AN EXPERT SYSTEM FOR CASH FLOW ANALYSIS

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Keywords: Expert Systems, Cash Flow Analysis, Artificial Intelligence, Management Accounting Applications

Abstract: This article describes an expert system for cash flow analysis called CFA--Cash Flow Analyzer, which uses knowledge based on ratio analysis and the budgetary statement of changes in cash flow. The system uses "If ... Then ..." rules to capture the expertise necessary to diagnose the source of cash flow problems and make recommendations on how to mitigate those problems.

1. AN EXPERT SYSTEM FOR CASH FLOW ANALYSIS

One of the most important problems facing management is managing cash. Cash is the "life blood" of the organization. Inappropriate management of cash may cause difficulty with creditors and may even lead to bankruptcy. Thus, cash flow analysis is a critical concern of management.

Cash flow analysis is concerned with budgeting cash flows and with diagnosing the causes of positive and negative changes in cash flows. It is used to diagnose potential cash flow problems and plan solutions to managing the firm's cash flows.

The purpose of this paper is to discuss an expert system for cash flow analysis. The system, CFA--CASH FLOW ANALYZER, uses rules based on ratio analysis and the budgetary statement of changes in cash flow to budget cash flow, diagnose the source of cash flow problems and make recommendations on how to mitigate those problems.

2. RECENT DEVELOPMENTS IN EXPERT SYSTEMS

Artificial intelligence can be defined as the study of how to make computers exhibit the characteristics associated with intelligence in human behavior. It includes the simulation of human activities such as robotics, natural language, vision systems and expert systems (Ref. 1).

Expert systems perform tasks normally done by knowledgeable human experts. They are developed by programming the computer to make decisions using some of the processes and knowledge of the human expert.

Expert systems usually have five major components: knowledge acquisition subsystem, knowledge base, inference engine, explanation module and the language interface (Ref. 2). The knowledge acquisition

module develops the accumulation, transfer and transformation of expertise from the expert to the system. Interactive computer systems can be used to interview a human expert to obtain this knowledge.

The knowledge base provides the set of knowledge that the system uses to process the data. Typically, this is the domain specific knowledge that the expert would use to solve the problem. Knowledge can be represented using a number of different methodologies. One of the most frequently used methods is the rule-based approach. Rule-based knowledge representation generally takes the form of "If ... (condition) Then ... (consequence/goal)." The rules may or may not include a numeric level of confidence or probability of occurrence.

The inference engine provides the basis to use the knowledge base to process the database. In a rule-based system, the inference engine normally uses either a forward or backward chaining approach. Forward chaining reasons toward a goal. Backward chaining reasons backward from the goal to determine if or how the goal can be accomplished.

The explanation module is used to explain why the system reached a particular decision or why the system is requesting a particular piece of information. The language interface provides English-like query language or graphics for the user to interact with the expert system.

3. EXPERT SYSTEM SHELLS

Initially, artificial intelligence languages, such as LISP (Ref. 3), generally were used to develop expert systems. However, recently expert system shells have been used to shorten the expert system development cycle.

Expert system shells are special software that simplify the development of an expert system by providing many user-friendly features. The inference engine can be specified and does not need to be developed. The knowledge base is easy to specify to the computer. The expert system shells also may allow the user to access existing databases, such as Base III and artificial intelligence languages.

There are a number of expert system shells, including, for example, M.1, EXSYS, Personal Consultant Plus and GURU. The cash flow analyzer discussed in this paper was developed using EXSYS.

4. APPLICATIONS OF EXPERT SYSTEMS IN MANAGEMENT ACCOUNTING

Cash management is often regarded as a "management accounting problem." There have been a number of different prototype expert systems built to solve accounting problems. Recent surveys are given by Akers et al. (Ref. 4), Lin (Ref. 2) and O'Leary (Ref. 5,6).

There have been at least two other applications of expert systems to management accounting problems. Palladium (Ref. 7) has developed an expert system for use by corporate management in analyzing capital budgeting problems. O'Leary and Munakata (Ref. 8) discussed a prototype expert system developed to assist in the design of an information system to aid management decision making. Other possible applications of expert systems in management accounting include setting transfer prices, analyzing variances, performance analysis and corporate planning and budgeting.

