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An expert decision support system for auditor going concern evaluation

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The University of Texas at Arlington, 1989

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AN EXPERT DECISION SUPPORT SYSTEM FOR

AUDITOR GOING CONCERN EVALUATION

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AN EXPERT DECISION SUPPORT SYSTEM FOR AUDITOR GOING CONCERN EVALUATION

by

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ABSTRACT

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This research examines and models quantitative and qualitative factors in auditor going concern decisions. The nature of the audit decision domain is investigated from a diagnostic problem approach. Consideration is given to the problems of uncertainty and ambiguity, and the appropriateness of a rule-based system is ascertained. The domain knowledge consists of substantial expertise and heuristic judgment.

The going concern concept and related accounting standards are reviewed. Consequences of incorrect decisions are discussed. Ratio analysis is examined as it impacts on the ability of a quantitative model to classify firms as bankrupt or nonbankrupt. Previous research in this area is reviewed.

Building on the bankruptcy prediction work of others, financial statement data is analyzed using discriminant analysis, logit analysis, and recursive partitioning. Qualitative data and procedural knowledge are represented symbolically using expert system techniques.

The logit analysis output is examined to identify companies whose probabilities are near 0.0, indicating a strong probability of bankruptcy, or 1.0, indicating a strong probability of nonbankruptcy, and in the midrange (0.4 to 0.6), indicating marginal companies. Classification accuracy of the marginal companies is poor (27% and 36%), indicating the need for consideration of qualitative factors.

Case studies consisting of bankrupt, nonbankrupt, and marginal companies were presented to practicing auditors and auditing professors for appraisal. Their initial assessment was traced by verbal protocol analysis, then their ratings on various items were processed by the prototype expert system for comparison.

The system developed in this research is intended to serve as a decision aid for auditors. The goal of this study was to determine the feasibility of using a rule-based system in the domain of the going concern decision.

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CHAPTER 1

INTRODUCTION

Definition of the Problem

This research examines and models quantitative and qualitative factors in auditor going concern evaluation. This involves problem diagnosis and decision making in a domain where a portion of the task is fairly well structured, but a certain amount of judgment and expertise is required. The structured portion can be modeled using quantitative data and traditional statistical techniques. The judgmental factors are qualitative, linguistic, or "fuzzy" by nature. Model development requires data acquisition, knowledge elicitation, linguistic evaluation, model building and validation.

As with many real-world decisions, going concern evaluation is made in an environment in which some goals, variables, and constraints are imprecise. Terminology may be vague, variables may be linguistic rather than numeric, and boundaries may be poorly defined. Reasoning is frequently informal, incorporating intuition, judgment and heuristics. These traits are particularly prevalent in systems where the human element is a major constituent. In such domains, great importance is attached to expertise. Experts have experience and a refined sensitivity to environmental cues and their relevance to the problem at hand.

In Negoita's words:

> Problem solving is thinking. The activity is analogous to building a bridge from the mainland to an island; the mainland is the body of understanding a person already possesses, and the island is some factual knowledge that is as yet unassimilated by the mind. The aim of thought old. (Negoita, 1981, 23)

In bringing about this intelligible relationship, an expert behaves differently from a novice. An expert, being familiar with a task and its environment, either recognizes a structure or creates one in what to a novice might appear to be an ill-structured problem. The expert organizes information into clusters or chunks and compares them to previously stored domain-specific patterns. He gains insight into a situation by monitoring only a few key variables. Cues are identified and weighted to form a global evaluation. Results are regularly summarized and hypotheses formulated. A novice, on the other hand, will apply general problem-solving methods, analyze data sequentially, and perhaps miss important relationships. He will not know the relative importance of various cues and may be overwhelmed by the disorganization of the information. As the novice gains experience, his solution becomes more structured, and his methods are less vague and more programmable. A novice can benefit from a model which encodes some of the expertise and/or asks questions that lead to proper structuring of the problem. The expert may also benefit from a model which does some of the preliminary evaluation and aids in consistent treatment of a repetitive problem.

Dealing with Imprecision and Uncertainty

In attempting to impose structure on a problem in an ill-structured environment, a decision maker must deal with uncertain knowledge and data, incomplete information, and/or randomness. Some characteristics of the environment may be described linguistically rather than quantitatively. Rolston (1988) suggests possible forms of reasoning to be used in dealing with these problems:

1. Monotonic reasoning systems where the number of facts known to be true at any specified time is always increasing, never decreasing
2. Nonmonotonic reasoning systems where a set of tentative beliefs is tracked and revised when new knowledge is obtained
3. Reasoning based on probability
4. Reasoning based on certainty factors, where an expert's judgment is subjectively quantified
5. Fuzzy reasoning, where grades of membership in fuzzy sets are subjectively assigned on the basis of context.

Many of these notions are derived from or related to MS/OR techniques. For example, Zeleny (1975) discusses management science linguistics, fuzzy mathematics, and qualitative management science.

Linguistic Variables

Linguistic variables may be treated with Ralston's forms of reasoning and provide a systematic means for an

approximate characterization of ill-defined phenomena. A linguistic variable is one whose value is not a number but a word or sentence in a natural or artificial language. For example, COST could be a numeric variable with a value of $3.95, or it could be a linguistic variable with a value of "high", "low", "outrageous", etc. A linguistic variable may be manipulated in much the same way as a numeric variable by mapping an underlying base variable which is numeric or by subjective labeling. Computations are performed behind the scene, and afterwards, linguistic approximation is employed to convert numbers into words.

Ganoe (1986) used this approach in analyzing liquidity. Financial ratios are input as numeric data and converted into tentative qualitative assessments by comparison with industry ratios. These linguistic values are submitted to a rule base which evaluates the firm's overall liquidity. Another rule base examines the causes of any liquidity problems and outputs a linguistic assessment.

The Diagnostic Problem

Broadly speaking, diagnosis is an attempt to ascertain the state of a system from external observations. Pipino offers a three part definition:

> Diagnosis of a system is the process of (1) determining the presence or absence of unacceptable system states, (2)identifying the cause of these unacceptable states and (3) given the system is in an acceptable state, determining whether the system will enter an undesirable state from its present state within a given time period. (Pipino, 1975, 13)

A diagnostic problem may be characterized by uncertainty, ambiguity and imprecise specification. Valuations may be given in approximate or linguistic terms. A computer-aided diagnostic system requires that the analyst consider methods of coping with this fuzziness. First, sources of fuzziness must be identified. Then, a representation scheme must be devised to incorporate the fuzziness into a mechanized diagnostic procedure.

Scope of This Study

The domain of this research is in the area of financial analysis. More specifically, this research aims to develop a decision model dealing with bankruptcy prediction. This was examined from the perspective of independent auditors in their "going concern" evaluation.

An auditor is expected to issue an opinion on the fairness of financial statements. Furthermore, if he feels that the company is not likely to continue in existence for at least one year, he adds an explanatory paragraph expressing his doubts. In this evaluation, he collects, evaluates, and weights various kinds of evidence. Some of the evidence, in the form of readily available quantitative data, is very straightforward. Other parts of the decision process may be unstructured and ill-defined, calling on the auditor's professional judgment and expertise. After completing all audit procedures, the auditor uses the available evidence as a basis for making an informed judgment and rendering a

comprehensive opinion taking all financial statements into consideration. This study attempts to model portions of the judgment process.

Financial statements of bankrupt and nonbankrupt companies are examined and a prototype decision model is produced which discriminates viable from failing firms. Companies in either Chapter 7 or Chapter 11 proceedings are used in the bankrupt sample. Judgmental factors are added to the model using expert systems techniques. The model integrates concepts from several areas, including management science, statistical analysis, decision support systems, expert systems, and auditing.

The judgment process in the business failure question is a good illustration of Pipino's three-step diagnostic procedure. First, the auditor determines the presence or absence of unacceptable system states by looking for indications that a company is suffering financial distress. Second, if an unacceptable state exists, the auditor attempts to identify the causes and judge the severity of the problem. The auditor may ascertain management's plans for dealing with the problem and form an opinion on their effectiveness. Third, if the system is presently in an acceptable state, the auditor can determine whether the system will enter an undesirable state within a given time period. For the auditor, this time period will be until the next financial statement (generally one year). This diagnostic process is

analogous to clinical diagnostic reasoning in the domain of medicine. Messier and Hansen believe "there is a direct analogy between the way a physician diagnoses a disease and the way an auditor 'diagnoses' the state of a client's accounting systems and financial statements." (Messier and Hansen 1985, 187)

The Auditor's Perspective

Individual investors, portfolio managers, bankers, and other investment advisers rely on audited financial statements in making investment decisions. In the past, there has been an "expectations gap" between what users of financial statements believe auditors are responsible for and what the auditors perceive as their responsibility. Campbell and Mutchler (1988), in reviewing facets of this debate, indicate that some auditors fear that rendering a statement of uncertainty regarding a firm's continued existence might become a self-fulfilling prophecy or cause the loss of a client. According to this viewpoint, the auditor's responsibility is only to judge the validity of the financial statements, not to interpret them for the user. On the other hand, a clean opinion to an entity that subsequently fails may have creditors and investors considering litigation against the auditors. Since continuing errors in going concern judgments could undermine the credibility of the profession, there is a need for objective, unambiguous, and defensible audit procedures.

In May of 1988 the AICPA issued a series of new auditing standards that attempt to narrow the expectations gap. One of the new guidelines, Statement on Auditing Standards (SAS) 59, deals with the assessment of going concern status. In the absence of information to the contrary, an entity is assumed to be a going concern (that is, it is expected to continue in existence for the foreseeable future). Ordinarily, information that significantly contradicts the going concern assumption relates to the entity's inability to continue to meet its obligations as they become due without substantial disposition of assets, restructuring of debt, externally forced revisions of its operations, or similar actions.

The auditor has a responsibility to evaluate whether there is substantial doubt about the entity's ability to continue as a going concern for a reasonable period of time, not to exceed one year beyond the date of the financial statements. According to SAS 59, conditions which may cause substantial doubt include events such as the following:

1. Negative trends such as recurring operating losses or adverse key financial ratios
2. Other indications of possible financial difficulties, such as default on a loan or arrearages in dividends
3. Internal matters such as labor difficulties or substantial dependence on the success of a particular project

4. External matters such as legal proceedings, legislation, or similar situations that might jeopardize an entity's ability to operate.

If the auditor doubts the entity's likelihood of continued existence, possible or potential mitigating factors should be examined before forming a final opinion. Again by SAS 59, these include such items as:

1. Plans to dispose of assets
2. Plans to borrow money or restructure debt
3. Plans to reduce or delay expenditures
4. Plans to increase ownership equity.

If, after considering management's plans, substantial doubt about continued existence is perceived, the auditor should either add an explanatory paragraph to an unqualified report or disclaim an opinion.

Previous Research

Many previous studies have focused on business bankruptcy prediction, using data which is inherently quantitative or incorporated as indicator ("dummy") variables. Researchers have also studied auditors' cognitive processes with respect to decision making regarding the likelihood of business continuation. These studies will be addressed in a subsequent chapter. Little research has been done in this domain involving formal symbolic representation and mechanization of linguistic variables and judgment factors. Another

area that has not been explored is the area involving Bayesian inferencing in the subspace of "troubled" firms.

Many of the factors that an auditor must consider in evaluating the solvency of a firm are qualitative and not easily quantifiable. However, at the primitive level they may be symbolically represented as linguistic variables and expressed as IF (condition) THEN (consequence) production rules in a knowledge-based system. Blanning states that "Accounting is a rule-based profession, . . . expertise is needed to select the most appropriate rules and to supply data needed to implement the rules." (Blanning 1987, 36)

A computerized model incorporating the quantitative and some of the judgmental factors involved in the auditor's decision process could serve as a guide to investors, could serve as a check of consistency and consensus, and could serve as a training or decision aid to junior auditors. The purposes of this research are to develop a prototype of such a system based on a selected subset of the factors and to demonstrate the feasibility of the AI-based model. Waterman defines a demonstration prototype as:

> a small, demonstration program that handles a portion of the problem that will eventually be addressed. This type of program is often used in two ways: first, to convince potential sources of funding that AI and expert systems technology can effectively be applied to the problem in question; and second, to test ideas about problem definition, scoping, and representation for the domain. A typical rule-based demonstration prototype might contain 50 to 100 rules, perform adequately on one or two test cases, and take one to three months to develop. (Waterman, 1986, 139)

Prototyping is also used in the development of decision support systems. Sprague and Carlson (1982) describe a "throwaway prototype" as an acknowledged experiment designed to create user interest, develop builder skills, and reduce risk and investment.

Importance of This Study

Optimal decision making is a primary focus of management science/operations research (MS/OR). There has traditionally been a strong reliance on quantitative models and a systematic approach to problem solving. Recent researchers have extolled the virtues of decision support systems (DSS), artificial intelligence (AI), and expert systems (ES) as being valuable additions to the management scientist's tool kit. For example, O'Keefe et al. (1986) express the hope that expert systems will become an established part of OR, as fundamental as linear programming, simulation, statistics, or computing. The traditional focus on "management" is questioned by Bédard et al. (1984), who point out that DSS offer support to nonmanagerial personnel as well as to managers.

Many decision processes involve problem diagnosis, in which causal relationships are sought among variables believed to be associated with the problem at hand. Diagnosis is interlinked with problem structuring and model formulation. The accuracy of the diagnosis is determined largely by the accuracy of the model. Thus, it is important

that the model adequately portray the actual decision situation.

In modeling the auditor's going concern assessment, both quantitative and qualitative factors must be considered. Financial statements quantify information about a business entity. The auditor's opinion adds a qualitative dimension. Professional expertise and heuristic thinking are used in forming this opinion. Many of the decision criteria are fuzzy and not easily modeled.

As will be shown in subsequent chapters, quantitative models do a good job of classifying firms as bankrupt or nonbankrupt. But the auditor has small room for error in his analysis of business continuity, and a "good" model may not be sufficient. Accuracy becomes particularly vital in the case of marginal firms, and this is where a strictly quantitative model may be deficient. A model which incorporates qualitative data and encoded expertise would hopefully yield a higher rate of correct classifications than a more traditional model.

Users of audited financial statements rely on an auditor's opinion to form investment decisions. In the past, auditors have sometimes been reluctant to issue a qualified opinion even if they believed a company was financially distressed. Kida (1980) determined that auditors' predictions of problem firms did not coincide with their issuance of qualified opinions. He suggested that auditors

may be reluctant to formally express uncertainty due to the perceived consequences. For example, in the past an auditor might have been quick to disclose problems, fearing lawsuits by investors if a qualified opinion was not given and the firm subsequently became insolvent. On the other hand, an auditor might have feared losing a client if he did issue a qualified opinion and the company continued in business. Under the new guidelines, if an auditor feels substantial doubt about an entity's continued existence, he has no choice but to add an explanatory paragraph expressing this doubt.

Another concern for the auditing profession is that of judgmental consensus. According to Joyce and Libby:

> A major objective of professional training in degree programs and continuing professional education is to promote consensus in professional judgment. Within public accounting firms, detailed procedure manuals and review processes serve the same purpose. Finally, when auditor judgments are questioned in litigation or regulatory proceedings, successful defense often entails establishing a professional consensus (via expert witnesses) that the defendant acted in a prudent manner. (Joyce and Libby, 1982, 105)

Decision criteria and outcomes differ between auditing firms and between auditors. Also, an individual auditor may vary in his decision criteria over time. It would be beneficial to auditors and to users of financial statements if an accurate and reliable classification model existed for determining issues pertaining to the going concern concept. A model which incorporates the judgmental factors as well as the quantitative items would enhance consistency in auditing judgments. Junior auditors in the field could use such a

system for advice in the absence of a supervising auditor. This research demonstrates the feasibility of a decision aid in this area.

Research on the going concern issue is timely in that the AICPA's new standard became effective in January, 1989. This standard broadens an auditor's existing responsibilities by including an explicit directive to evaluate the entity's ability to continue to exist. Prior to this pronouncement, auditors were required merely to be aware that during a standard audit, evidence might come to light regarding doubt as to an entity's continuity. In that case, they are obliged to investigate further.

Developing the Model

In evaluating the likelihood of an entity's continuity, a combination of quantitative and linguistic variables were considered. Previous researchers have debated the use of various statistical techniques in bankruptcy prediction. Financial ratios have proven useful in this evaluation and were used in this research, drawing upon previous studies. Data was gathered for companies which had and had not entered bankruptcy. This data set was used to develop quantitative models which classify or predict the probability of bankruptcy for a given company when its financial statement data is input.

For consideration of both quantitative and qualitative factors, case studies were presented to auditing experts.

After analyzing financial statement data, conditions and events relating to a firm's well-being, and management's plans, the experts were asked to make assessments of the likelihood of bankruptcy. Query responses served as input to the rule base, which rendered a "degree of belief" of business failure.

Validation

Three statistical techniques were applied to the financial statement data - discriminant analysis, logit analysis, and recursive partitioning. Classification accuracies were compared and a holdout sample used for validation. The rule base was validated by practicing auditors and auditing professors. Case studies were analyzed through verbal protocols ("thinking out loud") and predictions compared to those obtained from the prototype expert system.

CHAPTER 2

REVIEW OF THE LITERATURE

Several areas of research pertain to this study. These are first considered broadly, then the persective is narrowed to the specific application area.

Most real world problems require decision makers to deal with complexity, priorities and tradeoffs, quantification and measurement. The decision process can be simplified if a problem can be structured sufficiently to allow modeling and manipulation.

Structuring the Decision Process

Thirty years ago, Simon and Newell (1958) labeled as "well-structured" those problems that can be formulated explicitly and quantitatively, then solved by known and feasible computational techniques such as those provided by management science. "Ill-structured" problems then, are problems which are not well-structured. In these problems, essential variables may be symbolic or verbal rather than numeric. Secondly, the objective function or goal may be vague and nonquantitative. Simon and Newell expressed the belief that, to be coextensive with the field of management, OR/MS must have the tools and techniques that will extend its range to that whole field. They predicted the development of

Newell (1969) claims that the way to deal with an ill-structured problem is to convert it to a well-structured problem "via the one transducer that exists, namely, man." He believes that the initial problem statement, in its external representation, is translated into some internal representation. This, in turn, is manipulated by some organized program in the problem solver's memory in attempting to derive a solution. There is an inverse relationship between a method's generality and its power. The ability to be a general problem solver is one of the primary distinctions between human intelligence and machine intelligence. If the human has only these general problem-solving abilities to fall back on, a particular problem will appear ill-structured. However, if he has prior experience with this type of problem, it may appear well-structured to him. Hence the notion of ill-structuredness is vague.

Van Gigch discusses the treatment of complex structure as follows:

> When dealing with a large system, the analyst cuts into the complexity of the situation by simplifying it. He narrows his problem down by making it more specific. He deals with subsystems whose bounds he can explain and comprehend. He tries to move to the realm of situations where he has more programmed methods, models, and algorithms at his disposal, and where the probabilities of his success are relatively enhanced.
> (Van Gigch, 1978, 380)

The notion of subsystems is supported by Meredith and Turban (1982), who include the systems approach and systems analysis as a characteristic of management science. Powers

et al. (1984) identify two major problem solving strategies using this approach: analysis and synthesis. A problem can be analyzed, or broken down, into a hierarchy of component subproblems that can then be studied and solved in relative isolation. Then, component solutions are synthesized, or recombined, within a single hierarchical structure. This method provides a valuable tool for dealing with complex systems.

Martin and Oxman (1988) call this concept problem reduction and cite it as a technique for creating a structure that makes problem solving easier. A divide-and-conquer strategy decomposes a given problem into sets of smaller problems. The decomposition continues until all the generated subproblems have solutions. These solutions are consolidated to get the solution to the bigger problem.

This approach is effective in the going concern decision. For the auditor, much of this decision process is structured by conforming to "generally accepted accounting principles" (GAAP) and "generally accepted auditing standards" (GAAS). These are guidelines developed by the American Institute of Certified Public Accountants (AICPA) which, according to Arens and Loebbecke (1988) provide a framework for interpretations.

SAS 59 (1988) assists the auditor in structuring the decision process regarding the continued existence of a business entity. Two major components of the decision are

(1) consideration of conditions and events, and (2) consideration of management plans. Each of these components may be decomposed into manageable pieces relating to causes of financial difficulties and possible corrections.

Dealing with Uncertainty

Even after a structuring process is applied to a problem, much uncertainty may remain. Some aspects of the system may be described ambiguously, and portions of the decision may rely heavily on heuristics and judgment. Researchers have suggested different procedures for dealing with uncertainty.

Zadeh (1973) proposed a new approach to the analysis of complex, ill-defined systems. He believes the behavior of such a system can be described using linguistic variables and fuzzy algorithms. Linguistic variables may be related through conditional fuzzy statements such as "If x is small then y is very large." Then fuzzy algorithms may be applied, such as "Reduce x slightly if y is large." This process will yield an approximate solution to a specified problem.

Wenstop points out that, "irrespective the fuzziness of linguistic values, it can hardly be denied that they do convey information." (Wenstop 1980, 100). Wynne (1982) attempts to make a "cool-headed assessment" of the fuzziness methodologies as a management science tool. He believes the new tehniques will greatly expand the useful limits of the discipline by allowing it to deal with the world "as is" rather than the way the modeling assumptions presume it.

In a series of three articles, Zadeh (1975) expanded the mathematics of fuzzy logic involving linguistic variables. One of the difficulties of applying computer technology to humanistic systems (those where human judgment is an influential component) is what Zadeh calls the "principle of incompatibility" which asserts that high precision is incompatible with high complexity. However, by applying existing mathematical techniques in the manipulation of linguistic variables, complex and ill-defined phenomena can be described in reasonably precise terms. This is accomplished through the association of a linguistic variable with an underlying numerical base variable or through subjective assignments of grades of membership in fuzzy sets.

