheless, they are amply quoted and seem to have substantially added to the academic knowledge-of-the-world.

3. RESEARCH DESIGN

Prototype expert system construction is essentially a model-building effort. It would typically entail: (1) comprehension of the problem being faced, (2) extraction of "expert rules" from practitioners, (3) design of prototype systems based on these rules, (4) programming and implementation of the prototype system and (5) prototype system testing.

This proposal entails these steps for a very simplified system that deals with a complex issue. It adds to traditional prototype system development as it may be used as a setting for Human Information Processing studies into accounting information usage.

3.1. METHOD IN EXPERT SYSTEMS

An emerging body of literature has evolved in the construction of expert systems. (Hayes-Roth, Waterman, and Lenat, 1983) These efforts build models with integrated human expertise. Their evaluation is still in the pre-paradigmatic stage. The main methodological issue involved is system structure. The proposed structure is presented in next section.

3.2. SYSTEM STRUCTURE

The structure of the "Broker's Aid" is described in Figure 1. It entails man-machine interface for four functions: (1) specification of investor characteristics, (2) modification of specific portfolios, (3) insertion of expert rules and (4) system prompting on specific features.
3.3. THE DATABASE

The database is a composite of:

1. The Value Line database (contains financial statements and other financial information)

2. The CRSP monthly tape (contains security price information)

3. The Dow-Jones Information Retrieval service (contains updated current information on specific companies)

4. Selected macroeconomic information

If company specific data are merged through their CUSIP numbers. Macro data are related to specific dates and/or sectors. (e.g. Dow Jones Index, M1, M2, GNP, sector indices). The initial database contains fifty randomly selected companies and ten macro variables over a period of ten years. All data is quarterly oriented. Years 0 to 5 serve as the initial time-series database while the additional years are used in the simulation of five years of actual time.

3.4. PORTFOLIO CONSTRUCTION

The system uses a simplified Sharpe model to construct portfolios. It initially selects, out of the tradeable subset, three portfolios standard (high, average and low) levels of risk. These "system portfolios" are complemented by portfolios constructed using heuristic rules and
updated based on system learning.

"Investor portfolios", on the other hand, are developed using man–machine interaction. The investor initially states a cash level and a risk profile. The system helps in the portfolio construction by suggesting alternative stock choices and their weight in the portfolio. Each successive choice balances the portfolio towards the investor's stated risk tolerance.

3.5. FILTERING MODULE
A set of stock selection criteria was drawn from an "expert broker". These are integrated into a basic heuristic rule set that represents the "surface knowledge" of the broker. Many probabilistic estimates, choice criteria and, inference determination procedures are arbitrarily set. Probability revision rules, both for primordial rules as well as for inference construction, are later revised based on actual data from portfolio performance monitoring.

3.6. MONITORING MODULE
The monitoring module performs two basic tasks: (1) "learning" from performance measurement and (2) Buy–Sell advising. The learning process identifies successful trading strategies as well as less successful ones providing probabilistic rule revision strategies to the filtering and portfolio construction modules. The buy–sell advisor uses stock valuation models to identify expected high and low points as well as trading ranges. In addition a crude form of chartism is attempted.

If trading ranges are reached, the system advises to buy or sell through the portfolio construction module where a rebalancing of the portfolio is performed. This process is attempted both on "system" and "investor" portfolios. Buy–sell rules and replacement advising algorithms were constructed from a hybrid set of "expert broker" and academic literature rules.

3.7. EVALUATION
Ten test portfolios and 3 simulated investors (student assistants) are used to trade on a basic set of 50 stocks over 20 decision points (end of each quarter in the simulated 1978–1983 period). Overall performance indexes and behavioral measurements are used to compare portfolios (system, investor and random) and user reaction to the "broker's aid".

4. DISCLAIMER
I will spend full time, during the summer, on research matters primarily dealing with this proposed project within the school's policy on Off-Term Research Grants.
5. OUTPUT AND TIMETABLE

5.1. TIMETABLE

I intend to have a complete system specification design completed by the end of the Spring semester.

By the end of the summer, and as the product of the Faculty Research Grant, I intend to have the prototype system (with about 30 rules) completed. In addition I will have a system description paper that will specify the main features of the system.

5.2. OUTPUT

I aim at three papers as the product of this effort:

1. Broker's Aid System Description: *Communications of the ACM*

2. Ex-Ante estimation of Expert Systems Feasibility based on prototypes: *MIS Quarterly*

3. Information Utilization and Probabilistic Assessment and Heuristic Rules in the Usage of Accounting Information: *The Accounting Review*

6. OTHER ISSUES

Contingent on the results of this study I will be applying for an NSF grant.

I will not be receiving additional research funding from any other sources during my term off. I also do not believe this proposal to fall within the scope of any of the Research Centers.

7. PERFORMANCE ON PREVIOUS GRANTS

I have completed manuscripts and working papers related to funding on all previous grants. These are at different stages of the publication process.


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