In addition, the cash management problem is a fertile area for the application of expert systems technology to two other tools used in management accounting: linear programming and forecasting. O'Leary (Ref. 9) discussed using expert systems in linear programming to help formulate the program and analyze the output by taking advantage of the structure of the problem and the meaning in the variables, due to the particular application. Such an approach could be used in cash management. Similarly, an expert system could be used to formulate and interpret the results of forecasts used in cash management. Such a system would take advantage of the domain of cash management to provide meaning to the variables.

5. CASH MANAGEMENT MODELS

There have been a number of analytic models developed for the cash management problem. One of the first models proposed for cash management was the EOQ inventory model. This lead to the application of other inventory models to cash management problems (Ref. 10).

Forecasting techniques, of varying complexity, have been used to estimate cash inflows and outflows. Some of the approaches used include regression analysis and time series.

Unconstrained decision rules based on probability theory also have been developed (Ref. 11). In addition, linear programming and goal programming have been proposed for the cash management problem in order to meet the constraints of cash flow problems (Ref. 12,13).

Unfortunately, analytic models often are not used because users do not understand them or because the assumptions of the model do not fit the situation (Ref. 14). For these reasons, an expert system designed to interface with the user, using general models that the user understands, e.g., accounting models, may prove to be more useful than some of the analytic models.

An expert system for cash management can be useful to both large and small businesses. Large businesses, that have experts specializing in cash management can benefit from an expert system for a number of reasons. First, an expert system would bring to bear a consistent set of knowledge in cash management problems. This could ensure that top managements' goals and objectives are considered cash management problems. Second, the system could be used to make recommendations on the routine decisions, while the expert concentrates on the more unusual problems. Small businesses, that may not have the expertise of larger businesses can use the expert system as a source of expertise.

6. CFA--CASH FLOW ANALYZER: AN EXPERT SYSTEM

CFA is a preliminary prototype expert system designed to aid the user in cash flow management. Such an exploratory prototype model is a first step in understanding the development of expert systems for the cash management problem.

6.1 Model Overview

CFA is a system designed to help the user diagnose cash flow problems, budget cash flows and plan solutions. CFA takes input from the user on the anticipated account totals based on a series of interactive

questions. Using that input CFA processes the data by using ratio knowledge and knowledge based on the statement of changes model. The system also can provide recommended actions based on the processed financial information. The flow of information is summarized in figure 1.

GENERAL MODEL OVERVIEW

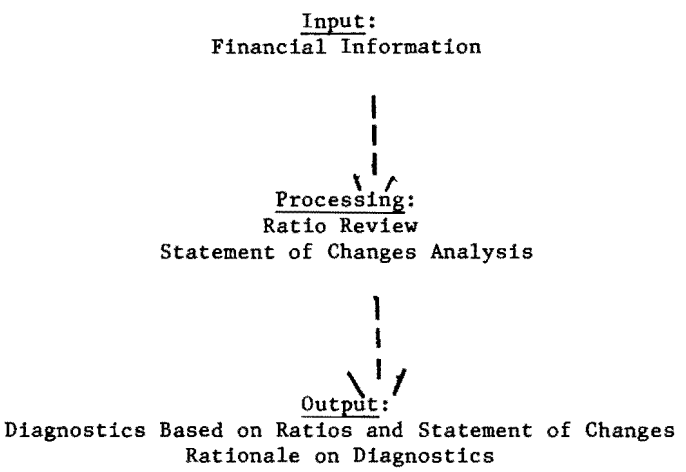

Exhibit 1

6.2 Ratio Knowledge

Ratio analysis has been used in at least two previous expert systems. Bouwman (Ref. 15) used accounting ratio analysis as the basis of an expert system to diagnose difficulties of firms. Biggs and Selfridge (Ref. 16) used knowledge about the behavior of accounting ratios as an aid in the development of the "Going Concern" judgment that faces the auditor.

Financial statement analysis provides a number of alternative ratios that can be used in the analysis (Ref. 17). Ratios can provide information on the source of cash problems and lead to prescriptive recommendations. Ratios can be used to analyze a number of facets of the firm's financial position. However, cash flow is reflected primarily in those ratios that are used to measure liquidity. The ratios used in CFA are summarized in table 1.