To illustrate, consider the fuzzy set "tall men." A man who is five feet tall might be assigned a degree of membership of zero, meaning he is definitely not tall. On the other hand, a man who is seven feet tall will be assigned a membership degree of one, meaning he is definitely tall. Heights between five feet and seven feet will be assigned subjective degrees of membership between 0 and 1. For example, a man who is 5'8" tall may be assigned a degree of membership of 0.32.

Fuzzy subset mathematics involves combinations and manipulations of "fuzzy" unions and "fuzzy" intersections. One of the more lucid explanations of these procedures is presented by Schmucker (1984).

Another discussion of the mathematical techniques for dealing with fuzziness can be found in Bellman and Zadeh's work. They define a fuzzy environment as one in which "the goals, constraints, and consequences of possible actions are not known precisely." (Bellman and Zadeh 1970, 141). A distinction is made between fuzziness and randomness. Fuzziness is a type of imprecision associated with fuzzy sets. Randomness, on the other hand, has to do with uncertainty concerning membership or nonmembership in a nonfuzzy set. The mathematical techniques for dealing with fuzziness are different from those dealing with randomness and probability theory.

McKean and Dworetzky (1985) point out that fuzzy logic overcomes an important limitation of probability theory in dealing with medical diagnosis. In probability theory, the likelihood that an event will occur is determined by multiplying all the individual probabilities involved. But in a diagnostic problem, more symptoms of a particular disease increase the correctness of the inference that the patient has that disease. Instead of multiplying probabilities, fuzzy logic combines them in such a way that each new bit of information supports an emerging pattern.

Another proponent of fuzzy set theory is Negoita, who views fuzzy sets as an approach to dealing with complexity. He advocates reducing the complexity of an object "not by changing that object, but by changing our views about it."

(Negoita 1981, 6). Different levels of complexity can be accommodated by combinations of fuzzy sets.

Another approach to dealing with uncertainty is the use of Bayesian statistics to update prior probabilities with new evidence to obtain new probabilities for events of interest. Prior probabilities are frequently difficult to determine and may be subjective in nature. Jackson (1986) offers an illustration from the field of medical diagnosis wherein the researcher wishes to know the conditional probability that a particular disease (d) exists given that the patient is suffering a certain symptom (s), i.e., P(d|s). Bayes Theorem may be used to calculate this probability: $P(d|s) = [P(d)P(s|d)]/P(s)$. This relates the prior probability P(s|d) of the symptom (s) being exhibited by the disease (d) to the posterior probability that a person exhibiting the symptom has the disease. The expression P(d) represents the probability that the patient has the disease, irrespective of symptoms. The two numerator factors P(d) and P(s|d) are continually updated as new data is collected. This assigns greater weight to current statistics than to prior information. For a discussion of this in a clinical context, the reader is referred to Ledley and Lusted (1959).

Still another method which has proved useful in dealing with uncertainty is the use of "certainty factors" which quantify the degree to which the decision maker believes a given conclusion. Certainty factors are propogated with the

inferences of a rule base, where inexact reasoning is based on the construct IF A (to degree x) THEN B (to degree y). Facts (such as B) may be concluded by more than one rule. Suppose, for example, that fact B is concluded with a certainty factor of 0.60 by one rule and later by another rule with a certainty factor of 0.70. A combining function blends the outcomes. One way of combining the inferences is explained by Martin and Oxman (1988) as follows:

1. Take the difference between the first certainty factor (0.60) and 1.00 [that is, 0.40]
2. The difference (0.40) is multiplied by the certainty factor of the second conclusion (0.70) to give an increment of 0.28.
3. The increment is added to the original certainty factor to arrive at the combined value of 0.88. Thus, as more positive information emerges, the confidence in a conclusion rises.

The concept of certainty factors was used in MYCIN, one of the best-known early "expert" systems. MYCIN was developed at Stanford University in the mid-1970s to aid physicians in the diagnosis and treatment of meningitis and bacteremia infections. According to Harmon and King (1985), MYCIN was the first large expert system to perform at the level of a human expert and to provide an explanation of its reasoning process. Its certainty factors are in the range -1 to +1, with +1 indicating complete belief in a conclusion and -1

indicating complete disbelief. MYCIN has a mechanism for carrying certainty factors through its inferential network and updating their values through mathematical operations. Certainty factors are employed in the current research, as implemented in the expert system building shell Personal Consultant Plus.

The Diagnostic Problem

Medicine is just one of many disciplines in which diagnostic problems occur. Isomorphisms across systems allow researchers to avail themselves of contributions in other fields. The following analogy between psychology and accounting illustrates this idea. In discussing psychological judgments, Hoffman states,

> The primary task of clinical diagnosis is that of collecting, evaluating, and assimilating information with respect to the patient. (Hoffman, 1960, 116)

In the same vein, but applied to professional audit judgment, Ashton says

> Audit decision making involves the collection, interpretation, and integration of audit evidence. (Ashton, 1983, 1)

The auditor's going concern evaluation may be considered primarily a diagnostic problem. Stefik et al. (1982) believe that a diagnostician must understand the system organization and the relationships and interactions between its subsystems, must decide which measurements to take and may need to combine several partial models. With regard to the diagnostic problem, Pipino states:

> A major obstacle confronting the analyst when developing a model of the system for purposes of diagnosis is the presence of uncertainty, ambiguity, and imprecision in the specifications of the system and in the results of the measurements that must be performed. At times, values of variables specifying the system and of criteria measuring performance are not amenable to precise quantitative representation. Valuations are then given in approximate or linguistic terms. (Pipino, 1975, 2)

Pipino believes that diagnostic models applicable to humanistic systems must have the capability of handling fuzziness. He sees the purpose of computer-aided systems as not to displace the human diagnostician or expert, but to complement his skills and assist in task completion. Pipino offers a definition of system diagnosis that involves detection, evaluation, and prediction, then develops a generalized representation framework of the diagnostic process. This process can also be likened to a problem in pattern recognition, where an attempt is made to associate a pattern of system responses (symptoms/nonsymptoms) with a distinct system state (disease, cause).

The tasks of diagnosis, interpretation, and prediction are listed as generic categories of knowledge engineering applications by Hayes-Roth et al. (1983). These authors characterize interpretation as inferring situation descriptions from observables, prediction as inferring likely consequences from given situations, and diagnosis as inferring system malfunctions from observables.

Applicability of Management Science

Before applying some of the tools of management science to the problem at hand, it will be helpful to discuss certain facets of the discipline. Magee (1973) characterizes the development of management science as consisting of three broad, overlapping phases:

1. The "primitive" phase of the 1950s with emphasis on the invention of quantitative techniques to be applied to generally small, well-defined problems.
2. The "academic" phase of the 1960s with emphasis on technique, education and theory
3. The "maturing" phase of the 1970s with a balance between theory and observation, attention to qualitative aspects, and interest in the "process" as well as in the "solution."

Lockett (1984) believes that MS/OR has an opportunity to move into a general problem-solving mode whose paradigm will have the freedom to cross organizational boundaries, will use new ideas from other disciplines, and will adopt an advocacy role in implementing correct solutions.

Sprague (1980) sees a coalescence of OR/MS with information technology in the form of interactive modeling and the evolution of decision support systems (DSS). He sees DSS as being involved in all phases of decision making (intelligence, design, choice and implementation), MIS only

in the intelligence phase, and OR/MS only in the choice phase.

Keen (1980) sees the relationship between DSS and traditional operations research as being that a DSS may include an optimization model but still rely on judgment. He sees DSS as applying to unstructured, non-routine decisions. In contrast to this, Cats-Baril and Huber (1987) claim that in practice, DSSs almost invariably support decision makers dealing with moderate to well-structured problems.

Some researchers have suggested adding a knowledge base to a DSS. For example, Courtney et al. (1987) combined a semantic network with mathematical models to support managerial problem diagnosis. Henderson (1987) claims that adding a knowledge base to a DSS can provide the capability of capturing and processing the qualitative insights that often are central to expert decision-making processes. He believes that some researchers view DSS as a delivery vehicle for the application of OR/MS. O'Keefe (1985) is of the opinion that OR will increasingly use the technologies of DSS and expert systems.

Luconi et al. (1986) present a framework of problem types matched with system types. The framework shows "expert support systems" (ESS) as the next logical step in each of two separate progressions. On one side of the framework, DSS is shown as evolving from traditional data processing. On the other side, expert systems is shown as evolving from AI

in the computer science realm. The authors believe we are now at the point where these two branches can be united to help solve a broad range of important practical problems.

Simon (1987) believes the MS/OR profession should aspire to increase its impact by incorporating techniques from artificial intelligence and attempting to solve problems in domains which are ill-structured, knowledge-rich and nonquantitative. He cites instances from the 1950s where AI and OR techniques were applied side by side, but the two disciplines later diverged.

Fordyce et al. (1987) support the viewpoint of incorporating aspects of AI into MS/OR. They warn of the hazards of a group defining itself by its tools rather than its mission. The mission of OR in helping to make decisions has been accomplished by tool-building and tool-borrowing from other disciplines. The authors describe similarities in the approaches used by builders of expert systems and by MS practitioners: both use structured investigation of the problem domain to identify the decisions being made and the heuristics being used, and both use "sophisticated" software.

Similarities between OR and AI are also disussed by Phelps (1986), who points out that both approaches build models, both use "heuristic" procedures in the absence of optimal ones, both use mathematics, computer implementation, and interdisciplinary teams. Phelps believes that a combination of the approaches is called for in the efficient

solution of complex problems, using objective models for those parts of a system capable of mathematical description and human-style heuristic reasoning for the more complex and behavioral parts. This is the approach which was used in the present research.

Problem Solving and Decision Making

Before attempting to model the auditor's diagnostic process, it will be helpful to discuss prior research in the area of problem solving in general.

The classic study in human problem solving was done by Newell and Simon (1972) over a seventeen-year period. These authors contend that humans, when engaged in problem-solving behavior, can be represented as information processing systems (IPS). These systems have certain fundamental characteristics which are invariant across tasks and individuals. The task environment (plus the intelligence of the problem solver) determines to a large extent the behavior of the problem solver, independently of the detailed internal structure of the IPS. This task environment is represented as a problem space, and problem solving takes place here. The structure of the task environment determines the possible structures of the problem space, which in turn determines the possible programs that can be used for problem solving.

In relating problem solving to decision making, Van Gigch states that "Decision making is a thinking process which pervades all problem-solving activity." (Van Gigch

1978, 81). A decision maker is influenced by his world view, his cognitive style, and his epistemology. His world view reflects his conception of what the world is like or the way in which the totality of a problem is viewed. Cognitive style refers to the way an individual performs perceptual and intellectual activities. This may be analytical, heuristic, or some combination thereof. Epistemology relates to the thinking and reasoning processes used to elicit, reach, and explain and guarantee "the truth" as an individual sees it. In striving to attain the goal of making the best decision, an individual starts from the evidence at hand and formulates a solution in the form of theories, strategies, plans, or alternatives.

In a study involving decision making by pathologists, Einhorn (1974) focuses on the use of diagnostic cues. He discusses and illustrates some necessary conditions for defining expertise within a given situation. The expert must identify information or cues from the multidimensional stimuli he encounters. While each cue is related to the final categorization, it also serves the function of leading the expert to other cues. Based on experience in a particular domain, an expert has built up expectations about cues and their interrelationships. Information is organized into clusters to reduce the dimensionality of the problem. These are weighted and combined to form a global evaluation.

Ashton (1974) discusses decision-making criteria with respect to the predictive ability of accounting data. He points out that prediction models derive from people, and that, for the same task, different people may employ models which require different data or use the data in different ways. Brunswik's Lens Model from psychology is applied to prediction. The lens model is designed for use in the examination of judgmental situations where humans make decisions or predictions based on a set of explicit environmental cues which are probabilistically related to an event of interest. Graphically, the world is divided into two parts - the environment on the left side of the lens and the individual's judgment system on the right side. In between are cues used by the decision maker. For further discussions of the lens model applied to auditors, the reader is referred to Libby (1975), Libby (1981), Libby and Lewis (1982), Ashton (1974), Snowball (1980), and Rigsby (1986).

Joyce and Libby (1982) attribute the surge of interest in an auditor's professional judgment during the 1970's to three factors: (1) an increase in litigation against auditors, (2) competition among auditors for clients, and (3) the discovery by researchers of the Brunswik Lens Model which provides a conceptual framework for studying and evaluating auditor judgment under uncertainty. The authors review three paradigms used in the study of human information processing in auditing: (1) the policy-capturing paradigm, (2) the

probabilistic judgment paradigm, and (3) the predecisional behavior paradigm. These are discussed in the following paragraphs. Each uses different research methodologies and is applicable to particular auditing areas.

The objective of policy-capturing research is to build mathematical representations of auditors' judgments. Analysis of variance (ANOVA) and multidimensional scaling (MDS) have been used in this area. In ANOVA, the researcher creates a set of audit cases that differ systematically from one another. By observing an individual's changes in judgment from one case to another, the researcher is able to estimate the importance of various cues. An estimate of consensus may also be made.

Unlike ANOVA, MDS permits modeling without a prespecification and manipulation of cues. This is advantageous where judgments are made on the basis of cues that are ill-defined and not easily quantifiable.

In using the probabilistic judgment paradigm, auditors are asked to make explicit statements of the probabilities of uncertain events. Modeling techniques are used that incorporate these subjective beliefs. As evidence is collected and evaluated, the beliefs must be revised heuristically.

The predecisional behavior paradigm attempts to obtain data on the process of making judgments, rather than focusing on only the input and output. One method of obtaining this

data is to ask decision makers to think out loud while performing a task.

Anderson (1984) discusses process tracing (the predecisional behavior paradigm) as an outgrowth of Newell and Simon's problem-solving theory. His task environment was the examination of a prospectus from an initial offering of equity securities. He recorded the verbalizations of the problem solvers and developed models. Throughout the article, he discusses analogies to the Newell and Simon model.

Bouwman (1983) applied the "thinking out loud" approach to a diagnostic task involving financial analysis. The verbal traces (protocols) were analyzed at various levels of detail, resulting in specific process models. Models and strategies were then coded and executed as a diagnostic computer program. Bouwman points out that computerized diagnostic models were previously available, but had a poor acceptance level because diagnosticians wanted an "explanatory path" to allow them to double check the program's reasoning. Further, many programs perform poorly in the unbounded, ill-defined environment of the real world. Bouwman believes that a program which is structured according to actual human decision-making processes will be more acceptable.

Bouwman found that, although the diagnosticians were faced with largely quantitative data, they did not deal with it in that form, but converted it to qualitative terms. For

example, when confronted with sales figures of $50000, $58000, and $62000, the diagnosticians stored the information in memory as "sales are increasing." Bouwman relates this to Newell and Simon's concept of time required to store "chunks" of information in human memory. Bouwman's computer program attempts to emulate this translation from quantitative to qualitative terms.

Another researcher interested in human judgment processes is Gibbins (1984), who developed twenty-one postulates regarding the psychology of professional judgment in public accounting. The postulates are divided among five components: (1) the judge's experience, (2) the triggering event, (3) the environment, (4) the response, and (5) the judgment process. The accountant is portrayed as relying very much on experience and on the supply of workable, efficient, and probably sophisticated judgment templates that accumulated learning has brought.

Felix and Kinney (1982) present a review of research on the auditor's opinion formulation process. The efficiency and effectiveness of various audit research methods are considered and cross-classified with respect to the process of auditor judgment. A flowchart is developed showing the steps of: (1) orientation, (2) preliminary evaluation of internal accounting controls, (3) tactical planning of audit activities, (4) compliance tests of pertinent controls, (5) evaluation of internal accounting, (6) substantive tests of

transactions and balances, (7) aggregation of results, (8) forming an opinion, and (9) preparing the audit report.

Still dealing with the opinion formulation process, Waller and Felix (1984) employ the schema construct from cognitive psychology as an organizing principle. The authors discuss short-term vs long-term memory, episodic vs semantic memory, and declarative knowledge (template schemata) vs procedural knowledge (procedural schemata). The auditor is proposed to have a number of global template schemata (GTS), each of which represents an entire audit at a high level of abstraction. A GTS is a network of nodes (which represent major elements or feature variables of the audit) and relations that link the nodes. Associated with each node are sets of conditions and possible values, which are modifiable across audits to allow for current goals and learning. The opinion formulation process is divided into four steps: (1) deciding to perform the audit, (2) gaining an understanding of the client and environment, (3) planning and execution of audit activities, and (4) forming an opinion.

It is proposed that the auditor has a procedural schema for a final test of the "fit" of the GTS to the current audit situation. This schema may include an analytical review of the financial reports, an evaluation of current litigation, and an examination of subsequent events that may affect the interpretability of the reports.

On a more cynical and perhaps pragmatic note, Weiss and Kulikowski express the belief:

> An understanding of how the human mind actually works in solving expert problems is not necessary to successfully produce the expert systems that will augment human capabilities and productivity. It is sufficient to be able to debrief an expert of his or her knowledge, and structure this knowledge in a uniform computer representation that will permit the application of consistent methods of processing on the computer.
> (Weiss and Kulikowski 1984, 3)

Appropriateness of a Rule-Based System

In recent years, researchers have attempted to model certain accounting decision processes through the use of rule-based systems. This is appropriate according to the criteria of Waterman (1986). He suggests that a rule-based approach should be considered only if expert system development is possible, justified, and appropriate. He then goes on to define these terms as described in the following paragraphs.

For ES development to be possible, all of the following should apply:

1. The task does not require common sense
2. The task requires only cognitive skills
3. Experts can articulate their methods
4. Genuine experts exist
5. Experts agree on solutions
6. The task is not too difficult
7. The task is not poorly understood.

With regard to the going concern decision, all of the preceding requirements are met. The skills involved are gained through education and experience. The existence of genuine experts is recognized through certification and rank in the firm. Articulation and agreement are aided by official guidelines, policy manuals, etc.

Waterman claims that for ES development to be justified, at least one of the following should be true:

1. The task solution has a high payoff
2. Human expertise is being lost
3. Human expertise is scarce
4. Expertise is needed in many locations
5. Expertise is needed in a hostile environment.

For auditors dealing with the going concern issue, the task solution does have a high payoff, as evidenced by the potential cost of a wrong decision (possible litigation or loss of a client, for example). The scarcity of human expertise is demonstrated by the high hourly fee of senior auditors. Their expertise is needed in many locations. (They must review every audit done by the firm.)

Waterman's list for the appropriateness of the ES approach is:

1. The task requires symbol manipulation
2. The task requires heuristic solutions
3. The task is not too easy

4. The task has practical value

5. The task is of manageable size.

Again, the going concern judgment qualifies. The task requires heuristics involving the use and manipulation of linguistic variables. The task is not too easy since it requires trained auditors. An auditor's report has practical value for many persons who are interested in the financial condition of a company. The task is of manageable size, since it is bounded for each firm and can be functionally decomposed according to the guidelines of SAS 59.

Prerau (1985) presents many of the same concepts, listing basic requirements of the domain related to problem type, availability of experts, management support, and potential payoff. Then he lists other desirable features such as the acceptability of a gradual phase-in, availability of test cases, stability of the domain, and the existence of expert systems in similar domains. Again, the going concern decision fits the criteria.

Silverman (1987) presents his list of concepts in the form of a rule set describing when to "hire" an expert system. He believes the ES approach is appropriate when it is relevant, feasible, optimal, and success-oriented. Then he provides rules regarding relevancy, feasibility, optimality, and success. His ideas are similar to those espoused by Waterman and Prerau.

DSS/ES in Accounting

The domain of accounting has proven to be a viable application area for DSS and rule-based systems. In discussing DSS and auditing, Bédard et al. (1984) say that DSSs are concentrated in task areas which have a structured component and a judgment (unstructured) component. The DSSs which seem to offer potential for audit research are primarily model-oriented and suggestive. A number of these systems could be further enhanced by the use of expert systems concepts.

Elliott and Kielich (1985) mention the complexity of the modern accounting practice as a driving force behind specialization. The demands on an expert's time can be lessened if his knowledge can be distributed through an expert system. This also protects the firm in the event that the expert departs unexpectedly. Another advantage of computerizing the knowledge is consistency in decision making.

Connell (1987) categorizes existing accounting expert systems into five areas: (1) audit and internal control, (2) taxation, (3) financial planning, (4) interpretation of regulations, and (5) other financially oriented systems. Auditing and taxation have been the most popular areas for ES development. These represent lucrative and labor-intensive areas for accounting firms and are obvious targets for modeling. Connell's list includes systems whose subdomains

are DP auditing, internal control, bad debts, materiality, compliance with accounting standards, tax advisement in designated areas, project appraisal, and risk assessment. Almost all of the systems are at the prototype stage.

Messier and Hansen (1987) give an overview of existing expert systems in auditing. According to the authors, these systems are intended to support, not replace, the auditor. Hence, they are classified as decision aids. In earlier research, the same authors (Messier and Hansen, 1984) classified decision aids according to the domain's degree of structuredness.

O'Leary (1987) discusses five accounting functions: (1) auditing, (2) accounting information systems, (3) tax, (4) management accounting, and (5) financial accounting. Several accounting expert systems are reviewed. O'Leary discusses limitations, primarily related to changes in the knowledge base.

Borthick (1987) discusses artificial intelligence, representation of uncertainty, and decision making in auditing. He then reviews some applications of expert systems in auditing and expresses the belief that they will eventually become an integral part of auditor decision making.

Before discussing the application of rule-based systems to the going concern decision, it will be helpful to discuss the history of the going concern concept and to examine previous research in financial statement analysis. Much work

has been done in the areas of ratio analysis and bankruptcy prediction. These studies will be reviewed before returning to the question of designing a model dealing with the going concern issue.

The Going Concern Concept

Herring and Rowlett (1974) tell us that early business ventures were generally formed for the purpose of a single mission, such as a ship voyage. Upon completion, profits would be distributed and the venture terminated. Later in the history of commerce, more permanent forms emerged, such as proprietorships, partnerships, and corporations. These forms of organization required that profits be determined periodically. Continuity of business activity is a primary characteristic of the going concern concept.

The going concern notion was conceived long before generally accepted accounting principles were established. Dicksee (1892) used the notion in discussing valuation of assets, Hatfield (1914) in valuing inventory, and Hatfield (1927) in dealing with certain expenditures and assets. Paton (1962) maintained that the existence of a distinct entity and the continuity of this entity were two theoretical postulates of accounting. The going concern concept has been gradually incorporated into the fundamental theory and practice of accounting.

A going concern has neither the intention nor the necessity of liquidating or significantly curtailing its

operations in the foreseeable future. Koh (1987) believes that the going concern concept can be justified on two primary bases: (1) it embodies economic and business reality, and (2) it reduces the impact of uncertainty in accounting measurement.

Under the going concern concept, it is assumed, in the absence of information to the contrary, that an entity will continue in existence for the foreseeable future. Auditors must consider what circumstances indicate such information. Sometimes this may be clear-cut, such as a firm in receivership or liquidation. At other times, an entity may exhibit signs of financial distress but continue to operate.

Koh claims that prior to 1981, there was little guidance from professional pronouncements in helping assess going concern status. In March of that year, the AICPA issued SAS 34, "The Auditor's Considerations When a Question Arises About an Entity's Continued Existence." According to this document,

> In an examination of financial statements in accordance with generally accepted auditing standards, the auditor does not search for evidential matter relating to the entity's continued existence because, in the absence of information to the contrary, an entity's continuation is usually assumed in financial accounting. Nevertheless, the auditor remains aware that auditing procedures applied primarily for other purposes may bring to his attention information contrary to that assumption. In forming an opinion on the financial statements, the auditor considers any such contrary information, together with any factors tending to mitigate that information underlying conditions. (SAS No. 34, 1981, 1)

SAS 34 provides examples of what might constitute contrary information, mitigating factors, and management plans. If the auditor concludes that the mitigating factors and management plans can compensate for the contrary information, there is no need to modify the standard "clean" audit report. However, informative disclosure of the uncertainty should be considered. If the auditor concludes that substantial doubt remains about the entity's ability to continue in existence, he should consider the recoverability and classification of recorded amounts of assets and liabilities. The going concern assumption allows the accountant to allocate costs over their expected lives to specific accounting periods. In the absence of this assumption, assets and liabilities must be listed at liquidation values rather than book values. Identifying the point at which uncertainties require the auditor to modify his report is "a complex professional judgment."

The issuance of SAS 34 produced a spate of research articles and discussion on how auditors were to implement the new standards. Some of these are reviewed in the section on predictive models.

Mutchler (1984), after interviewing auditors about the going concern opinion decision, reported that they did not believe SAS 34 provided any new guidance but was merely a codification of what was already being done. Williams (1984) received similar sentiments in his survey. A number of his

respondents highlighted the importance of having an authoritative pronouncement as reinforcement of their criteria. However, Killough and Koh (1986) believe that SAS 34 is inadequate in establishing objective, unambiguous, and defensible audit procedures to assess going concern status.

Even with SAS 34, there remained an "expectations gap" between what users of financial statements believe auditors should provide and what auditors believe they are responsible for. Questions were raised by Congress, the SEC, financial writers, judges, and members of leading accounting firms. At issue was the quality of financial reporting and the role auditors should play in detecting unethical financial reporting. For a partial listing of hearings and disussions, the reader is referred to Campbell and Mutchler (1988).

In response to these issues, the Accounting Standards Board of the AICPA, in 1988, released nine new statements on auditing standards (SASs). One of these (SAS No. 59) is related to the going concern decision. This was the most controversial of the new standards, according to Guy and Sullivan (1988). Many auditors believe that their responsibility is only to verify that financial statements have been prepared according to generally accepted accounting principles and present fairly the financial picture of the company. Interpretation and prediction are left to the user of the statements. Further, many auditors fear that a going concern opinion will become a self-fulfilling prophecy. In

response to the auditors' claims, users of the statements protest that auditors have access to inside information that is not reflected in the financial statements, and this information should be disclosed in the auditor's opinion.

SAS 59 increases the auditor's responsibility for assessing an entity's status as a going concern and changes the way in which doubts are reported. Now the auditor has an affirmative duty to document his opinion of going concern status, rather than acting only if such information comes to his attention during routine audit procedures. If substantial doubt exists as to the entity's continuity, an explanatory paragraph is required (not tied to recoverability and classification of assets and liabilities). The opinion, rather than being qualified "subject to" the effects of uncertainty, will be unqualified with the explanatory paragraph expressing substantial doubt.

According to SAS 59, conditions and events which may cause substantial doubt include:

1. Negative trends, such as recurring operating losses, working capital deficiencies, negative cash flows from operating activities, or adverse key financial ratios
2. Other indications of possible financial difficulties, such as default on loan or similar agreements, arrearages in dividends, denial of usual trade credit by suppliers, restructuring of debt, noncompliance with statutory

capital requirements, need to seek new sources or methods of financing or to dispose of substantial assets

3. Internal matters, such as work stoppages or other labor difficulties, substantial dependence on the success of a particular project, uneconomic long-term commitments, or need to significantly revise operations
4. External matters, such as legal proceedings, legislation, or similar matters that might jeopardize an entity's ability to operate; loss of a key franchise, license, or patent; loss of a principal customer or supplier; uninsured or underinsured catastrophe.

In determining the impact of these circumstances and events, the auditor should obtain information about management's plans to deal with them and assess the likelihood of their successful implementation. These plans may include disposing of assets, borrowing money or restructuring debt, reducing or delaying expenditures, or increasing ownership equity.

The full impact of SAS 59 remains to be seen. One expert involved in the present research stated that none of his firm's procedures have changed; SAS 59 simply formalized what was already practiced. Another expert expressed appreciation for the new guidelines, particularly in the definition of what constitutes a "reasonable length of time" (that being one year past the date of the financial statements being audited).

Reluctance to Qualify Opinions

In the past, auditors' expressions of doubt have not always coincided with the existence of problem companies. Altman and McGough (1974) showed that a substantial discrepancy exists between mathematical model abilities and auditor abilities to predict going concern problems. Their results indicated that Altman's discriminant bankruptcy prediction model, originally reported in 1968, predicted failure for 82 per cent of a sample of failed firms, whereas the auditors' opinions indicated going concerr problems in only 44 per cent of the cases less than one year prior to their entering bankruptcy proceedings. Later research by Altman (1982) showed similar results. The authors advocate that auditors use mathematical models to aid their determination of going concern opinion formulation.

The inconsistency between audit qualifications and bankruptcy was also revealed in a study by Menon and Schwartz (1987), wherein less than 43% of the companies studied received going concern qualifications the year prior to bankruptcy.

Deakin (1977) offered two possible explanations for the small number of qualified opinions by auditors:

1. Since the proportion of failing firms is small, the auditor places a small prior probability on the failure event. If the auditor behaves in a Bayesian sense, the revision of probabilities requires a preponderance of

evidence for failure before the probability shifts to a prediction of failure.

2. The auditor perceives a higher relative cost of classifying a nonfailing company as failing. This might result in the loss of a client or become a self-fulfilling prophecy.

Kida (1980) suggested that an auditor's identification of a problem company is separate from the decision to issue a going concern opinion. He believes that factors other than the likelihood of problems, such as the perceived consequences of qualifying, may be considered by auditors. For example, an auditor may be quick to disclose problems, fearing lawsuits by investors and creditors if a qualification is not rendered and the firm enters bankruptcy. On the other hand, the auditor may be reluctant to disclose perceived problems, fearing the loss of the client should the firm continue in operation.

In view of the discrepancy between firms receiving going concern opinions and firms experiencing financial failure, researchers have developed models which attempt to predict these two different occurrences. Many bankruptcy prediction models have been developed, mostly based on financial ratios. Nonquantitative factors are frequently represented by indicator (dummy) variables. A great deal of verbiage has been exchanged concerning the merits of different analytical techniques, treatment of outliers, statistical properties and

stability of data, base year, different accounting methods, macroeconomic variables, etc. Some of these studies are reviewed in the following paragraphs, beginning with a discussion of ratio analysis.

Ratio Analysis

McKinley et al. (1983) state that ratios are the best-known and most widely used of financial analysis tools. They allow the analyst to study the relationships among various components and to compare a company's performance to that of similar enterprises. Miller (1972) believes that some ratios represent cause and others represent effect. Gibson and Frishkoff (1986) caution that ratios will differ across industry groups and according to accounting methods used. For an interesting history of ratio analysis, the reader is referred to Horrigan (1968).

According to Platt (1985), financial ratios are traditionally classified into six groups measuring different characteristics. The groups are: liquidity, debt, activity, profitability, growth, and value. Courtis (1978) proposed a different categoric framework. He believes that analysts need a systematic and comprehensive approach to ratio analysis which will identify the linkages between different ratios and then explain their interrelationships in mapping a profile of corporate financial characteristics. One reason such a theory is lacking is that there is no consensus as to what information is embodied in particular ratio values. Courtis'

three areas of ratios are profitability, managerial performance, and solvency. These are in response to a prospective investor's questions as to: (1) whether the entity is making any money, (2) whether the management is any good, and (3) whether the entity is going to stay in business. These three categories are subdivided into a total of ten subcategories. Ratios can be placed in the overall schema according to their major import in a particular analysis.

Statistical Properties of Financial Ratios

Various researchers have investigated the statistical properties of financial ratios. Horrigan (1965) sees their essential nature as being: (1) approximately normally distributed (this is disputed by others), (2) highly correlated with each other, (3) highly correlated over time, and (4) subject to wide dispersion which can be reduced somewhat by industry stratification.

Deakin (1976) said there is a tendency to rely on the normal distribution as an approximation due to its available statistical techniques. He concluded that the normality assumption was untenable for ten of eleven ratios commonly used in bankruptcy prediction models. Histograms of the ratios and their trends were relatively flat, with a large number of outliers. Some distributions were highly skewed. Square root and logarithmic transformations sometimes produced normality, but no generalizations could be drawn.

There was some indication that ratios might be closer to a normal distribution within specific industry groups, but this observation was hindered by small sample size.

Ezzamel et al. (1987) deduce some common observations from distributional studies. First, positive skewness is prevalent. This may be attributed to the effective lower limit of zero but an indefinite upper limit on ratios. Secondly, distributions which depart radically from normality are characterized by extreme outliers. Thirdly, transformations may improve the approximation to normality, but do not solve the problems caused by outliers.

Business Failure and Its Prediction

Ratio analysis has been extensively used in business failure prediction models. There are differing opinions on what constitutes business failure, but most researchers operationalize failure as having entered bankruptcy. That will be the definition used in this study.

Argenti (1976) proposed three types of business failure trajectories:

1. Type I failure follows a very low profile, indicating that the business never gets off the ground
2. Type II shoots upward to fantastic heights before crashing down again
3. Type III are mature companies which enjoy good performance, suffer a partial collapse onto a sustained

plateau, after which there is a rapid decline to insolvency.

Mutchler (1983) asserts that Argenti's Types I and III are indicative of solvency problems as described in SAS 34 (1981) and would probably be easily identified by most bankruptcy prediction models. Type II may be indicative of the nonsolvency problems discussed in SAS 34 and would not be easily identified by the models because failure occurs so quickly. This is demonstrated in the study by Ohlson (1980) who noted that the firms misclassified by his model seemed to lack any warning signals of impending bankruptcy.

Among early researchers using financial ratios to predict bankruptcy were Beaver (1966) and Altman (1968). Beaver defined failure as any of the following: bankruptcy, bond default, an overdrawn bank account, or nonpayment of a preferred stock dividend. He matched a sample of failed firms with a sample of nonfailed firms and studied their financial ratios for a period of five years before bankruptcy. Each ratio was analyzed separately and a cut-off point selected so as to maximize the number of accurate classifications. This technique, called classification analysis or the dichotomous classification test, was essentially univariate.

Beaver tested for normality using a cumulative density function. His ratios were badly skewed, and simple transformations were of limited benefit. He noted that

this has serious implications for multivariate techniques which rely on the normality assumption.

The ratio distributions of nonfailed firms were quite stable over the time period tested. Distributions of the failed firms exhibited marked deterioration as failure approached, resulting in a widening gap between failed and nonfailed firms.

Altman used multiple discriminant analysis (MDA) on a group of manufacturing firms and successfully marketed his "Z-score" model. His definition of failure (and that of most subsequent researchers) took in only those firms that had actually filed for bankruptcy. Later, Altman et al. (1977) developed and marketed a newer model, "ZETA analysis", which took into account changes in financial reporting standards.

Jones (1987) lists other researchers who have used MDA in bankruptcy prediction in various domains. In general, these studies have been characterized by high classification accuracy.

In evaluating the worth of a model, Type I and Type II errors should be considered. A Type I error is predicting success for a company which subsequently fails; a Type II error is predicting bankruptcy when it does not occur. Deakin (1976) believes that accounting-oriented decisions tend to be more concerned with Type II errors. The impact of the different types of errors may be different for other acountants and for other interested parties. For example,

Altman (1977) points out that a commercial loan officer runs the risk of losing all or part of a loan if a Type I error is made, but has only an opportunity cost (which may be regained in other investments) in the event of a Type II error.

Several researchers have criticized the use of discriminant analysis in financial applications and have offered alternative modeling techniques. Eisenbeis (1977) claims that transformations may change the interrelationships among the variables and affect the relative positions of the observations of the group. He discusses several other problems with using discriminant analysis in financial applications. These include:

1. Distributions of the variables (MDA assumes a multivariate normal distribution)
2. Group dispersions (MDA assumes equal variance-covariance matrices)
3. Interpretation of the significance of individual variables
4. Reduction of dimensionality (some researchers have used principal components and factor analysis)
5. Definition of groups
6. Choice of appropriate a priori probabilities
7. Estimation of classification error rates

The problem of unequal variance-covariance matrices can be overcome by using quadratic discriminant analysis. This still assumes multivariate normality. Eisenbeis reports that researchers who have used this method have generally not

achieved a significant improvement over linear discriminant analysis. He recommends that, until further research is done, one must temper the conclusions by recognizing that they represent approximations that may be significantly biased in some cases.

Dambolena and Khoury (1980) found a substantial amount of instability in the financial ratios (as measured by their standard deviations and coefficients of variation) in the ratios of firms which went bankrupt compared with those which did not. This instability increased over time as the firm neared failure. By incorporating stability measures into a discriminant model, these researchers achieved a marked improvement over previous models, especially during the time period 3 to 5 years prior to failure. They concluded that the standard deviation of a ratio over time appears to be the strongest measure of its stability.

Some authors have trimmed the data in an effort to make it fit a normal distribution. Frecka and Hopwood (1983) used the same ratios treated by Deakin for a later time period and found that by deleting outliers, normality could be achieved for most ratios using a population of manufacturing firms and specific industry groupings.

Jones (1987) pointed out further difficulties with the discriminant analysis studies. Most researchers who have used this technique have used equal sample sizes of bankrupt/ nonbankrupt firms. Assuming equal probabilities of failing/

not failing, MDA will establish a cut-off at the midpoint between the two group mean discriminant scores. This is appropriate only if there is an equal probability of group membership. In real-world applications, there is a much lower probability of failure than of nonfailure. Thus the cut-off point should be adjusted to make classification into this group more difficult. Another consideration in establishing the cut-off score should be the cost of misclassification.

Joy and Tollefson (1975) argued that the predictive ability of MDA models was often exaggerated. Classification accuracy is based on a second sample from the same time period as that used to develop the model, rather than testing the model on data from a later time period, which would measure the true predictive ability. In a further discussion of predictive ability, Altman and Eisenbeis (1978) emphasize the point that a model is only useful for predictive purposes if the underlying relationships and parameters are stable over time (this is the stationarity assumption). Otherwise extrapolation of the model would be invalid.

Mensah (1984) expanded on the idea of stationarity of models. He points out that researchers typically pool data across different years without considering the underlying economic events in those years. His belief is that the models correctly identify the more common characteristics of failing companies which make them susceptible to bankruptcy. The actual occurrence and its timing depend on the coupling of

these characteristics with certain economic events (external to the firm) which exacerbate the situation. Mensah suggests that different ratios become important at different time periods depending on the economic events which triggered the bankruptcies for the period examined. He then develops a model which aggregates data according to economic conditions. The prediction accuracy and structure of the model differ across different economic environments.

Rose et al. (1982) also address the issue of economic environment. They believe macroeconomic indicators may be helpful in predicting business failure, since any given firm may have a higher propensity to fail during a recession. Their model contains six macroeconomic variables. Knowledge of these effects could be important to management for decision making and to auditors and financial analysts in determining risk of failure.

Chen and Shimerda (1981) analyzed several studies which use financial ratio analysis and tabulated the frequency of individual ratios and the main factors involved. Ratios are usually selected on the basis of their popularity in the literature together with a few new ones initiated by the researcher. The authors review research involving principal components and factor analysis. Differences in terminology sometimes confound the issue of which ratios should be grouped together.

Using principal components analysis, Laurent (1979) identified a set of ten factors which were interpretable and accounted for 90 per cent of the total variance in a set of forty-five financial ratios. From each of these factors, he extracted the ratio that had a high factor loading and was the most independent from ratios in other factor groups. This was done for ease of implementation and parsimony in a model using financial ratios. His final ten ratios explain 82 per cent of the variance in the original set.

Zavgren (1983) claims that discriminating power relates to the characteristics of a particular sample and not to any rationale regarding the actual importance of particular characteristics.

Pinches et al. (1973) used factor analysis to develop empirically-based classifications of ratios and to measure the long-term stability of these classifications. Forty-eight ratios were factored into seven groups. Some of the factors showed distinct upward or downward trends over the time period 1951-1969, but the composition of the groups was stable.

Benishay (1971) cautions that logically redundant financial ratios are often computed and treated as independent. In this case a ratio may appear to reinforce the message contained in the ratios from which it was derived and thereby bias conclusions. However, if only fully independent

ratios are included in the model, the information content of the semi-independent ratios will be lost.

An alternative to using discriminant analysis is to use a conditional probability model such as logit (logistic regression) analysis to estimate the probability of occurrence of a particular outcome. This may be preferable in bankruptcy prediction where it is not mere classification (fail/nonfail) that is usually required but rather the probability of failure. Logit analysis is based on a cumulative probability function and does not require multivariate normality or equal variance-covariance matrices. Researchers using logit analysis in financial distress studies include Ohlson (1980), Gentry et al. (1985), Casey and Bartczak (1985), Lau (1987), and Zavgren (1985).

Like MDA, the logit technique weights the independent variables and creates a score for each observation. This score may be used to determine the probabilities of membership in pre-defined groups. The coefficients of the independent variables can be interpreted as the effect on the dependent variable of a unit change in the independent variable. Because of the structure of logit analysis, the midranges of probability are more sensitive to changes in the independent variables than are the extrema. Jones (1987) suggests that accuracy in predicting bankruptcy among marginal companies (those in the midrange of scores) may be the real test of a model's usefulness. Presumably, most

analysts and most bankruptcy prediction models can accurately predict those firms with probability of failure near zero or one. For further discussion of the logit model, the reader is referred to McFadden (1974) or Pindyck and Rubenfeld (1981).

Ohlson (1980) points out that with MDA, the requirement of normally distributed predictors precludes the use of indicator (dummy) variables. He adds that a violation of the normality assumption may not be important if the only purpose of the model is to develop a discriminating device.

Press and Wilson (1978) discuss criteria for choosing between logit analysis and discriminant analysis. If the populations are normal and have identical covariance matrices, the authors recommend discriminant analysis. However, in most classification problems, at least one variable is qualitative, ruling out normality. In this case, logit analysis is preferred. Two empirical studies are reviewed, using both methods of analysis. The authors conclude that logit analysis provides better discrimination, but not by a large amount.

Collins and Green (1982) compare and contrast the three statistical models most frequently used for bankruptcy prediction. These models are multiple discriminant analysis (MDA), linear probability models (LPM), and logistic regression (logit analysis). The discussion focuses on their effectiveness, statistical properties, and theoretical

validity with respect to bankruptcy prediction. MDA and LPM rely on assumptions which do not hold, but they produce identical, uniformly good results. Thus, it appears that the models are fairly robust to violations of their assumptions in this particular problem setting. The authors believe that the logit model fits the problem well and is more consistent with a theory of financial distress. The logit model appears to produce lower Type I errors (classifying a firm as successful that actually fails in the next period). For the data set treated (161 observations), Type I errors were reduced by half when the logit model was used in place of MDA. The authors question whether the additional computational effort of logit analysis is justifiable given the modest improvement in forecasts, unless the cost of a Type I error is very great.

Frydman et al. (1985) used still another technique in bankruptcy prediction, that being recursive partioning, a nonparametric technique. This iterative method makes no assumptions about the distributions of the variables. When prior probabilities and costs of errors are specified, the method will seek to minimize misclassifiation costs. On the other hand, the method does not provide probabilities of group membership or a means of evaluating significance of variables.