Ratios can be compared to a number of different bench marks. Ratios can be compared to standards for the industry, other firms or the firm's previous performance. Accordingly, the standards of comparison should be developed with the particular firm and industry in mind.

If a ratio does not fall within a prespecified range, then the system can prescribe actions to mitigate the situation. Alternatively, the trend of the ratios can be analyzed. If a particular ratio is increasing or decreasing at a rapid rate then that can indicate the need to investigate or change strategies.

LIQUIDITY-BASED RATIOS

Proportion of Cash in Current Assets

(Cash + Cash Equivalents)/ Current Assets

Cash Available to Pay Current Obligations

(Cash + Cash Equivalents)/ Current Liabilities.

Current Ratio

Current Assets/Current Liabilities

Quick Ratio

(Current Assets-Inventory-Prepaid Expenses)/(Current Liabilities)

Accounts Receivable Turnover Ratio

Net Sales on Credit/Average Accounts Receivable

Inventory Turnover Ratio

Cost of Goods Sold/Average Inventory

Accounts Payable Turnover Ratio

Purchases/Accounts Payable

TABLE 1

6.3 Statement of Changes in Cash Position Knowledge

The statement of changes in cash flow provides another accounting model that has not been used in the development of previous expert systems, but has been used by accountants to analyze cash flow. The format of this statement can be modified for decision making purposes. For example, the changes can be grouped by changes in assets, liabilities, stockholders' equity, cash inflows, and discretionary and nondiscretionary cash outflows. Placing the assets in these categories allows the system to make recommendations based on the information that describes that category of outflows.

As with the ratios, the actions on which the parameters are based, are a function of the firm's policies and unique needs. Accordingly, CFA would have to be adapted to each unique situation.

6.4 Knowledge Base

The knowledge base is rule-based. CFA uses approaches that would be used by a management accountant to solve the problem. As noted above, there are three types of rules that use ratio information: comparison of a ratio to a standard, comparison of a ratio to a previous value of the ratio (a trend) and comparison of ratios to each other.

A sample rule of the first type would be

> If ((Cash+Cash Equivalents)/Current Assets) is less than Proportion of Cash in Current Assets-Standard then examine the possibilities to increase cash.

A sample rule of the third type would be

> If Accounts Payable Turnover is less than Accounts Receivable Turnover then Stretch Accounts Payables.

The rules that use the statement of changes in cash flow are of a similar nature. For example, the following is a sample rule that compares a quantity to a standard.

> If Net Operating Cash Flows are less than the Net Operating Cash Flow Standard then Make Arrangements to Borrow.

6.5 Why Cash Flow Analysis is a Good Application for Expert Systems

Cash flow analysis is a particularly good application for the use of expert systems technology for a number of reasons. First, it is a diagnostic type of application. There is a search for the source of the problem and how to mitigate that problem. The most successful applications of expert systems are generally of a diagnostic nature, e.g., medical systems. Second, the process of cash flow analysis is easily framed as a rule-based knowledge base. For example, the analysis of ratios can be couched as a set of rules. Third, there are not substantially divergent views of how to use financial information to analyze the cash flows of a firm. Instead, there is a promulgated approach to the use of such information (e.g., Ref. 17), that is used by management to analyze cash flow problems.

7. EXTENSIONS

CFA can be extended in at least two different directions. First, the current version of the system is aimed only at diagnosing problems in cash flows and implementing strategies aimed at mitigating those problems. It does not maximize income from the portfolio of short term instruments. It does not maximize the return on investment. Future enhancements could interface the capabilities of the current system with a portfolio management system that was designed to maximize particular company goals.

Second, the current system uses decision maker-based rules. Thus, the approach is a piecewise analysis of the financial information describing the firm. Alternatively, it may be that a management science approach, such as linear programming, could be used to further enhance decision making by providing a global or simultaneous analysis of the problem. As in O'Leary (Ref. 9), such decision making tools could be integrated into the expert system.

8. SUMMARY

This article has discussed an expert system for cash flow analysis based on accounting models of cash flow. The scope of expert systems in cash management can range from the current system to systems that include

and explain the output from analytic tools such as linear programming or forecasting tools.