In addition to bankruptcy prediction, recursive partitioning has been applied in the area of medical decision

making, mass spectra classification, and commercial loan classification. References are provided by Frydman.

Even a less experienced decision maker and a less sophisticated model should be able to distinguish between obviously healthy and unhealthy firms. Little research has been done in the "gray" area of marginal firms where a model would prove its true worth. Altman (1968) tested his discriminant analysis model on a holdout sample of 66 nonbankrupt firms, of which 65% had incurred two or three years of losses. Seventy-nine percent of the firms were correctly classified. Gentry et al. (1985) tested two logit models on a sample of 23 weak firms (based on a credit-watch list) and obtained accuracy rates of 70 and 78%.

Prediction of Going Concern Status

Several researchers have oriented their bankruptcy prediction studies toward the going concern opinion decision of auditors. Operationally, the definition of non-going concern has generally been defined as having entered bankruptcy. All of the studies reviewed in the following paragraphs were done with respect to the guidelines set forth in SAS 34 (1981). To date, no research has been published regarding the auditor's decision process under the guidelines of SAS 59 (1988). The two pronouncements are very similar in the discussion of contrary information, mitigating factors, and management plans. Hence, much of the previous research is still applicable.

Williams (1982) studied going concern evaluations under the guidelines of SAS 34. He believes that even with the guidance provided by professional pronouncements, there is still room for auditor judgment and variability. His study was primarily concerned with the qualitative solvency factors listed in SAS 34. Subjects were presented hypothetical case situations that contained manipulation of these factors as well as quantitative financial ratios. The five qualitative factors investigated were recurring operating losses, negative cash flow from operations, default on loans, arrearages in dividends, and denial of usual trade credit. These were assigned (0,1) values and analyzed using logistic regression (logit analysis). Results indicate that the most important of these are default on loans and recurring operating losses.

Levitan (1983) used MDA in analyzing financial ratios and trend variables related to going concern evaluation. He believes trends are important because accounting information necessarily reports on past events, but users of the information must form opinions about the future. He compared the bankruptcy predictions of his model to auditors' issuance of going concern qualifications. In his sample, auditors were never wrong when their opinion predicted continuity problems. Hence such an opinion is an important cue to the user of the financial statements. However, auditors could improve their percentage of correct classifications by

issuing qualified opinions more readily. Levitan believes that this may not be as important to them as working with their clients to prevent bankruptcy. Based on the results of Levitan's study, a going concern exception indicates virtual hopelessness, while the lack of it indicates nothing conclusive.

Levitan believes that an auditor should be especially alert to potential going concern problems and should seek additional evidence when the discriminant score is close to or on the wrong side of the cut-off point. Auditors' going concern exceptions did not correspond well to companies which did in fact fail. High variance suggested that auditors were not particularly consistent among themselves.

The inconsistency between audit qualifications and bankruptcy was also revealed in a study by Menon and Schwartz (1987), wherein less than 43% of the companies studied received going concern qualifications the year prior to bankruptcy.

Mutchler (1984) used interviews and questionnaires to study the going concern opinion decision. She derived a set of variables perceived by the subjects as useful in identifying a company with potential going concern problems and a set of variables useful in determining which of the problem firms would receive adverse opinions.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

Objectives of the Study

This study is exploratory in nature. Two key questions are:

1. Is it feasible to represent symbolically the knowledge used in the auditor's going concern decision?
2. Can the resulting system make correct diagnoses?

A secondary objective is:

3. To determine the discriminatory power of a selected set of financial ratios.

This research builds on previous endeavors in the area of bankruptcy prediction. A set of financial ratios was chosen from those proven useful in the past, and similar quantitative techniques were applied. The first hypotheses to be tested was:

H_o: The ratios used here discriminate equally as well as those used by previous researchers

H_a: The ratios used here are better than those used by previous researchers

Test statistic: McNemar's T value (discussed in Chapter 4)

Hypotheses which can be tested on the rule-based model are:

H_o: This knowledge-based model discriminates equally as well as the other (quantitative) models

H_a: This knowledge-based model discriminates better than the other models

Test statistic: McNemar's T value

Even if a knowledge-based model discriminates only as well as, but not better than, the quantitative models, it can be defended in that it is probably more user-friendly, can process linguistic data, can handle uncertainty, and can be refined as more expertise is encoded. Historically, quantitative models have done a fairly good job of discriminating between bankrupt and nonbankrupt firms, but there is a limit to how much better they can be made, and they have the handicap of being sample specific. A knowledge-based model can expand the set of factors considered in identifying financially troubled firms, can make suggestions to the user, and can ask for more information when needed. Expertise can be encoded in a knowledge-based model so that a user of such a system has more than just numbers to look at. Further, the exploration of this area is just beginning, so there is ample room for innovation and improvement.

Financial ratios were used in this research to develop quantitative models utilizing multiple discriminant analysis, logit analysis, and recursive partitioning. Classification accuracy was compared to that obtained by earlier

researchers. Then the quantitative models were used as a basis of comparison against the knowledge-based model.

Evaluation of Results

The quantitative models were evaluated by traditional hypothesis testing and classification accuracy as described in subsequent paragraphs. Diagnostic accuracy of the knowledge-based model was not measured in this way, but on a case-by-case basis where the outcomes were known and could be checked against the model. These were compared to the results obtained from the strictly quantitative models. This was limited to a small number of cases for two main reasons: (1) Large portions of the data for the knowledge-based model are unique for each company; (2) An auditor's expertise and intimate knowledge of a company are required to provide the information on the qualitative factors.

Discriminant and logit analysis, dealing only with quantitative data, can be evaluated by statistical testing of a formally stated hypothesis. For example, in discriminant analysis, an F-test can be constructed for the null hypothesis of equality of group means. In logit analysis, a maximum likelihood Chi-square statistic is used to test the hypothesis that a parameter is zero. These models may also be evaluated by the percentage of classification accuracy.

Numerical criteria are also available in CART (the software used for recursive partitioning) to evaluate how well a split separates classes. One is the Gini criterion;

the other is the twoing criterion. The user chooses the one he prefers. The Gini index provides the probability of misclassification. The twoing criterion provides a measure of node impurity. CART is discussed in greater detail later in this chapter.

A different approach must be used to evaluate the effectiveness of a model based on expert systems technology. Just as one does not generally judge a human expert based on some numerical score, neither can an expert system be evaluated in this way. As expressed by O'Keefe, expert systems "allow us to build knowledge-based symbolic models rather than mathematical or statistical models." (O'Keefe 1988, 111). Weiss and Kulikowski (1984) describe two approaches in evaluating the performance of this type of model: the anecdotal approach and the empirical approach. In the anecdotal approach, model designers describe to domain experts situations in which the system has or has not performed well. Then attempts are made to improve the system. With the empirical approach, performance is evaluated over many problem cases stored in a data base. Interpretations by the model are compared to known end conclusions, and the proportion of correct conclusions is computed.

Gaschnig et al. assert that evaluation is going on constantly as an expert system is being designed and implemented. They cite such questions as:

- Is the knowledge representation scheme adequate or does it need to be extended or modified?
- Is the system coming up with right answers and for the right reasons?
- Is the embedded knowledge consistent with the experts?
- Is it easy for users to interact with the system?
- What facilities and capabilities do users need?

(Gaschnig et al., 1983, 242)

Rather than simply being built, an expert system evolves. Waterman describes five stages of the evolution:

Demonstration prototype	The system solves a portion of the problem undertaken, suggesting that the approach is viable and system development is achievable.
Research prototype	System displays credible performance on entire problem but may be fragile due to incomplete testing and revision.
Field prototype	System displays good performance with adequate reliability and has been revised based on extensive testing in the user environment.
Production model	System exhibits high quality, reliable, fast, and efficient performance in the user environment.
Commercial system	The system is a production model being used on a regular commercial basis. (Waterman, 1986, 140)

In an iterative process of feedback and refinement, a system progresses toward increasingly higher levels of performance. According to Ford, the performance level of an expert system is "primarily a function of the completeness

and quality of the facts and heuristics in the knowledge base, rather than the sophistication of the reasoning techniques." (Ford 1985, 25).

The system built in this research was validated by comparison of verbal protocol analysis to results obtained from the model. Practicing auditors and auditing faculty members analyzed case studies of bankrupt, nonbankrupt, and marginal firms. Their assessments of likelihood of bankruptcy were compared to the certainty of bankruptcy computed by the model when the experts' ratings were processed. At the same time, the qualitative aspects of the model were validated. The generality of the model was tested as the experts verbalized their assessments of a company's financial performance.

The Science Paradigm vs the Systems Paradigm

Another perspective on hypothesis testing and system modeling is that of "hard" versus "soft" systems as defined by Van Gigch (1978) or the "exact" versus "inexact" sciences of Helmer and Rescher (1959). In a "hard" system domain, the Science Paradigm may be used in a "formal logico-mathematical derivation" of a hypothesis which can be explained or predicted from evidence gained by observation. The auditor's going concern decision falls closer to the "soft" systems side of the spectrum. The task involves quantitative analysis as well as judgment based on knowledge and experience. Only certain facets of the phenomenon of

bankruptcy may be modeled analytically and numerically. Whereas scientific domains are governed by the laws of nature, the domain of the present research is governed by man-made laws and customs. In addition to analysis and deduction, the decision process requires synthesis and induction. The decision maker cannot rely strictly on formalized methods of thinking. He must take into account the weight of evidence stemming from few observations and small chance of replication. It may be necessary to make a prediction based on weak or inconclusive evidence. These are application areas of the Systems Paradigm.

According to Van Gigch (1978), the Scientific Method recommends that a hypothesis always be postulated before tests are begun. Then an experiment is designed to test the hypothesis, measurements are taken, and the hypothesis subjected to statistical tests. In "soft" systems, on the other hand, it is not uncommon to allow testing to start without a hypothesis. This is attributed to a lack of replications of the observations, and the possiblilty of new relationships being discovered as the experiment is conducted.

Wynne (1984) classifies OR as an engineering or "hard" science and MS as a social or "soft" science. His view is similar to that of Vazsonyi (1982) who believes that OR/MS in general and DSS in particular represent the application of the scientific method to decision making.

Importance of the Research

According to Dun and Bradstreet (1985), the rate of bankruptcy filings for listed commercial and industrial enterprises in 1985 was 114 per 10,000. The highest rate in a list covering 1926-1985 was 154/10,000 in 1932; that is, a rate of 1.54%. Given this small likelihood of bankruptcy, many auditors have not had experience with this phenomenon. They may lack the necessary judgment skills to issue an accurate going concern opinion. A decision model would add structure to the process and encode some expertise, making the decision more objective and less dependent on an individual auditor's experience. An additional benefit of such a model would be to lend consistency even to an expert in the area. Furthermore, the model could be used by an auditor as a persuasive analytical tool in discussing problems with a client and recommending changes in policies and/or procedures.

As cited in Chapter 2, much research has been done using financial statement data in bankruptcy prediction. Most of this has dealt with ratio analysis. As evidenced by the results, financial ratios are generally valid discriminators between successful and unsuccessful firms. However, ratios are merely symptoms of underlying problems. Some management groups can overcome (or outlast) these problems; others cannot. Quality of management is difficult if not impossible to quantify. In this, as well as in other mitigating or

confirming factors, auditor judgment plays a vital role. A model incorporating judgmental factors should be superior to a strictly quantitative model in that problem areas can be spotted earlier and dealt with on a timely basis. Business failure is usually a gradual process occurring over a period of time; bankruptcy is simply the point in time where the failure is legally recognized. Details of the process are unique for each company. A model seeking to portray the process must look for traits that are commonly found in bankrupt firms, recognizing that there is no exact "template."

Previous researchers have confined their analyses to various combinations of financial statement variables. Nonquantitative items have been represented by indicator variables or by regressing one variable on others to reflect trends. Levitan and Knoblett (1985) quantified some of the factors suggested in SAS 34, such as "recurring losses" and "working capital deficiencies."

A model which utilizes techniques from artificial intelligence can more realistically reflect the auditor's judgment process. For example, rather than use a 0,1 indicator variable for "working capital deficiencies," an expert system will allow the auditor to indicate whether such deficiencies exist and whether (and to what extent) they are significant. Thus, we have symbolic rather than numeric representation and manipulation of knowledge. This enables

us to capture some of the qualitative insights of human experts and to aggregate them in a meaningful way. A model which is useful to an auditor in evaluating enterprise continuity requires a certain amount of "number-crunching", as well as the encoding of nonquantitative factors. It is the intent of this research to do both.

One of the major goals is to analyze marginal firms according to expert criteria. It is obvious that the strictly quantitative models do a good job on most firms, but those which are misclassified have extensive implications in the auditing environment. Because of this, we need a more refined classification model. Given the previous estimate of a 1% bankruptcy rate for listed firms, the auditor is working in a small subspace of financially distressed firms. He must exercise prudent judgment in assessing their likelihood of survival. Since they are already in economic straits, he does not want to pronounce the death knell by giving them a qualified opinion. But he runs other risks if he gives a clean bill of health to a firm that subsequently fails.

Bayesian inferencing enters into the analysis when we consider the subpopulation of marginal firms. Given the total group of candidates for bankruptcy, how many (and which ones) will actually fail? And given the 1% probability of bankruptcy, what fraction of this 1% are being missed by the auditor and/or by a classification model? This is an area

where an expert support system can be of benefit to an auditor.

In developing the rule base for such a system, consideration can be given to the SAS 59 factors as they apply to marginal firms. For example, a firm's problems may be related to exogenous variables (referred to as "external matters" in SAS 59) such as crude oil prices, interest rates, etc. Some industries are more susceptible to damage than others; and within the same industry, one firm may be able to survive adversity better than another. An expert auditor would be able to analyze the effect of these factors on an individual company. Encoding this expertise would be advantageous to his firm and to less experienced auditors. This system would address the issues that do not concern the vast majority of firms which are obviously healthy or already bankrupt.

Phases of Decision Modeling

The decision model developed in this research reflects the three phases of the decision process stated by Simon (1977): intelligence, design, and choice. In the development of the model, the intelligence phase involves gathering information about what traits distinguish bankrupt firms from nonbankrupt ones. For the user of the model, this phase consists of inputting information on a particular company. The design phase involves the actual building of the model. Information distinguishing bankrupt and nonbankrupt firms is

encoded in the form of a knowledge base with accompanying rules. The choice phase consists of outputting a probability of bankruptcy for the firm of interest. The auditor must then decide whether to issue a qualified opinion.

The flow in the model is from intelligence to design to choice, with return to an earlier phase permitted. For example, an auditor using the system may review or revise previous input, and he may ask for an explanation or rule-trace.

A major objective of this research was to incorporate judgmental factors and expertise into a decision model. Two of the more traditional methods (multiple discriminant analysis and logit analysis) were used on the quantitative data as a basis for comparison. Then a newer nonparametric technique, recursive partitioning (as embodied in CART), was applied to the quantitative data. Again, comparisons were made. Qualitative factors mentioned in SAS 59 were incorporated into a knowledge base and codified as rules. A user interface elicits information pertaining to these factors.

Model Development

The bankruptcy prediction model developed in this research was built in two phases. The first phase dealt with strictly quantitative financial statement items. These items were analyzed using the previously mentioned quantitative techniques. The second phase of model development made use of an expert system building shell (Personal Consultant™

Plus) to analyze judgmental variables. Each of the methodologies is discussed in more detail in the following paragraphs.

Multiple Discriminant Analysis

Multiple discriminant analysis (MDA) is a statistical technique used to classify an observation into one of two or more a priori groups. In the case of bankruptcy prediction, there are two predefined groups: bankrupt and nonbankrupt firms. Classification is accomplished through the development of a discriminant function which is generally a linear combination of independent variables. This function may be represented by the form

$$Z = w_1X_1 + w_2X_2 + \ldots + w_nX_n$$

where Z = the discriminant score for a particular observation

w_i = the discriminant weight of the ith variable

X_i = the ith independent variable

i = 1, 2, . . . n

The discriminant function is derived in such a way as to minimize the possibility of misclassification. This is done by maximizing the between-group variance relative to the within-group variance. That is, the variation in the values of Z between the two groups should be much greater than the variation in the values of Z within the two groups.

The hypothesis to be tested in MDA is that the group means of the two or more groups are equal. An equivalent statement of the hypothesis is that the Mahalanobis distance

D^2 is equal to zero, where D^2 is the distance between the two group centroids (mean Z scores for each group). An F-test can be constructed to test the hypothesis. This can be stated mathematically as:

$$H_o: \quad D^2 = 0$$

$$H_a: \quad D^2 \neq 0$$

Test statistic:

$$F^* = [n_1 n_2/(n_1+n_2)]\,[(n_1+n_2-p-1)/(n_1+n_2-2)p]\; D^2$$

where n_1 and n_2 are the respective group sizes and p is the number of independent variables

Rejection rule: Reject H_o if $F^* > F_{p,\ n1+n2-p-1}$

The interested reader is referred to Berenson et al. (1983) for the supporting mathematics.

Figures 3.1 and 3.2 illustrate two possible distributions of Z-scores for the univariate case. These concepts can be extended to the multivariate case. In Figure 3.1, the overlap between the two distributions A and B is small, indicating that the function is a good discriminator. The function in Figure 3.2 is not such a good discriminator, as indicated by the large overlap.

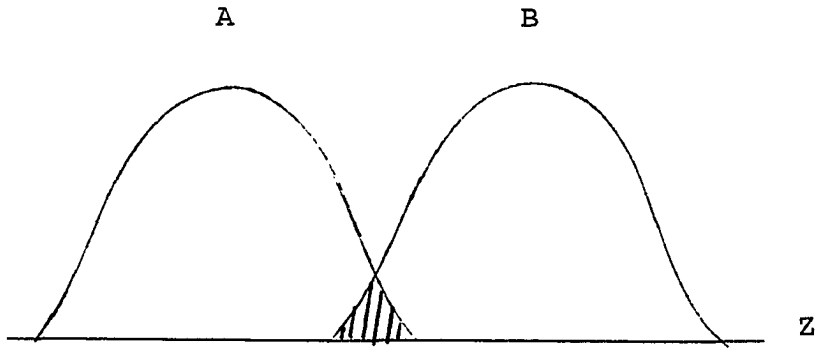


Figure 3.1 Good Discriminator

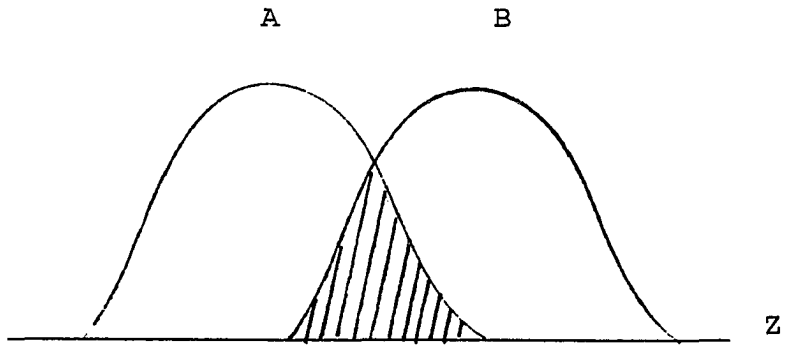


Figure 3.2 Poor Discriminator

In order for the inferences of Fisher's MDA to be valid, certain assumptions should be met. The independent variables are assumed to have a multivariate normal distribution, with equal variance-covariance matrices for the groups that are to be classified. According to Hair et al. (1987), MDA is not very sensitive to violations of these assumptions, unless violations are extreme.

In applying MDA, part of the data set is used as an analysis sample to develop the discriminant function. A "cutting score" is derived to determine group classification for each observation. The resultant function is then applied to the remainder of the data set (a holdout sample) for validation. A classification matrix is derived for both the analysis sample and holdout sample. This matrix (also called the "confusion" matrix) shows the number of observations correctly and incorrectly classified. From this, a "hit" ratio may be computed, indicating the percentage of observations correctly classified.

These concepts are expanded upon and illustrated with numerical data in the succeeding chapter when experimental results for the bankruptcy classification model are presented. PROC DISCRIM from SAS Institute, Inc. will be implemented using financial statement variables.

Logit Analysis

The logit model is based on the cumulative logistic probability function and has been found appropriate in many situations involving a binary dependent variable (bankrupt/ nonbankrupt, for example. The function has the general shape shown in Figure 3.3 with asymptotes of 0 and 1.

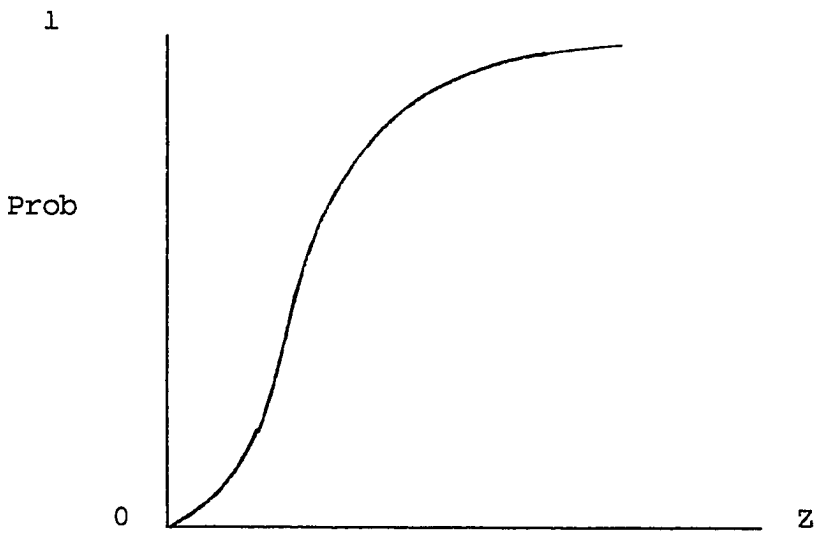


Figure 3.3 Logit Function

As in MDA, the logit technique weights the independent variables and creates a Z-score for each observation. Mathematically,

$$Z = b_0 + b_1X_1 + b_2X_2 + \ldots + b_pX_p$$

The b coefficients are maximum likelihood estimators. Their individual significance, as well as goodness of fit of the model, can be tested with a Chi-square statistic.