This system and other such cash management systems can aid cash flow analysis in a number of ways. First, they can lead to a consistent analysis of the input data, minimizing the inconsistencies of human information processing. Second, they can analyze the information at the "initial screening level" and let the expert spend his/her time analyzing the more difficult aspects of the problem. Third, such systems allow the transfer of cash management expertise to those firms that do not have such expertise.

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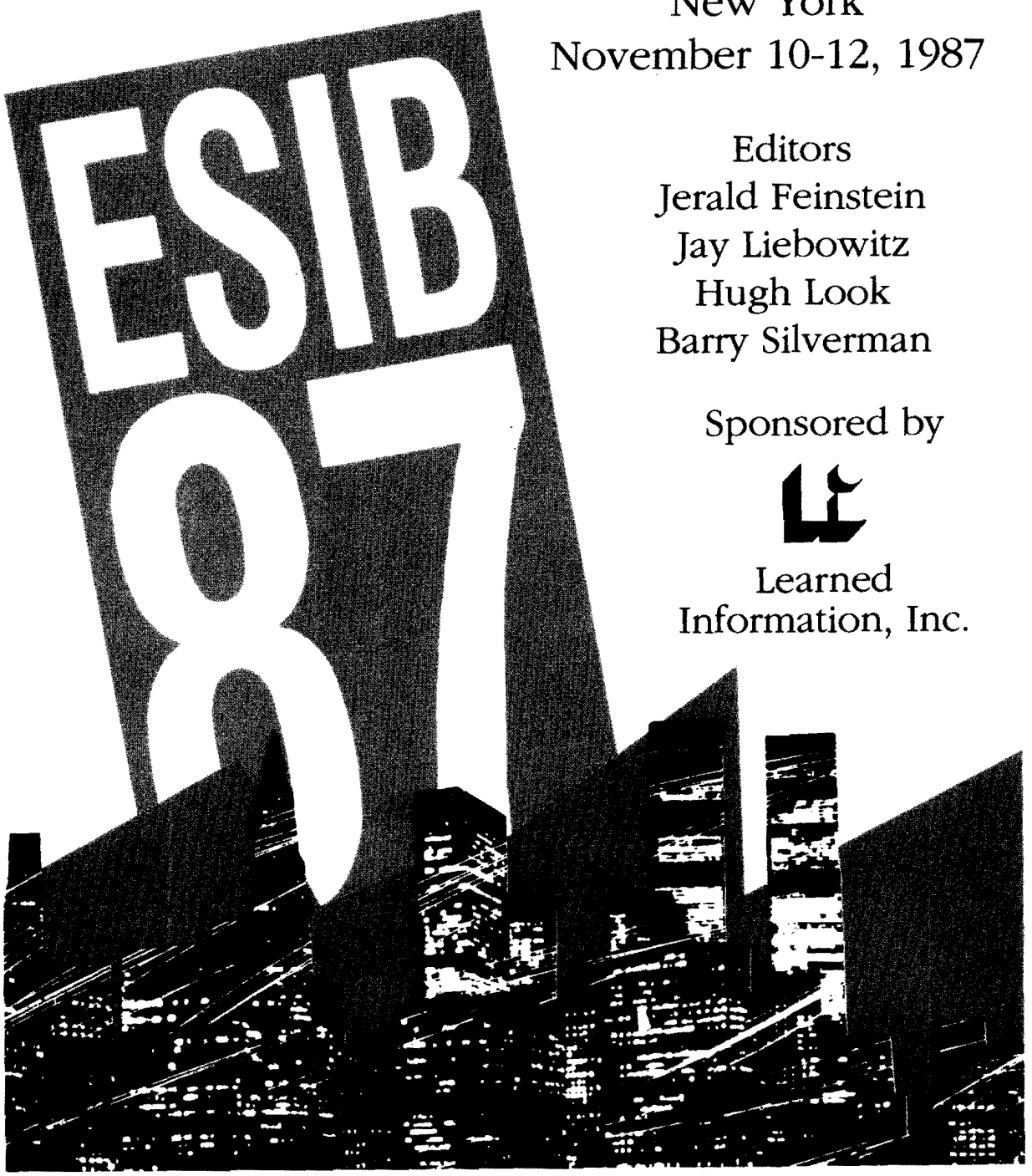
Proceedings of the First Annual Conference on

Expert Systems in Business

New York
November 10-12, 1987



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