The Z-scores may be used to estimate E(Y), or equivalently, the probability of group membership ($\hat{\pi}$). For the cumulative logistic function, $E(Y) = \hat{\pi} = 1/(1 + e^{-Z})$. This may be transformed into an expression in terms of Z as follows:

a) Multiply both sides of the equation by $1 + e^{-Z}$ to obtain $\hat{\pi}(1+e^{-Z}) = 1$ or equivalently, $\hat{\pi} + \hat{\pi}e^{-Z} = 1$

b) Solving for e^{-Z} yields $e^{-Z} = (1-\hat{\pi})/\hat{\pi}$

c) Since $e^{Z} = 1/e^{-Z}$, we can obtain $e^{Z} = \hat{\pi}/(1-\hat{\pi})$

d) Taking the natural logarithm of both sides yields

$Z = \ln[\hat{\pi}/(1-\hat{\pi})]$

Thus, the Z-score is simply the natural logarithm of the odds of a particular outcome.

The slope of the cumulative logistic distribution is greatest at $\hat{\pi}=1/2$. Hence midrange probabilities are more sensitive to changes in the values of the independent variables. In the context of bankruptcy prediction, it seems reasonable that once the probability of bankruptcy is close to 1.0, large changes in the independent variables are not likely to increase the probability significantly. An analogous statement can be made for probabilities near zero. Companies with probabilities near zero or one can probably be easily classified by most analysts, whereas those with mid-range probabilities require more expertise or a more sensitive model.

In comparing logit analysis to MDA, Collins and Green (1982) assert that the logit model appears to produce lower Type I errors (classifying a firm as healthy which subsequently fails) but is not significantly better at classification accuracy. Furthermore, they maintain that MDA seems fairly robust to violations of model assumptions. Unless the cost of Type I errors is large, the additional computational effort of the logit model compared to MDA may not be

worthwhile. In the present study, PROC LOGIST from SAS Institute, Inc. will be used in the development of a logit model to classify firms as bankrupt or nonbankrupt.

Recursive Partitioning

The Recursive Partitioning Algorithm (RPA) is a computerized, nonparametric classification technique based on pattern recognition. This algorithm has been embodied in computer software known as "Classification and Regression Trees" (CART). The model is in the form of a binary classification tree which assigns objects to pre-defined groups in such a way as to minimize misclassification costs.

The inputs to RPA include an original sample of observations on N objects, together with their group classification, prior probabilities of group membership, and costs of misclassification (expressed as a ratio, such as "A Type I error is 5 times as costly as a Type II error"). The ability to deal with costs of misclassification is particularly helpful in the case of bankruptcy prediction, because this cost often depends on the perspective of the user of the model. A banker, for example, would find a Type I error more costly than a Type II error (where Type I is misclassifying a future bankrupt firm and Type II is misclassifying a healthy firm). The cost of a Type I error will be the loss due to loan default; the cost of a Type II error will be the opportunity cost at having funds idle or invested at a lower return. An auditor, on the other hand, may find a Type II

error more costly than Type I. For example, with a Type II error, the auditor may lose a client, face possible litigation, and/or issue a self- fulfilling prophecy. A different auditor may feel that a Type I error is worse, in that investors who rely on his report may file suit claiming he has failed to disclose problems.

An advantage of RPA is its handling of nonhomogeneity; that is, different relationships hold between variables in different parts of the measurement space. For example, once the data is split in two, then the best split for the data going left generally differs from the best split for the data going right. Also, the data may be split on the same variable at different points in the tree.

Classification accuracy of a function may be determined by the use of a test sample whose correct classification is known. For instance, in a bankruptcy prediction model, the classification tree may be constructed using a portion of the data and tested with the remainder. Or the model may be built with data from one time period and tested with data from a comparable period.

A method of determining classification accuracy for smaller sample sizes is cross-validation. With this procedure, a classification rule is constructed from the data with one or more cases omitted. Then the omitted cases are used as test data. In an iterative process, every case is used to construct a classification rule, and every case is

used exactly once in a test sample. The true misclassification rate is estimated from the composite of the models. For supporting mathematical theory, the reader is referred to Breiman et al. (1984).

Binary tree structured classifiers are constructed by repeated splits of subsets of X (the set of all cases, each of which has observations on n variables) into two descendant subsets. Figure 3.4 illustrates the procedure for a hypothetical tree where firms are classified into groups B (bankrupt) and NB (nonbankrupt). The CART program selects the single independent variable that will classify cases with the expected lowest misclassification cost. An appropriate cut-off is established, based on data conditions.

For example, split 1 might be of the form

G_1 = {Firms whose ratio of Cash/Total Sales $\leq$ 0.25}

and G_2 = {Firms whose ratio of Cash/Total Sales $>$ 0.25}

At this point, group G_1 consists of mostly bankrupt firms and G_2 of mostly nonbankrupt. But there is still substantial "impurity", so other variables are sought for further partitioning. This process is repeated until the nodes are considered sufficiently pure and the cost of misclassification is relatively low. It is possible that a variable used in an early partitioning may be used again (with a different cut-off point) on later subsets.

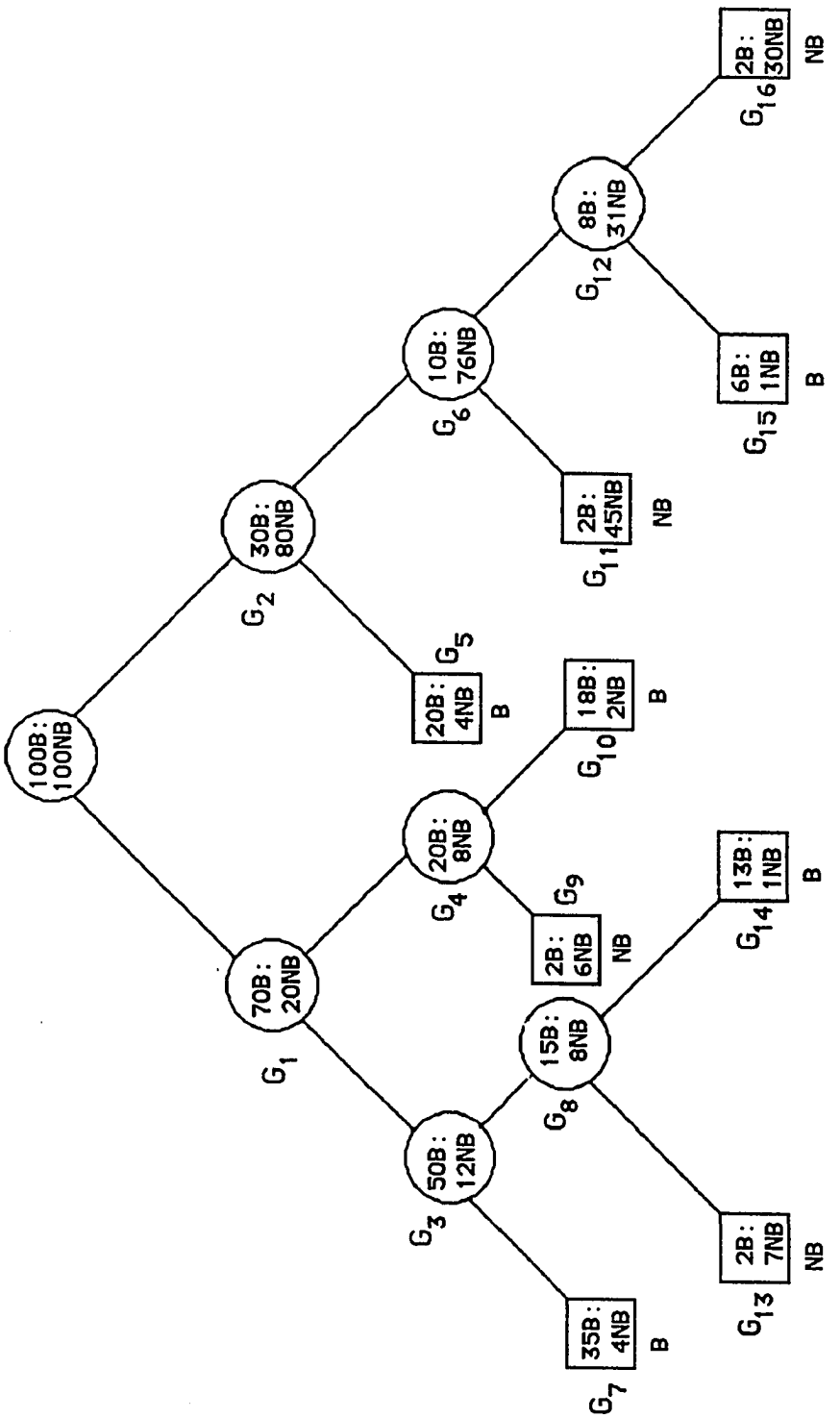


Figure 3.4 Classification Tree

Subsets which are not split (G_5 for example) are called terminal subsets (or nodes) and are indicated by rectangular boxes. Nonterminal subsets are indicated by circles. The terminal nodes form a partition of X and are assigned class labels (B or NB in the present example).

CART handles missing values by identifying surrogate splits which are most similar to the split whose variables are missing their values. This is done by defining measures of similarity between the splits and using the best one whose values are available. Tree construction revolves around three elements:

1. The selection of the splits
2. The decision of whether to declare a node terminal or to continue splitting it
3. The assignment of each terminal node to a class

The assignment of nodes to groups is done in such a way as to minimize the expected cost of misclassification (also known as resubstitution risk). Consider a terminal node t which has $n_i(t)$ objects from group i and let N_i be the size of the ith group in the original sample (i=1,2). Define c_{ij} as the cost of misclassifying a group i object to group j, and let π_i denote the prior probability of the object belonging to group i. The risk (cost) of assigning node t to group 1 is defined as $R_1(t) = c_{21}p(2,t) = c_{21}\pi_2 p(t|2) = c_{21}\pi_2 n_2(t)/N_2$. Here $p(2,t)$ = probability that an object is from group 2 and falls into node t, and $p(t|2) = n_2(t)/N_2$ = the conditional

probability of a group 2 object falling into node t. Similarly, $R_2(t) = c_{12}\pi_1 n_1(t)/N_1$.

The terminal node t is assigned to a group corresponding to the minimum risk; thus the assignment rule is a Bayesian rule. The resulting Bayes risk of node t is $R(t) = \min(R_1(t), R_2(t))$. The risk of the entire tree R(T) is the sum of risks of its terminal nodes. If $c_{12} = c_{21} = 1$ and $\pi_i = N_i/N$, then $R_i(t) = n_i(t)/N$. That is, if the costs of misclassification are equal and the prior probabilities are the proportions of the groups in the original sample, then a terminal node may be assigned according to the group with the largest representation.

Dealing with Nonquantitative Factors

In the domain of financial analysis, there are many factors which cannot easily be quantified. Heuristic reasoning may be modeled in part using certain techniques from artificial intelligence. An expert's domain knowledge is codified in some systematic way. This constitutes knowledge representation. The representation method chosen for the current research is that of frames. A frame is a data structure for representing a stereotyped situation. The frames model and organize domain entities and concepts and are arranged hierarchically corresponding to problem decomposition. Associated with each frame are rules and parameters.

Personal Consultant™ Plus has one or more specified goals (objectives) for each frame. The user may specify input parameters or take default values. Parameters may be restricted as to type and may be solicited with prompts and explanations. Each parameter is assigned a certainty factor which represents a measure of belief that the parameter value is correct. The system is menu-driven and can be executed on several models of microcomputers. A window-oriented interface allows a knowledge base to be built by responses to prompts for desired operations. After the knowledge base is built, a client uses similar menus and windows to run the model.

In this research, frames and appropriate rules were created for the factors discussed in SAS 59 with respect to the auditor's going concern analysis.

Selection of Variables

Table 3.1 presents a listing of the thirteen financial ratios used in the current study. This list is selected from ratios proven popular (and useful) in earlier research and is by no means exhaustive. Karels and Prakash (1987) believe that the large diversity of ratios in use is because of the limited theoretical basis for choosing them. The selected ratios do have a bearing on the going concern issue. Table 3.2 lists the factors measured by the respective ratios.

TABLE 3.1

FINANCIAL RATIOS USED

X1 = Current Assets/Current Liabilities
X2 = (Cash + STI + Net Rec.)/Current Liabilities
X3 = (ICO + DDA)/(CL + LTD)
X4 = (CL + LTD)/Total Assets
X5 = (Current Assets - Current Liabilities)/Total Assets
X6 = ICO/Total Assets
X7 = (ICO + Income Tax + Interest Expense)/Total Assets
X8 = Net Sales/Total Assets
X9 = Retained Earnings/Total Assets
X10 = Current Assets/Net Sales
X11 = (Current Assets - Current Liabilities)/Net Sales
X12 = Current Assets/Total Assets
X13 = (Cash + STI)/Total Assets

Notes: STI = Short Term Investments
DDA = Depreciation, Depletion, and Amortization
CL = Current Liabilities
ICO = Income From Continuing Operations
LTD = Long Term Debt

TABLE 3.2

INTERPRETATION OF RATIOS

Ratio	Factor
X1	Short-term liquidity
X2	Short-term liquidity (more rigorous test)
X3	Availability of funds
X4	Financial leverage
X5	Working capital relative to total capitalization
X6	Return on investment
X7	Productivity, irrespective of financing
X8	Sales-generating ability of assets
X9	Cumulative profitability
X10	Inventory turnover
X11	Working capital turnover
X12	Relative liquidity of assets
X13	Cash Position

The ratios were input into the three models discussed earlier (MDA, logit analysis, and CART). In addition, a trend variable was included showing how many of the three years prior to bankruptcy a company incurred a loss. This

factor can be easily quantified, and "recurring losses" is a negative trend according to SAS 59. One other variable used was industry code (DNUM in COMPUSTAT), for the purpose of determining whether CART would find a meaningful split on ratios according to industry group. Different ratios may be significant, or a ratio may be significant at different levels for different industries.

Sample Selection and Data Collection

For purposes of a pilot study, financial statement data was collected for 49 bankrupt companies. In keeping with the methods of earlier researchers, these companies were matched with nonbankrupt companies of the same industry and approximately the same asset size. A simple modification of this would be to pair the firms based on revenues. The intent of this matching process is to cancel the effects of confounding factors which are not directly related to bankruptcy. Asset size was taken three years prior to bankruptcy to offset any effects of impending failure on this factor.

Most researchers have selected the same number of nonbankrupt firms as bankrupt firms. This 1:1 pairing causes misleading proportions in the sample compared to the overall population. As mentioned earlier, the bankruptcy rate in recent years has been slightly over 1%. For the 49 bankrupt companies, this would require about 5000 nonbankrupt companies for the sample to be representative of the population. This presents great logistic difficulties. Casey and Bartczak

(1985) found approximately four nonbankrupt firms per bankrupt firm as a median ratio over all industries. They used those proportions in their study.

For purposes of comparability to results obtained by other researchers, the current research used the ratio of 1:1 bankrupt/nonbankrupt companies. An additional justification is that the focus of the present research is not necessarily to develop "the best" bankruptcy prediction model, but to show the feasibility of utilizing some of the newer techniques, such as recursive partitioning and expert systems technology. In order to alleviate some of the disproportionality between groups in the sample vs the population, MDA and CART allow the user to specify prior probabilities. In logit analysis, the probability cut-off point may be set by the user to shift the assignment of values.

Of the 98 total firms, 60 (30 bankrupt and 30 nonbankrupt) were used as an analysis sample for model development. The remaining firms were used as a holdout sample for model validation. After the models were analyzed with the pilot data, a larger sample of 200 firms was studied in a similar manner.

Bankrupt firms were chosen from listings in the Wall Street Journal Index for the years 1980-1988 and from a list of deleted companies in Moody's Industrial Manual. Industry codes and further references were obtained from Predicast's F&S Index. Utilities, transportation companies, and financial

services institutions were excluded. These firms are structurally different and have a different bankruptcy environment. Financial statement information was obtained from COMPUSTAT, Moody's Industrial Manual, Moody's OTC Manual, annual reports and 10-K reports for the three years preceding bankruptcy. Data on nonbankrupt companies was obtained from the same sources for the same three year period as that of the corresponding bankrupt firms. A listing of the 100 bankrupt firms in the data set is given in Appendix A. The corresponding nonbankrupt firms are listed in Appendix B.

Classification accuracy was compared among the different models. Then, results from each technique were compared to those obtained by previous researchers using the same techniques.

For the rule base, qualitative factors are expressed in the form of frames with accompanying goals, parameters and rules. These reflect the considerations mentioned in SAS 59 pertaining to the auditor's going concern evaluation.

Knowledge Base and Certainty Factors

There are three frames in the prototype expert system: COMPANY, CONTRARY-INFO and MITIGATING-FACTORS. The latter two are child frames of the COMPANY frame. Each frame has rules and parameters related to its subdomain. For example, the CONTRARY-INFO frame has parameters and rules relating to conditions and events which might be contrary to the going concern assumption. The COMPANY frame has parameters and

rules which combine the values from CONTRARY-INFO and MITIGATING-FACTORS subframes to arrive at an overall certainty of failure.

An example of a parameter in the CONTRARY-INFO frame is NEGATIVE-TRENDS. The system elicits input from the user as to the significance of certain negative trends and arrives at a composite significance rating (a certainty factor). Figure 3.5 shows what the user would see on the screen. He is asked to move the cursor to the appropriate point on a scale from 1 to 10 for each item. If the cursor is not moved, a significance rating of zero is recorded, indicating this item has no known significance. The significance ratings are converted to certainty factors scaled from 10 to 100. The system views any response with a certainty factor greater than 20 as significant. This threshold of 20 is strictly pragmatic and originates with Buchanan and Shortliffe (1984), the creators of the concept of certainty factors. This cut-off point prunes the network, with the implication that a certainty factor of 20 or less reflects too little evidence supporting the hypothesis.

The rule pertaining to NEGATIVE-TRENDS is

```
IF NEGATIVE-TRENDS = RECURRING-LOSSES
   OR NEGATIVE-TRENDS = WORKING-CAPITAL-DEFICIENCIES
   OR NEGATIVE-TRENDS = NEGATIVE-CASH-FLOWS
   OR NEGATIVE-TRENDS = ADVERSE-RATIOS
   OR NEGATIVE-TRENDS = OTHER
THEN CONTRARY-INFO CF 50
```

Figure 3.5 Sample Screen

```
NEGATIVE-TRENDS
Please indicate the significance of the following items:
.....Yes      RECURRING-LOSSES
.....Yes      WORKING-CAPITAL DEFICIENCIES
.....Yes      NEGATIVE-CASH-FLOWS
.....Yes      ADVERSE-RATIOS
.....Yes      OTHER
```

The rule given above states that if any of the responses is selected, then the parameter NEGATIVE-TRENDS receives a rating of 50% of the strongest of the items listed. The disjunction OR uses the significance (certainty) of the strongest item. A conjunction AND would use the smallest certainty factor (cf). The phrase cf 50 at the end of the THEN clause assigns a weight to this factor's contribution to CONTRARY-INFO. A cf in the range of 50 to 80 can be translated as "there is suggestive evidence that ..." A cf above 80 indicates "strongly suggestive evidence" and a cf between 0 and 50 implies "weakly suggestive evidence."

Certainty factors are neither additive nor multiplicative, but approach 100 asymptotically as incremental evidence for a hypothesis is accumulated. For example, suppose the most significant item in NEGATIVE-TRENDS is RECURRING-LOSSES with a significance rating of 8. This

becomes a certainty factor of 80. When the 50% weighting is applied to it, the certainty factor becomes 40; i.e., there is now weakly suggestive evidence of CONTRARY-INFO. Another parameter to be considered is INTERNAL-MATTERS with the rule

```
IF INTERNAL-MATTERS = LABOR-DIFFICULTIES
   OR INTERNAL-MATTERS = DEPENDENCE-ON-A-PROJECT
   OR INTERNAL-MATTERS = UNECONOMIC-COMMITMENTS
   OR INTERNAL-MATTERS = NEED-TO-REVISE-OPERATIONS
   OR INTERNAL-MATTERS = OTHER
THEN CONTRARY-INFO CF 50
```

The procedure is the same as before. If any of the items is significant, INTERNAL-MATTERS is assigned a certainty factor of 50% of the strongest certainty factor of the items listed. Suppose that UNECONOMIC-COMMITMENTS has the highest significance rating at 5; i.e., a certainty factor of 50. Fifty percent of this is 25, to be combined with the earlier cumulative certainty factor of 40.

The mathematics is as follows: The new cf (25) is applied to the portion of disbelief remaining from the previous cumulative cf of 40; that is, 25% of (100 - 40) or 15. This incremental certainty is added to the previous cumulative cf for a new cumulative certainty of 55. In this way, positive or negative evidence has an incremental effect on the significance of the goal parameter CONTRARY-INFO, without jumping to conclusions prematurely.

As was done in the preceding THEN clauses, the system builder may assign weights to the various pieces of evidence. These may be varied if a consensus of weights can be obtained

from auditing experts. In the present study, all conditions and events are given equal weights of 50, representing the low side of "suggestive evidence." According to Dawes and Corrigan (1974), linear models are robust over deviations from optimal weightings. Libby (1981) believes this finding implies that the most crucial element in decision making may be the variables selected and not their weights.

In the present system, once a certainty factor is obtained for CONTRARY-INFO, the user is queried as to the significance of management's plans in overcoming any financial difficulties that exist. These responses are accumulated as MITIGATING-FACTORS. The final computations of the system are to consolidate the relative strengths of CONTRARY-INFO and MITIGATING-FACTORS to ascertain a certainty factor for FAILURE-LIKELY.

Table 3.3 shows the likelihood of failure for varying relationships between conditions and events contributing to CONTRARY-INFO and management's plans contributing to MITIGATING-FACTORS. These values represent subjective probabilities elicited from experts. Buchanan and Shortliffe (1984) state that for small values of prior probabilities, certainty factors approximate conditional probabilities. In the present research, the prior probability of bankruptcy is small (about 1%). This, coupled with the fact that most experts can fairly easily express their beliefs in terms of probabilities, led to the use of probabilities in the table.

This matrix is converted to rule form so that input may be processed by the model to determine the certainty of failure (or nonfailure) of a company.

TABLE 3.3

LIKELIHOOD OF FAILURE

		Unfavorable Conditions and Events			
		Strong	Medium	Weak	None
Management Plans	Strong	0.20	0.15	0.10	0.001
	Medium	0.50	0.40	0.20	0.01
	Weak	0.85	0.75	0.40	0.05
	None	0.90	0.80	0.60	0.10

Gorry et al. (1973) used a similar approach in developing the first phase of a computerized medical diagnostic aid. They cite the belief that a clinician who performs well at diagnosis must have a good grasp of the relevant probabilities through his experience and familiarity with the literature, and that he can state his opinion with reasonable accuracy. Gorry and his coworkers relied on subjective probabilities in the initial phase of model building because examination of the literature in their domain failed to yield sufficient quantitative information. The estimated probabilities from the domain experts must be approximately correct if the program is to perform successfully, but it also appears that small errors in the

estimates are not important. This is borne out in the work of Cooper and Clancey, cited by Buchanan and Shortliffe (1984). Rules were modified and mapped cnto certainty factor scales of varying coarseness (using ten, five, four, three, and two intervals). Degradation of performance was not pronounced until the number of intervals decreased to three. The researchers believe this indicates that their system (MYCIN) is not fine-tuned and does not need to be.

Disclosure of Doubts

According to SAS 59, after the auditor has considered conditions and events, then management plans, he must consider how much (if any) information to disclose in his report. If he still feels substantial doubt about the entity's ability to continue as a going concern for the next year, he must consider the adequacy of disclosure and decide which information to report. If his initial doubt is alleviated after consideration of management's plans, he must consider whether to disclose his initial doubts.

Among the experts consulted for this study, there was no consensus on the tendency to disclose problems or on the effect of disclosure. One expert believed there was a tendency toward not disclosing problems unless they were clearly obvious, for fear of losing a client. Two experts support the idea that a qualified opinion may become a self-fulfilling prophecy and would hesitate to qualify unless the evidence was really strong. Another expert believed there was

a bias toward disclosure, to avoid the possibility of a malpractice suit. Any clients an auditor would lose by this tendency would be those in weak financial condition, who might be less desirable clients anyway. In dealing with such a client, the auditor must do a more in-depth analysis with larger data samples. A third expert stated that his firm does not have a tendency to err in one direction or the other, but asks, "If we're wrong, how dumb will we look?" He believes that the tendency to disclose or not disclose may be related to type of industry; for example, many pipeline companies are involved in litigation over "take or pay" contracts dating back to the years of severe natural gas shortages in the northeast. If these contracts are invalidated, some of the companies involved will undoubtedly go bankrupt. But to date auditors have not shown a tendency to qualify their opinions because all of the lawsuits settled have been in favor of the pipeline companies.

Still another expert discussed the predicament in which auditors may find themselves in the case of a marginal company. If problems are disclosed and a company remains in business, management and stockholders may sue the auditors. If problems are not disclosed and the company fails, there is an indeterminable number of potential investors and creditors who will be considering litigation against the auditors. It is difficult for the auditor to imagine the scope of the implications of a wrong decision.

There is scant literature on the effects of disclosure, with most of this related to investment decisions and stock prices. Dodd et al. (1984) found little evidence of a stock price effect when qualified opinions were disclosed publicly. They believe this is related in part to the timing of the release of the auditor's report and the fact that much of the negative information was previously available and already incorporated in the stock price. Firth (1978) found that some types of audit qualification had a significant impact on investment decisions while others had very little. He hypothesized that a going concern qualification would impart new information to investors and have a downward impact on stock prices.

Reference was made in the literature review of Chapter 2 on the possibility of a qualified opinion becoming a self-fulfilling prophecy in the matter of bankruptcy. Some auditors support this viewpoint, while others feel that the audit report adds nothing to the information an astute analyst could extract from the financial statements. The experts interviewed for this research had few definite opinions on the effect of disclosure on the likelihood of failure. One hypothesized that at low probabilities of bankruptcy, a qualified opinion would alert investors to the possibility that the auditor had some valuable inside information, resulting in a feeling of wariness on their part, and possibly increasing the probability of bankruptcy

for lack of funding. This same expert believed that a qualified opinion would have little impact at high probabilities because the financial difficulties would be obvious to most people considering an investment in the company. Another expert suggested that at high probabilities of bankruptcy, a qualified opinion would not change the probability but might expedite the process due to shutting off of funds or a higher interest rate. A third expert did not believe that a general statement can be made as to the effects of disclosure on the probability of bankruptcy. Only when a reader of the financial statements finds the auditor's opinion contrary to what he would expect does he become wary. In this case he might believe the auditor has inside information that makes the company look either better or worse than indicated by the statements. Further, if the financial statements look bad, but there is favorable "inside" information, management would probably be trumpeting it. This expert also expressed the view that a qualified opinion is not the black mark it once was. A company may have been telling its creditors it is having problems and needs relief on payments. An unfavorable auditor's opinion would confirm this and might cause the creditor to ease up some. This expert also states that creditors have become more sophisticated and realize that a company can look bad because of a downturn in the market or other factors not necessarily indicating poor management.

If a consensus could be reached on the effects of disclosure, it would be a simple matter to add one or more rules to the model revising the probability of bankruptcy after disclosure. Due to the lack of consensus, the model simply alerts the user of the system that he should consider the need to disclose his doubts or add an explanatory paragraph to his report.

Knowledge Acquisition

Reference has already been made to the elicitation of subjective probabilities for Table 3.3. These were obtained in a straightforward manner by simply showing the empty table to experts, explaining the context, and asking them for their assessments of probabilities under the various combinations.

Another form of knowledge acquisition serves the purpose of validating the rule base, as well as the wider purpose of learning some of the information an auditor seeks and evaluates when making a going concern assessment. The method used is what Wright and Ayton (1987) call "concurrent protocols" in which the "thinking out loud" data is obtained at the time the expert solves the problem. Wright and Ayton believe this method is more likely to provide relevant knowledge than simply asking the expert what he does and how he does it. They support the opinion previously mentioned that in a repetitive prediction task, only the knowledge of which variables to include in the model is important, not their weights.

In the present research, experts were presented case studies of firms classified by the logit model as having probabilities near 1.0 (definitely nonbankrupt) and 0.0 (definitely bankrupt) and in the midrange of marginal firms (0.4 to 0.6). They were asked to address the specific items mentioned in SAS 59, rate each on a scale of 1 to 10 as to significance, and render an assessment of certainty of failure. These significance ratings were directly input to the rule base and comparisons made on cumulative certainties. Interviews were recorded for convenience of recall at a later time. The analysis suffers some limitations in that the experts had only the information that was written in the case study and in the financial statements, without access to management or additional information when needed. A more thorough analysis could be made by an auditor in a true-to-life situation where he is familiar with management and can elicit additional reports.

The system is not intended to replace the auditor, but to aid in structuring the decision process and in compiling the various factors involved, including the application of encoded expertise. As the prototype system evolves, other frames can be added with their accompanying goals, parameters, and rules. Much of this is left for future research. The goal of the present study was primarily to determine the feasibility of this approach to intelligent decision support.

CHAPTER 4

ANALYSIS AND EVALUATION OF DATA

Expected Results

Since the financial ratios used in this research have proven useful in previous studies, it was expected that they would be good discriminators between bankrupt and nonbankrupt firms. Results from the pilot study and the full study support this belief.

For the CART analysis, an additional variable was industry code. Since CART may split more than once on the same variable, it is conceivable that a given ratio may prove significant at different locations on the binary tree, depending on industry code. As a hypothetical example, a healthy firm in industry A may be expected to have a high X_1 ratio, whereas in industry B, a high ratio would be abnormal. If CART builds a large enough tree, this distinction between industries might reveal itself.

Some of the companies which were misclassified by the quantitative models were tested on the expert system prototype. It was proposed that when qualitative variables are incorporated in the analysis, most of these would be correctly classified. For example, one of the companies which was misclassified had been judged by its auditors to have "overstated its assets." This would cause a misdiagnosis by

a strictly quantitative model, whereas an auditor aware of the discrepancy could input this judgment into a knowledge-based system and hopefully get a correct classification of the company.

Results of Pilot Study

Discriminant analysis and logit analysis both yielded fairly good results on the analysis of quantitative data. Classification accuracy on the holdout sample in MDA was 92% in the best model. The logit model classified the analysis sample (the data used to build the model) with 99% accuracy. CART had accuracy rates in the 90% range. The following paragraphs provide a more detailed analysis of the different models.

Discriminant Analysis Results

The hypotheses to be tested in discriminant analysis can be stated as:

H_o: $D^2 = 0$, where D^2 is the distance between group centroids

H_a: $D^2 \neq 0$

Test statistic:

$$F^* = [n_1 n_2/(n_1+n_2)][(n_1+n_2-p-1)/(n_1+n_2-2)p]D^2$$

where n_1 and n_2 are the respective group sizes, and p is the number of independent variables

Rejection rule: Reject Ho if $F^* > F_{p,\ n1+n2-p-1}$

To check for practical significance, the percentage of correctly classified observations may be computed.

Discriminant analysis was first performed on the full data set of 98 companies (49 bankrupt, 49 nonbankrupt). Then the data was split into two groups, with 60 companies used for developing a discriminant function and the remaining 38 used as a holdout (validation) sample. Each of these subsets had equal proportions of bankrupt and nonbankrupt firms.

Specifications on data handling were varied for a total of eight runs. Variance-covariance matrices were pooled for half of these and kept separate for the other runs. A Chi-square test provided by the computer printout indicated non-homogeneity of the covariance matrices, so they should not be pooled.

Another variation was to specify prior probabilities of 0.01 for bankruptcy and 0.99 for nonbankruptcy. Default priors were 0.5 for each classification, reflecting the proportions in the sample.

An F* value was calculated for the results on the analysis sample. From the printout, D^2 has a value of 7.0411. Sample sizes are 30 for each group, and there are 14 independent variables. The resulting F* value is 10.66. The appropriate F value from Table B.4 of Berenson et al. (1983) is approximately 3.25 at alpha = 0.01. Since $F^* > F_{14,45}$ we reject the null hypothesis. That is, this model is significant.

The rates of correct classification for the different models are shown in Table 4.1. As can be seen, the overall

classification rates are better (or at least as good) when the variance-covariance matrices are not pooled. In this case, the measure of generalized squared distance between the group centroids is based on the individual within-group covariance matrices rather than the pooled matrices. This procedure partitions the sample space in what Berenson et al. (1983) call the quadratic discriminant function, as opposed to Fisher's linear discriminant function discussed earlier. According to Berenson, these two forms of the discriminant function will be more in disagreement as the analysis sample gets smaller, the variance-covariance matrices get farther apart, the group centroids get closer together, and the number of variables increases. Also evident in Table 4.1 for most cases is a decrease in classification accuracy when population prior probabilities are imposed on the model. This is particularly pronounced when the data is split into analysis and holdout samples with the variance-covariance matrices pooled. The reduced performance level is presumed due to the large disproportion of bankrupt cases in the sample as opposed to that specified for the population.

When prior probabilities are specified, the cut-off Z-score is adjusted; that is, if a Z-score is above a certain value, the firm is classified into one group (nonbankrupt, for example) and if below that value, classified into the other group. By assigning the prior probability of 0.99 for

nonbankruptcy, it is more likely that a given observation will be assigned to that group.

TABLE 4.1

RATES OF CORRECT CLASSIFICATION
Discriminant Analysis, Pilot Data

		Equal Priors		Priors .01,.99	
All Data	Pooled	BR:	91.84%	BR:	91.84%
		NBR:	93.88%	NBR:	100%
		Overall:	92.86%		95.92%
	Not Pooled	BR:	97.96%	BR:	91.84%
		NBR:	95.92%	NBR:	100%
		Overall:	96.94%		95.92%
Analysis Sample	Pooled	BR:	86.67%	BR:	36.67%
		NBR:	93.33%	NBR:	100%
		Overall:	90%		60.29%
	Not Pooled	BR:	96.67%	BR:	96.67%
		NBR:	100%	NBR:	100%
		Overall:	98.33%		98.33%
Holdout Sample	Pooled	BR:	89.47%	BR:	42.11%
		NBR:	89.47%	NBR:	94.74%
		Overall:	89.47%		68.42%
	Not Pooled	BR:	100%	BR:	89.47%
		NBR:	84.21%	NBR:	89.47%
		Overall:	92.11%		89.47%

Pinches (1980) contends that when prior probabilities in the population are very dissimilar, the specification of priors in a computer program tends to swamp the results that would have been achieved on the basis of the predictor

variables by themselves, diminishing the model's accuracy. In the pilot study, this is pronounced in the smaller samples.

Specification of priors may also serve the purpose of injecting a bias when the cost of misclassification is higher for one group than for the other. For example, if an auditor would rather err toward misclassifying a bankrupt firm rather than a nonbankrupt one, he could set the priors to give a higher probability to nonbankrupt firms.

The relatively high "hit" ratios in the present study indicate that a function has been derived which discriminates well between bankrupt and nonbankrupt firms. A chance model based on equal prior probabilities would produce correct classifications 50% of the time. That is, if all observations were arbitrarily assigned as "nonbankrupt", half of them would be correct.

To be worthwhile, a discriminant function should perform better than a chance model. Hair et al. (1987) believe that the classification accuracy should be at least 25% greater than that achieved by chance, given equal group sizes. For example, if chance accuracy is 50%, the classification accuracy should be greater than 62.5%. By this criteria, six of the discriminant functions in the present research are good.

Results of MDA in this pilot study compare favorably to those obtained by other researchers, as shown in Table 4.2.

TABLE 4.2

PREVIOUS MDA RESEARCH

Researcher	Sample Size	Overall Accuracy
Altman (1968)	66	83.5%
Deakin (1972)	64	78%
Edmister (1972)	84	93%
Blum (1974)	230	95%
Deakin (1977)	143	84-94%
Kida (1980)	40	90%
Levitan (1983)	70	93%

It is difficult to assess the relative importance of the discriminating variables in MDA. The coefficients cannot be interpreted in the same way as those of regression analysis. Eisenbeis (1977) reviews several methods for determining discriminant weights. All of the methods assume equal dispersion matrices, which has been disproven for the present data set. Pinches (1980) suggests examining the relative weights by a number of different methods and looking for similar indications of variable importance.

To satisfy the curiosity in case one wants to assume robustness to violations, an estimate of relative weights is shown in Table 4.3 for the sample of 98 firms. According to Joy and Tollefson (1975), the differences may be interpreted as the portion of the discriminant score separation between the groups ($\bar{Z}_1$ and $\bar{Z}_2$) that is attributable to each variable.

As indicated in the table, X_6 has the largest discriminating power, followed by X_7 (with a negative coefficient).

TABLE 4.3

DISCRIMINANT WEIGHTS
Pilot Data

	Bankrupt	Nonbankrupt	Difference
Constant	-23.18	-18.97	-4.21
X1	3.38	3.26	0.12
X2	2.48	2.53	-0.05
X3	-0.87	-0.37	-0.50
X4	40.34	38.13	2.21
X5	-2.36	3.11	-0.75
X6	3.55	-5.84	9.39
X7	0.69	8.12	-7.43
X8	2.43	2.56	-0.13
X9	12.24	13.45	-1.12
X10	1.03	2.05	-1.02
X11	2.94	2.05	0.89
X12	1.19	-1.43	2.62
X13	-8.95	-9.78	0.83
YRLOSS	3.67	0.67	3.00

In addition to the problem of nonhomogeneous dispersion matrices, a further complicating factor in interpreting the coefficients is the presence of high collinearity among the ratios (many of them use the same or similar factors). No attempt was made to detect or avoid multicollinearity.

Logit Analysis Results

Logit analysis was run on the entire pilot data set of 98 observations. Only one company (a nonbankrupt firm) was misclassified for an accuracy rate of 99%. This rate is misleading since it tests the same sample that was used to develop the model. A more valid test would be to run the model against holdout data.

PROC GLM from SAS Institute, Inc. was used to generate a linear discriminant function, whose scores were plotted against the predicted probabilities from PROC LOGIST. This enabled a visual inspection of the distribution of the bankrupt and nonbankrupt firms. A sample plot is shown in Appendix C. Unless otherwise specified, the cut-off point for classification into the two separate groups is a probability of 0.5. The graphical distribution of the classes seems to indicate that this is a good cut-off for the present sample.

Collins and Green (1982), in comparing logit analysis to discriminant analysis, found a modest increase in the overall classification rate and a substantial reduction in Type I errors (classifying a failing firm as successful). They claim this is an important result since the purpose of the model is to identify firms that are likely to fail.

Table 4.4 lists the maximum likelihood coefficients from logit analysis. These represent the incremental effect of each variable on the log-odds ratio $\ln [\pi/(1-\pi)]$. As in MDA, X_6 is the most significant variable, followed by X_5 and X_3.

The model has a Chi-square value of 121.40 with 14 degrees of freedom. The corresponding critical value at alpha = 0.001 is 36.123, from Table B.2 of Berenson et al. (1983). This would lead to a rejection of the null hypothesis that the chosen ratios fail to distinguish between bankrupt and nonbankrupt firms. Again, because of high correlation among the predictor variables, care must be exercised in the interpretation of the individual coefficients.

TABLE 4.4

MLE ESTIMATORS FROM LOGIT ANALYSIS
Pilot Data

Variable	Beta
Intercept	45.77
X1	-6.57
X2	-19.98
X3	98.12
X4	-2.10
X5	101.26
X6	-162.90
X7	-0.42
X8	-7.53
X9	25.15
X10	2.19
X11	22.03
X12	-43.72
X13	28.42
YRLOSS	-15.74

Results for three other researchers using logit analysis in bankruptcy prediction are shown in Table 4.5.

TABLE 4.5

PREVIOUS LOGIT ANALYSIS RESEARCH

Researcher	Sample Size	Overall Accuracy
Ohlson (1980)	2163	96%
Zavgren (1985)	90	82%
Gentry et al (1985)	66	83%

CART Results

The hypotheses in CART may be stated as:

H_o: A tree can be constructed which classifies firms as accurately as the other quantitative models

H_a: Such a tree cannot be constructed

Test statistic: McNemar's T value

The first CART run was on the entire data set of 98 observations. Prior probabilities of group membership were based on sample representation, 50% in each group. The cost of misclassification was set equal for either a Type I or Type II error. The first tree, with nine terminal nodes, was selectively pruned (by CART) until a tree with just two terminal nodes was declared optimal. Optimality is based on the simplest tree having close to the minimum estimated error rate. This estimate is determined by cross-validation, wherein every case is used both in tree construction and in error estimation.

The two nodes were created by a split on the variable X_6, one of the variables found significant in discriminant and logit analysis. A firm whose X_6 ratio is less than 0.0075 is classified as bankrupt, others as nonbankrupt. After cross-validation, the accuracy rate for bankrupt firms was 92% and for nonbankrupt firms, 84%.

CART computes the relative importance of variables, as listed in Table 4.6 for the pilot data. This index (normalized to a maximum of 100) is based largely on the idea of surrogate splits. Even if a variable is never used to split a node, it may often give the second or third best split. Hence, it does provide predictive information. The authors of the software caution against a too literal interpretation of the exact numeric values, given their somewhat ad hoc derivation.

CART was run twice more on the entire data set, with adjustments in the prior probabilities and cost of misclassification. With prior probabilities set at 0.01 and 0.99 for bankruptcy and nonbankruptcy, respectively, the original tree had 12 nodes. When pruned to optimal, all firms were classified as nonbankrupt and the tree had only the original root node, with no splits. Thus, 50% of the firms in the sample were misclassified.

When the cost of a Type I error was set at a ratio of 10 to 1 compared to a Type II error, the optimal tree had 3 terminal nodes, representing two splits: on X_6 at a value of

0.0075 and on X_1 at a value of 1.31. After cross-validation, classification accuracy was 96% for bankrupt firms and 73% for nonbankrupt firms. This reflects the new goal of minimizing total misclassication cost.

TABLE 4.6

VARIABLE IMPORTANCE IN CART
Pilot Data

Variable	Relative Importance
X6	100
X3	94
X4	87
YRLOSS	86
X7	76
X9	71
X2	64
X1	60
X5	57
X11	47
X13	26
X12	8
X8	8
DNUM	1
X10	1

Using the same analysis and holdout samples as with discriminant analysis, a tree was built and tested. The optimum tree developed from the analysis sample (with equal

priors and equal costs of misclassification), had only one split. This was on X_6 at a value of 0.0095. When applied to the holdout sample, 4 of the 38 cases were misclassified (1 bankrupt and 3 nonbankrupt). This represents a classification accuracy of 89%.

The variable DNUM, representing industry code, never appeared as a splitting variable in the optimal trees of the present analyses. It sometimes was present in one of the larger, nonoptimal trees.

The only researchers who have used CART in bankruptcy prediction are Frydman et al. (1985). Their sample consisted of 58 bankrupt and 142 nonbankrupt firms. Their model used 20 variables, mostly in the form of financial ratios. Priors were specified at .02 and .98 and various costs of misclassification were tested. Classification accuracies ranged from 71% to 95%.

McNemar Test for Significance of Changes

The McNemar test is a nonparametric test designed to determine the significance of changes in dichotomous classifications. The test considers pairs (X_i, Y_i) where X_i represents the state of the subject before the experiment (bankrupt or nonbankrupt in the present study), and Y_i represents its state afterward. For the present application, the test may be used to compare the results of the different models; for example, one discriminant model against another, MDA versus logit or CART, or the results of the present study

against those of previous researchers. The test is described by Conover (1980, 130-133) and involves a contingency table as illustrated below in Table 4.7.

TABLE 4.7

CONTINGENCY TABLE

		Model #2 Correct	Model #2 Incorrect
Model #1	Correct	a	b
	Incorrect	c	d

The values a, b, c, and d represent the number of cases in each category. The null hypothesis is that classification was not altered from one model to the next.

The test statistic to be used is $T_1 = (b-c)^2/(b+c)$ for $(b+c) > 20$ (a Chi-square test) and $T_2 = b$ for $(b+c) \leq 20$ (a binomial test). The appropriate test statistic is compared to a tabular value t. For the binomial test, the null hypothesis is rejected if $T_2 \leq t$ or if $T_2 \geq n-t$. For the Chi-square test, reject H_o if T_1 exceeds the (1-alpha) quantile of a chi-square random variable with 1 degree of freedom. Notice that a and d do not enter the computation. This is because they represent no change from one classification to the other.

The McNemar test is illustrated below in the comparison of an MDA model to a logit model. The discriminant model classified 48 firms as bankrupt and 47 as nonbankrupt. (There

were actually 49 in each category; hence, 3 were misclassified.) The logit model applied to the same set of data classified 49 as bankrupt and 48 as nonbankrupt. The contingency table is shown below.

TABLE 4.8

LOGIT VS MDA

		Logit Model: Correct	Logit Model: Incorrect
MDA Model	Correct	95	0
	Incorrect	2	1

Since (b+c) < 20, we use the test statistic $T_2 = b$; that is, $T_2 = 0$. In Conover's Table A3, for $n = (b + c) = 2$ and $p = 0.5$ (equal probabilities), the tabular values are 0.0 or greater for all values of alpha. Since $T_2 < t$, we reject H_O. This implies that the classification was significantly altered. Since logit analysis classified more firms correctly than did MDA, this would seem to indicate that logit did a better job of distinguishing bankrupt from nonbankrupt firms.

Misclassified Firms

In discriminant analysis, logit analysis, and CART, the misclassified firms can be listed for further examination by the user. This was particularly valuable in the present research. Some of the misclassified firms were input to the rule base so their qualitative aspects could be analyzed.

The hit ratio on the marginal firms was much lower than that on samples covering the spectrum of financial health.

What if the one misclassified firm in logit analysis had been a marginal firm? Given a 1% rate of bankruptcy rate, suppose that 5% of all firms are classified as bankruptcy candidates. In a sample size of 100 (near the size of the present sample), five firms would be classified as marginal. If just one of these were misclassified, that would represent a 20% error rate among marginals. This illustrates the importance of having an adequate model. Qualitative expert systems analysis could provide a vital tool.

Expanded Data Set

The quantitative models were tested with a larger data set of 200 companies: 100 bankrupt and 100 nonbankrupt, again matched by asset size, industry, and year. Each model was analyzed with the entire data set, then with the set split into analysis and holdout samples of equal size. Results were generally not as good as with the smaller pilot data set. This could be due to the sample-specific nature of the models. Perhaps there were more outliers or atypical observations in the larger sample. Possible causes for the reduced performance were not pursued, because the primary goals of the present research lie in other areas.

In both the pilot data and extended sample, variances around the means of the financial ratios tended to be much larger for the bankrupt firms than for the

nonbankrupt companies. Intuitively, this would seem to lead to a higher rate of misclassification for bankrupt firms than for nonbankrupt ones. Results of the quantitative models generally bear this out.

Discriminant Analysis on the Full Data Set

Table 4.9 shows the results of discriminant analysis on the full data set, as well as on the analysis and holdout samples. Overall classification accuracy for the full set improves slightly (from 82.5% to 84.5%) when the variance-covariance matrices are pooled, and Type I errors decrease at the expense of Type II errors. For the analysis sample of 100 companies (50 bankrupt and 50 nonbankrupt), the pooled and nonpooled versions yield the same overall classification accuracy of 86% but differ in Type I and Type II errors. The holdout sample with pooled variance-covariance matrices has an accuracy rate of 85%, with higher Type I than Type II errors.

Table 4.10 shows the discriminant weights for the full data set. As with Table 4.3, these must be interpreted with caution. The heaviest weights again belong to X_6 and X_7 but this time X_7 has the greater weight, and the sign on X_6 has reversed from that on the pilot data.

TABLE 4.9

RATES OF CORRECT CLASSIFICATION
Discriminant Analysis, Full Data Set

		Equal Priors	
All Data	Pooled	BR:	83.0%
		NBR:	86.0%
		Overall:	83.5%
	Not Pooled	BR:	70.0%
		NBR:	95.5%
		Overall:	82.5%
Analysis Sample	Pooled	BR:	86.0%
		NBR:	86.0%
		Overall:	86.0%
	Not Pooled	BR:	76.0%
		NBR:	96.0%
		Overall:	86.0%
Holdout Sample	Pooled	BR:	78.0%
		NBR:	92.0%
		Overall:	85.0%
	Not Pooled	BR:	64.0%
		NBR:	92.0%
		Overall:	78.0%

TABLE 4.10

DISCRIMINANT WEIGHTS
Full Data Set

	Bankrupt	Nonbankrupt	Difference
Constant	-19.13	-13.75	-5.38
X1	1.54	1.46	0.08
X2	2.47	2.44	0.03
X3	-0.83	-0.42	-0.41
X4	32.30	26.00	6.30
X5	11.69	11.02	0.67
X6	-12.45	-19.28	-6.83
X7	8.39	15.51	-7.13
X8	2.67	2.29	0.38
X9	4.79	4.35	0.44
X10	3.43	2.88	0.55
X11	-1.25	-1.26	0.01
X12	-3.36	-1.84	-1.52
X13	-7.34	-4.17	-3.17
YRLOSS	2.73	0.93	1.80

Logit Analysis on the Full Data Set

Logit analysis was run on the 200 companies, then on the analysis and holdout samples. Marginal companies were defined as those whose probability of bankruptcy in the full model was between 0.40 and 0.60. Eleven such companies were found

and used as a holdout sample against the model developed by the remaining 189 companies.

Maximum likelihood estimators are shown in Table 4.11. As with discriminant analysis, X_6 and X_7 have the heaviest weights. Model Chi-square is 113.22 with 14 degrees of freedom.

TABLE 4.11

MLE ESTIMATORS FROM LOGIT ANALYSIS
Full Data Set

Variable	Beta
Intercept	5.44
X1	-0.58
X2	0.19
X3	3.23
X4	-6.32
X5	3.24
X6	-14.30
X7	8.08
X8	-0.69
X9	1.26
X10	-1.73
X11	-0.02
X12	0.71
X13	6.99
YRLOSS	-1.34

Classification accuracies are shown in Table 4.12 for the full data set and for the analysis/holdout samples of 100 firms each. When the 11 marginal firms were part of the full model, only 4 were classified correctly. When used as a holdout sample on the model developed from 189 firms, only 3 of the 11 were properly categorized. This shows a weakness of a strictly quantitative model when dealing with firms in the "gray area" of a moderate degree of financial distress.

TABLE 4.12

RATES OF CORRECT CLASSIFICATION
Logit Analysis, Full Data Set

All Data	BR:	86%
	NBR:	88%
	Overall:	87%
Analysis Sample	BR:	96%
	NBR:	94%
	Overall:	95%
Holdout Sample	BR:	72%
	NBR:	84%
	Overall:	78%

CART on the Full Data Set

CART's optimal tree on the full data set had two terminal nodes, splitting on X_6. After cross-validation, classification accuracy was 77% for bankrupt firms and 86% for nonbankrupt. Table 4.13 shows the relative importance of

the variables. Notice that X_6 is listed as second in importance, even though the optimal split was on this variable. This is reflective of the fact that CART finds the tree which gives the lowest overall misclassification cost (including a cost associated with the complexity of the tree) and takes into account the concept of surrogate splits. Remember also from the earlier discussion that the relative importance of variables is based on a somewhat ad hoc procedure not to be taken too literally.

TABLE 4.13

VARIABLE IMPORTANCE IN CART
Full Data Set

Variable	Relative Importance
X4	100
X6	97
X9	96
X3	95
YRLOSS	84
X7	74
X2	69
X1	66
X11	60
X5	45
X13	25
X10	16
X12	11
X8	8
DNUM	1

The analysis sample also split on variable X_6. The variable importance list is different from that of the full sample, but the same variables make up the top four. Classification accuracies are 80% and 94% for bankrupt and nonbankrupt firms, respectively. When the analysis tree was applied to the holdout sample, 76% of the bankrupt firms and 90% of the nonbankrupt firms were correctly classified.

Logit Technique Selected

This research considers final classification accuracy of the combination of two models: a quantitative model and a knowledge base. The quantitative model chosen was logit analysis, based on the following considerations:

1. The logit printout of probabilities facilitates the identification of marginal firms
2. In bankruptcy prediction, it is not mere classification into fail/nonfail that is important, but the probability of failure
3. There are no distributional assumptions
4. Collins and Green (1982) believe the logit model is more consistent with a theory of financial distress than are other techniques
5. On the holdout sample of 100 firms, logit analysis was at least as accurate as multiple discriminant analysis and CART. This is shown below in Tables 4.14 and 4.15, using the McNemar test as discussed earlier.

TABLE 4.14

LOGIT VS MDA, HOLDOUT SAMPLE

Logit Model

		Correct	Incorrect
MDA	Correct	71	14
Model	Incorrect	7	8

Since b+c > 20, the Chi-square test is used, with T_1 = (14-7)2/(14+7) = 2.33. From Conover's Table A2, t = 3.841 for alpha = 0.05. Since T_1 does not exceed t, we fail to reject Ho: Classification accuracy was not altered from one model to the other.

TABLE 4.15

LOGIT VS CART, HOLDOUT SAMPLE

Logit Model

		Correct	Incorrect
CART	Correct	71	12
Model	Incorrect	7	10

In this case, b+c < 20, so we use T_2 = b = 12. From Conover's Table A3, we obtain t = 5 approximately, at alpha = 0.05. Since T_2 > t, we fail to reject Ho: Classification accuracy was not altered from one model to the other.

Importance of Qualitative Factors

An auditor using only the logit model would have an overall error rate of 5% to 28%, depending on which sample contained the company of interest. If this happened to be a bankrupt company in the holdout sample, the probability of

getting a correct classification is only 72%. Even though the probability of bankruptcy is low, it is a high-consequence event when it does occur, so a high accuracy rate is desirable.

The quantitative models suffer from the weakness of being sample specific. Generalizations must be made with caution if at all. A few atypical companies can skew the results. Sample variances can be large. For example, looking at the mean of a ratio identified as being an important discriminator, X6, for bankrupt companies, its lowest value in any sample is -0.280, and its maximum value in any sample is -0.214. This represents a difference of 0.066, or 30.8%.

Sample effect is pronounced in one of the case studies analyzed by experts in the present research. "Company H" was processed by three runs of the logit model with random groupings of other companies. In the full data set of 200 companies, the predicted probability was 0.44; i.e., a marginal prediction of bankruptcy. In another run of 100 companies, the probability was 0.71; i.e., fairly strong for nonbankruptcy. In still another run (the pilot study), the probability was 0.04, strong for bankruptcy. This pointedly illustrates the importance of considering qualitative factors in the going concern determination. The true status of the company was nonbankrupt.

Not only should the qualitative factors be considered; in some cases they are of paramount importance. One of the

experts stated that his firm's focus on considering SAS 59 is whether a firm has had to seek concessions from its creditors either in or out of bankruptcy court. Once this occurs, he says, everything is qualitative. At this point in time his firm feels the risk of giving a clean opinion is too great, so they issue a qualified opinion expressing their doubts. Another expert asserted that the going concern opinion is the most subjective of all auditing decisions.

The prototype expert system developed in this research permits the input and evaluation of qualitative factors. These encourage consideration of company-specific characteristics and modify some of the skewness of a strictly quantitative model. When fully developed, the system can prompt an auditor to be sure he has considered all pertinent aspects of a case.

Results of Prototype Analysis

To test the effectiveness of the prototype, auditing experts were presented case studies for companies in varying degrees of financial health. The companies are described in Appendix D, and the experts' discussions are summarized in Appendix E. The notation used indicates the case by letter and the expert by number. For example, H-3 indicates "Company H" was analyzed by Expert #3.

A total of ten experts provided assistance, either in stepping through case studies or discussing the going concern issue. Five of these were audit partners in "Big Eight"

accounting firms, three were practicing accountants who have experience in auditing, and two were auditing professors with work experience in the field.

Five case studies were prepared: one for a severely troubled firm which subsequently entered bankruptcy (Company E), one for an especially healthy firm (Company O), and three which were classified as marginal by the logit model. (Company S entered bankruptcy in the following fiscal year; Company P and Company H survived.) Because of time constraints, not every case was analyzed by every expert. Table 4.16 shows a comparison of expert predictions vs model predictions for each case analyzed. "F" indicates a prediction of failure, "NF" of nonfailure. The top value in each cell indicates the expert's subjective assessment; the lower value indicates the degree of belief of the knowledge base, derived analytically from processing the expert's significance ratings on individual items through the rule base. (The rule base is given in Appendix F.)

The auditors were in agreement with each other and with the actual audit opinion on all cases. Their analyses seemed similar, and the same things seemed important to them. They made correct decisions on all but one of the companies, that being Company S. This was a high-tech company which entered Chapter 11 bankruptcy 11 months into the new fiscal year. The auditors noted the company's huge loss and heavy investment in research and development, but felt that for such a company

the numbers in the financial statements were not out of line. Some experts stressed the fact that their projection was for only a twelve-month time frame. The company operated in a strongly competitive market with pressure to keep up with new innovations and achieve timely delivery to the marketplace. The company suffered increasing liquidity problems and deterioration in profitability in the new fiscal year. Success of new products and a sufficiently long economic life to recover development costs are vital in such an environment. One of the experts claimed there is no way an auditor (or anyone else) can predict this.

TABLE 4.16

FAILURE PREDICTIONS

Company

Expert	S	E	O	P	H
#1	90% NF 90 NF	90% F 90 F	95% NF 90 NF	70% NF 90 NF	70% NF 90 NF
#2	90% NF 90 NF	89% F 80 F	100% NF 90 NF		
#3	85% NF 90 NF	90% F 80 F	100% NF 90 NF		
#4		80% F 90 F		"No Problems" 90 NF	"No Problems" 90 NF
#5		"Pretty Likely" 90 F			"No Problems" 90 NF
#6	90% NF 90 NF			90% NF 90 NF	80% NF 90 NF
True Status	F	F	NF	NF	NF

For each case analysis, a trace was put on the model to record the cumulative effect of evidence for and against failure. These are included in the ratings sheets in Appendix E. A sample playback file and rule-by-rule trace are shown in Appendix G. The prototype emulated the experts' decisions in all cases, with the certainty of failure or nonfailure generally close to the experts' assessments. The largest divergence was for Expert #1 with Company P and Company H. As can be seen from the model traces on Cases O-1 and P-1 in Appendix E, the cumulative certainty of CONTRARY-INFO is -91 for Company O and -14 for Company P. These are reflected in the expert's relative probabilities of nonfailure for these two firms. He sees Company O as being stronger. Because of the coarseness of the prototype model, the two companies are given the same degree of belief of nonbankruptcy. This discrepancy between the model and expert assessment can be easily corrected by further refinement of the rule base.

In the case of Company H as analyzed by Expert #1, his basic distrust of the format of the financial statements may have biased his probability of nonfailure. The complaint about the statement format was counted as just one item in the model's aggregate and did not contribute a disproportionate weight to the accumulated degree of belief. A refined model which allows the user to attach weights to particular items would remedy such discrepancies.

Combined Models

The logit model misclassified all three of the marginal firms listed in Table 4.16 but was correct on the two companies at the ends of the spectrum of financial health. Thus, it had an accuracy rate of 40% on the five firms but zero percent on the marginal firms. The auditors had a success rate of 80% overall and 67% (two out of three) on the marginal firms.

If a combination of quantitative and qualitative models were used in the auditor's going concern assessment, the overall accuracy rate would be improved. For example, the logit model had a 78% accuracy rate on the holdout sample and 87% on the entire data set of 200 companies. If a knowledge-based model with a 67% accuracy rate were added on to analyze the misclassified firms, there would be an incremental improvement in overall classification accuracy. If 67% of the missed 22% of the holdout sample were correctly classified by the rule-based model, this would add almost 15% (.67 X 22%) to the 78% correctly classified (i.e., 93%). Using the 87% rate, two-thirds of the missed 13% would give an incremental improvement of almost 9% for a total accuracy of 96%. The logit model could presumably be improved by restricting it to one industry group. (Different ratios are important at different levels for different industries.) Also, the rule base could be refined by reflecting specialized expertise in a particular industry. The combination of the two refined

models should give an even higher accuracy rate. There is some point of irreducible uncertainty wherein the auditor could be advised to consider qualifying his opinion.

Understandably, inferences cannot be made to the general population because of the limited number of cases considered here. Average time spent by the auditing experts was 20 to 30 minutes per case. Obtaining large samples would be prohibitive timewise.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Summary of Results

Results are promising and lend encouragement to further endeavors. The prototype model was able to capture ratings on qualitative factors and produce the same decisions as the experts. The SAS 59 factors provide a good basis from which to develop an intelligent decision support system.

Another revelation was the consistency of analytical technique and thought processes from one auditor to another. Even when the auditors were in error, they were in error together and for the same reasons. This holds promise for being able to obtain consensus and model decision making in at least parts of the domain. On some items, such as the effect of disclosure, getting a consensus does not seem to be possible.

Certainty factors, in some respects, created problems in this research as discussed below. But they demonstrated a quality that is also present in the auditor's going concern decision, that being the increased degree of belief or disbelief in the failure of an entity as evidence is accumulated.

Generality of Knowledge-Based Model

The knowledge-based model is built upon professional auditing standards and covers the topics mentioned by experts as being important in the going concern assessment. One expert stated that "SAS 59 serves as a conceptual framework that you start with." Another said that it simply formalizes what was already in practice. Some experts mentioned specific details they look at which represent refinements of the broader categories of SAS 59. These can be incorporated in future model development.

Contributions of this Research

This research confirms the value of quantitative models in bankruptcy prediction, but also reveals their limitations. An auditor needs a decision aid which incorporates both quantitative and qualitative factors. A strictly quantitative model teaches us little if anything about an expert's decision processes. Part of the motivation for the present research was to study the cognitive processes an auditor goes through in making the going concern decision. Thought processes used by different auditors seem to be very similar. This research has demonstrated the feasibility of using expert system techniques in this domain.

This research demonstrates the value of a knowledge-based model in evaluating marginal firms. Judgment is particularly crucial in assessing the likelihood of failure

in ıese cases. Modeling of this judgment in a decision support system can be of benefit to the user.

Problems with Certainty Factors

Auditors have a good understanding of probabilities. As explained earlier, certainty factors approximate conditional probabilities fo: low prior probabilities. But there are significant differences in the two concepts, as far as uses and interpretations. Certainty factors are superior to probabilities in providing for increased belief as supportive evidence is collected. The probabilities in Table 3.3 were used as an approximation to certainties, but this entails a certain amount of peril. For example, in cell (1,1) the probability of bankruptcy is expressed as 0.20. This may be converted to a certainty factor of 20, but in the software package used, a cf of 20 or less is considered not significant. If the probability is converted to the equivalent statement that the probability of nonbankruptcy is 0.80, this could be translated to a certainty factor of 80 for nonbankruptcy, which in turn becomes a certainty of -80 for bankruptcy. In terms of certainty factors, a certainty of 20 for bankruptcy is vastly different from a certainty of -80 for the same event. One is insignificantly positive; the other is very significantly negative. For future research, it will be essential to attune the domain experts to the concept of certainty factors, or to find a different measuring device. One possibility is the Dempster-Shafer theory of

evidence, which attempts to overcome some of the drawbacks of probability theory and certainty factors. Chapter 13 of Buchanan and Shortliffe (1984) outlines this theory. Continued use of the present software package dictates the use of certainty factors.

The requirement that a certainty be greater than 20 to be considered significant may on occasion have a huge impact when the ranges are somewhat broad as in the present study. As an example, in one case study the accumulated certainty for CONTRARY-INFO on the first four items in "conditions and events" was 42 (that is, in the upper range of "weakly suggestive evidence.") The only item left for consideration was "aggregate effect." When this was assigned a rating of 20 (not significant, according to the rules of this software package,) the resulting cumulative certainty for CONTRARY-INFO was downgraded to -14. This implies that there is not information contrary to the going concern assumption, but the result is not significant (since this too is less than 20 on the negative side of the scale). In the interval of -20 to 20, the system regards the information as inconclusive. Repeating the process but assigning a rating of 30 to aggregate effect, the cumulative certainty of CONTRARY-INFO is 51. This is because the rating of 30 is registered as significant, and it adds to the previous positive certainty of 42. The rapid swinging back and forth of certainty factors is a hazard to correct assessments when categories

are broad. This indicates a need to exercise careful control over the assignment of certainties.

Recommendations for Further Research

There are many possible variations on the basic research presented here. One interesting item would be to assign different weights to the factors in the model and see if the belief of Dawes and Corrigan (1974) is borne out. When questioned on factor weights, one expert put heavier weights on "negative trends" and "internal matters" than on other conditions and events. On management plans, he put heavier weights on "plans to borrow money or restructure debt" and "increase ownership equity," stating that these two items would have a longer lasting effect on survival of the company. Another expert agreed that "negative trends" was the most important of the conditions and events measuring the health of a company. A third expert felt that the most important aspect of managment plans was the ability to borrow money or restructure debt. Gaining a consensus from experts on the weights would be an interesting challenge.

The model developed in this research can serve as a foundation for expansion and refinement. For example, Table 3.3 relating strength of management plans to severity of problems can be further refined into narrower ranges. This would provide a more stringent measure of what constitutes "strong", for example. Such a refinement would take many cases and close attention by a motivated expert and would

serve as a test of replicability of Clancey and Cooper's findings. The aim of the present research was to obtain an aggregate assessment on broader categories. The prototype developed here could be expanded and refined over a long period of time, as more cases are evaluated and more expertise is encoded. An expert system is not just built; it evolves.

The focus of the system could be narrowed to model an expert in a particular area, such as oil and gas companies. Many "Big Eight" accounting firms have such audit specialists. The accuracy of both the quantitative model and qualitative model could be improved through the refinement of limiting them to a particular industry.

Other factors could be incorporated into the model, such as a provision for cost of errors and inclination to disclose or not disclose. This would reflect the attitude toward risk of an individual or a firm. An auditor could be prompted to consider the consequences of an unfavorable decision.

The system could be expanded to allow a more in-depth analysis of problem areas. For example, if there has been a steady erosion of working capital, its components could be examined to identify causes and assess the impact of management strategy. Management plans could also be examined in more detail by the model. Various levels of planning and implementation could be analyzed.

The present model accepts only numerical ratings as input. An enhanced model would accept verbal input to be assigned to variable names. For example, the user might be asked to list other significant problems. This could be accepted as multi-line input and stored internally for processing in a more sophisticated rule base.

There is also the question of how the "gray area" of marginal firms is defined. In the present research, firms which were assigned a probability between 0.4 and 0.6 by the logit model were classified as marginal. Other defining parameters might be used in a different environment. There is a definite need to consider the addition of qualifying remarks to an audit report of firms in the gray area, but what is the gray area? A general "fragility index" would be helpful, perhaps reflecting the susceptibility of an entity to damage by exogenous or other variables.

Some of the experts in the present research addressed issues that were not specifically mentioned in SAS 59 and are outside the scope of the current model. These concerns confirm the opportunities for research in this field. A full decision model could walk the auditor through every kind of thing he should consider in his going concern analysis. This would add structure and consistency and be of benefit to auditors of different levels of experience and expertise.

At the prototype level, this model could be adapted fairly easily to related domains. For example, a financial

analyst assembling an investment portfolio could use such a system for rating investment alternatives. A banker could benefit from expert support in loan decisions. Any analysis of financial soundness involves both quantitative and qualitative factors. Much of the evaluation requires judgment and experience. A system which incorporates both quantitative and qualitative factors will be more valuable than one which considers either by itself.

APPENDIX A

BANKRUPT COMPANIES

	COMPANY	BANKRUPTCY DATE
1	AM International Inc	4/82
2	Advent Corp	3/81
3	Allegheny International	2/88
4	Amarex Inc	12/82
5	American Healthcare Management Inc	8/87
6	American Pacific Intl Inc	10/80
7	Amfesco Industries Inc	11/85
8	Amfood Industries Inc	9/85
9	Anglo Energy Inc	11/83
10	Asbestec Industries Inc	3/88
11	Barclay Industries	11/81
12	Basix Corp	3/88
13	Beehive International	10/84
14	Beker Industries	10/85
15	Bennett Petroleum Corp	9/82
16	Berkey Inc	7/88
17	Berry Industries Corp	10/84
18	Bobbie Brooks Inc	1/82
19	Buttes Gas & Oil Co	11/85
20	Cardis Corp	5/88
21	Care Enterprises	3/88
22	Charter Co	4/84
23	Coleco Industries	7/88
24	Commodore Corp	6/85
25	Computer Communications Inc	11/80
26	Computer Devices Inc	11/83
27	Conesco Industries Ltd	8/85
28	Container Industries	12/86
29	Continental Steel Corp	11/85
30	Cook United Inc	10/84
31	Cramer Inc	3/88
32	Crompton Co Inc	10/84
33	Cyclotron Corp	2/83
34	Dant & Russell Inc	11/82

35	Datatron Inc	6/85
36	Dreco Energy Services Ltd	6/82
37	Endotronics Inc	3/87
38	Engineered Sys and Development Corp	8/88
39	Evans Products Co	3/85
40	FSC Corp	10/81
41	Family Entertainment Centers	8/84
42	Fashion 220 Inc	12/81
43	Flame Industries Inc	6/83
44	Flanigan's Enterprises Inc	11/85
45	Geophysical Systems Corp	3/83
46	Gilman Services Inc	5/82
47	Good (L. S.) Co	5/80
48	HRT Industries Inc	11/82
49	Heck's Inc	3/87
50	Hiller Aviation Inc	1/84
51	Hunt International Resources Corp	3/85
52	Information Displays Inc	5/84
53	Kelly-Johnston Enterprises	4/85
54	Koss Corporation	12/84
55	LTV Corp	7/86
56	Lazare Kaplan Intl	10/83
57	Leisure Dynamics Inc	1/83
58	Lionel Corporation	2/82
59	Lovelady (Ike) Inc	11/84
60	MGF Oil Corp	12/84
61	Magnuson Computer Systems Inc	3/83
62	Manville Corp	8/82
63	Marion Corp	3/83
64	McLouth Steel Corp	12/81
65	Mesta Machine Co	2/83
66	Mobile Home Industries	12/84
67	National Data Communications	9/83
68	Nexus Industries Inc	4/85

69	Nucorp Energy Inc	7/82
70	Ohio-Ferris Alloys Corp	11/86
71	Phoenix Steel Corp	8/83
72	Pizza Time Theatre Inc	3/84
73	Revere Copper & Brass Inc	10/82
74	Richton International Corp	3/80
75	Robins, (A. H.) Co	8/85
76	Robintech Inc	7/83
77	Rodac Corp	2/82
78	Ronco Teleproducts Inc	2/84
79	Salant Corp	2/85
80	Schaak Electronics Inc	7/85
81	Solid State Technology	8/81
82	Solomon (Sam) Inc	8/80
83	Steelmet Inc	2/83
84	Storage Technology Corp	11/84
85	Sykes Datatronics Inc	8/85
86	Tacoma Boatbuilding Inc	9/85
87	TeleCom Corp	2/81
88	Texscan Corp	11/85
89	Threshold Technology Inc	11/82
90	Tidwell Industries	8/85
91	Tobin Packing Co Inc	9/81
92	Towle Manufacturing Co	3/86
93	Towner Petroleum Co	9/84
94	Transcontinental Energy Corp	10/84
95	Wedtech Corp	12/86
96	Western Co. of North America	2/88
97	Wheeling-Pittsburgh Steel Corp	4/85
98	Wickes Companies	4/82
99	Wilson Foods Corp	4/83
100	X-Cor International Inc	2/80

APPENDIX B

PAIRED NONBANKRUPT COMPANIES

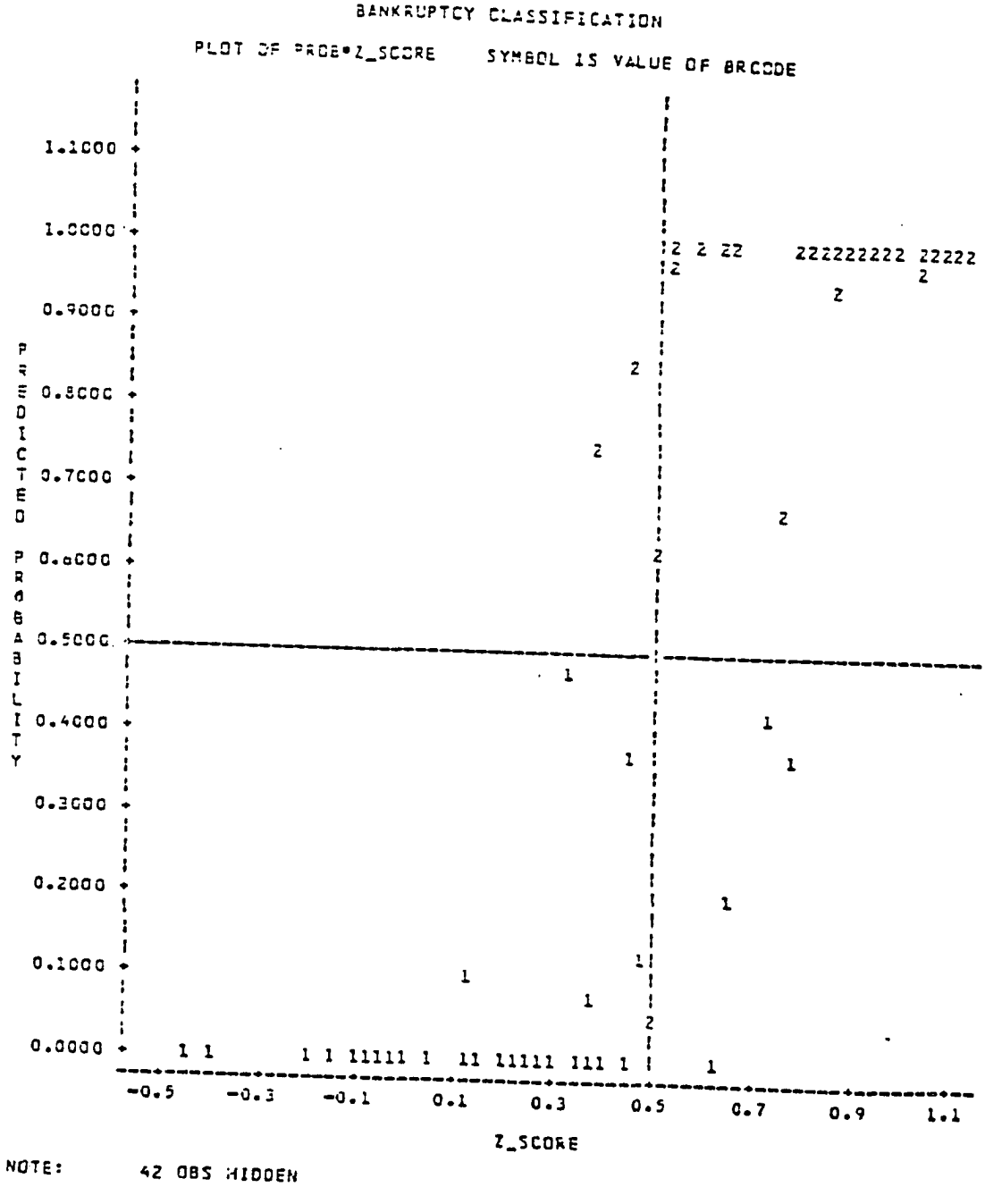
	COMPANY
1	Harnischfeger Industries Inc
2	Universal Security Instrument
3	Whirlpool Corp
4	Wiser Oil Co
5	Charter Medical Corp
6	Webb Resources Inc
7	Wellco Enterprises
8	Cracker Barrel
9	Blocker Energy Corp
10	Uniforce Temp Personnel Inc
11	Ply-Gem Industries
12	Harland (John H.) Co
13	MSI Data Corp
14	First Mississippi Corp
15	Oklahoma Energies Corp
16	BDM International Inc
17	Hinderliter Industries Inc
18	Panex Industries Inc
19	Adobe Oil & Gas Corp
20	Steego Corp
21	National Healthcorp
22	Petrolane Inc
23	Coleman Co
24	Conner Homes Corp
25	Analogic Corp
26	Zentec Corp
27	Deltak Corp
28	Swedlow Inc
29	Andal Corp
30	Best Products
31	Supreme Equip & Systems Corp
32	Avondale Mills
33	Base Ten Systems Inc
34	Trus Joist Corp

35	Napco Security Systems Inc
36	Trico Industries
37	Datum Inc
38	Pneumatic Scale Co
39	Lowe's Companies
40	Howell Corp
41	Taco Viva Inc
42	Neutrogena Corp
43	Aztec Manufacturing
44	Three-D Depts Inc
45	GTS Corp
46	Optel Corp
47	Glosser Brothers Inc
48	Ames Dept Stores Inc
49	Price Co
50	United Aircraft Products Inc
51	Holly Sugar Corp
52	DBA Systems Inc
53	Bob Evans Farms
54	Wells-Gardner Electronics
55	Armco Inc
56	Designcraft Industries
57	Progroup Inc
58	Toys R Us Inc
59	Brock Exploration Corp
60	Brown (Tom) Inc
61	Electronic Associates Inc
62	Owens-Corning Fiberglass Corp
63	Energy Reserves Group
64	NVF Co
65	Aro Corp
66	Angeles Corp
67	Aero Systems Inc
68	Movie Star Inc

69	Camco Inc
70	CCX Inc
71	Florida Steel Corp
72	Pizza Inn Inc
73	Insilco Corp
74	Lenox Inc
75	Novo Industries
76	Pantasote Inc
77	Chemineer Inc
78	Chadwick-Miller Inc
79	Work Wear Corp
80	Royal Intl Optical Corp
81	Digilog Inc
82	Greenman Brothers Inc
83	Consolidated Fibres Inc
84	Tandon Corp
85	Alpha Microsystems
86	American Ship Building Co
87	Hajoca Corp
88	Aydin Corp
89	Orbit Instrument Corp
90	Oakwood Homes
91	Friona Industries Inc
92	Oneida Ltd
93	Damson Oil
94	Unit Corp
95	Superior Industries Intl
96	Gearhart Industries Inc
97	Colt Industries Inc
98	Forest City Enterprises Inc
99	Holly Farms Corp
100	Puritan-Bennett Corp

APPENDIX C

SAMPLE PLOT: PROBABILITY VS Z-SCORE



APPENDIX D

CASE STUDIES

CASE STUDY 1 (COMPANY S)

Description of company:

Company S develops, manufactures, markets and services computer data storage equipment, high speed impact and laser printers, and small business turnkey systems. Tape and disk units and printers are for use with mainframe computers and are IBM-compatible. In addition, the company is a major supplier of high performance tape drives to original equipment manufacturers for use with minicomputers.

Founded in August 1969. At end of 1983 had 15,732 employees, offices in all major U.S. metropolitan centers and growing international operations.

Predictions from logit analysis: Probability = 0.51 in full data set of 200 companies (marginal, nonbankrupt); probability = 0.97 in holdout sample of 100 companies (definitely nonbankrupt)

Revenues by Product (in millions of dollars):

	1983	1982	1981
Disk Subsystems	358.3 (41%)	559.5 (52%)	466.7 (51%)
Tape Subsystems	401.7 (45%)	379.2 (35%)	307.6 (33%)
Printer Subsystems	99.4 (11%)	85.4 (8%)	61.5 (7%)
Other Products	27.2 (3%)	54.7 (5%)	86.2 (9%)
	886.6	1079.2	922.0

The decrease in revenues in 1983 was due primarily to a decline in sales of the 8650 disk subsystems. The increase in printer revenues as a percentage of total revenues is attributable to the decline in disk revenues. The decrease in revenues from "other products" is due to the sales of two subsidiaries.

Dividends: The company has never paid cash dividends on its common stock and currently anticipates that future earnings will continue to be retained for use in its business. Revolving credit and note agreements contain restrictions on payment of cash dividends and repurchase or redemption of outstanding stock. Distribution of assets to stockholders is prohibited, and maintenance of certain financial ratios is required.

Capital Stock Authorized: 60,000,000 shares;
outstanding 34,214,997; reserved 7,176,683
Stock Traded: NYSE

Financial statements are provided with this case study.

Selected financial ratios for Company S, a bankrupt company (BR) and a nonbankrupt company (NBR) in similar businesses:

	Company S	BR	NBR
CA/CL	2.301	0.330	3.558
(Cash + STI + Net Rec)/CL	1.179	0.081	2.719
(ICO + DDA)/(CL + LTD)	0.118	-0.820	0.137
(CL + LTD)/TA	0.278	-1.362	0.610
ICO/TA	-0.007	-1.756	0.004
(ICO + Inc Tax + Int Exp)/TA	0.018	-1.567	0.006
Net Sales/TA	0.700	0.349	0.791
RE/TA	0.193	-5.219	0.095
CA/Net Sales	0.702	1.925	1.074
(CA - CL)/Net Sales	0.397	-3.903	0.772
CA/TA	0.492	0.672	0.849
(Cash + STI)/TA	0.006	0.014	0.340
Yrs of losses in last 3 yrs	1	3	1

CA = Current Assets, CL = Current Liabilities, STI = Short Term Investments, ICO = Income from Continuing Operations, DDA = Depletion, Depreciation, and Amortization, LTD = Long Term Debt, RE = Retained Earnings, TA = Total Assets

Other Ratios for Company S

	83	82	81	80	79	78	77
Current assets + current liabilities	2.30	2.42	1.78	2.51	2.04	1.56	1.76
% cash & securities to current assets	1.27	1.68	0.70	2.08	3.67	1.50	2.94
% inventories to total assets	43.59	47.43	40.48	43.14	50.84	60.87	54.89
% working capital to net worth	69.98	57.46	48.00	90.20	71.64	49.55	52.30
% property depreciated	32.46	26.72	20.73	17.98	20.52	18.50	25.10
Capitalization:							
% long-term debt	26.06	27.81	22.43	35.72	42.13	36.14	44.33
% deferred income taxes	8.78	12.00	9.70	9.86	4.26	3.71	3.13
% common stock & surplus	55.16	60.19	67.87	54.42	53.61	60.15	52.54
Sales + inventories	2.06	3.12	3.54	2.94	4.32	2.37	2.57
Sales + receivables	2.23	3.99	2.98	2.81	5.41	4.60	3.97
% sales to net property	217.39	316.48	344.17	324.17	489.64	521.20	537.82
% sales to total assets	44.26	65.27	68.13	64.94	90.14	72.01	65.68
% net income to total assets	...	5.37	7.68	6.15	9.51	8.74	7.15
% net income to net worth	...	11.92	17.68	18.03	25.57	24.17	18.51

Excerpts from President's letter to shareholders in 1983 annual report:

> Results for the year 1983 were disappointing. Revenues dropped to $887 million from $1,079 million in 1982. Company suffered a net loss of $41 million compared to a profit of $65 million for the previous year.
>
> Loss was caused by three factors:
>
> 1) A significant decline in disk business caused by reduced demand for 8650 disk product line and by delays in getting new 8380 disk to market. Heavy demand for 8650 experienced in late 1981 and 1982 was lost as IBM began shipping its 3380 disk in late 1982. Company S's competing 8380 disk was

scheduled for production shipments in the second quarter of 1983, but shipments did not begin until November 1983.

2) A provision for losses resulting from the termination of a limited partnership mainframe computer aware of a six to nine month delay in the project because of a need to redesign certain components. This delay, coupled with significant previous cost overruns, led to a reevaluation and a decision not to provide additional funds. Of the 1983 loss of $41 million, $31.5 million resulted from discontinued operations associated with this project. Following its termination, several lawsuits were filed by or on behalf of the limited partners of the project. See Note 14 on the attached financial statements.

3) Heavy expenses that resulted from getting several new products to market. Besides the investment in engineering, these products required heavy expenditures for manufacturing startup, marketing and field engineering. Some of these products are the most advanced of their type in the market.

While there will be a loss in the first part of 1984, management expects to return to profitability and acceptable growth during the year. Efforts and resources will be devoted to improving and solidifying position as a leading supplier of data storage products.

Management's Discussion and Analysis:

1983 was the first year in which the company incurred losses from continuing operations since 1971. This is in addition to the loss from discontinued operations previously mentioned.

Revenue for 1983 declined 18% from 1982, compared to a 17% increase from 1981 to 1982. Cost of revenues, as a percentage of revenues, increased to 76% in 1983 compared with 67% in 1982 and 64% in 1981. The 1983 increase is attributable to several factors: increases in costs to refurbish used products, increases in the amount of equipment refurbished, increased depreciation expense on rental equipment, higher product costs due to lower manufacturing volume, higher percentage of field service at a lower profit margin than manufacturing.

Previously, the company's financing needs were met through funds provided by operations, borrowings, and lease financing activities. Losses incurred in 1983, as well as extensive capital investment in new products, necessitated increased reliance on external sources to finance operations. Preference of customers for leasing rather than purchasing equipment has affected cash flow and increased the need of obtaining external funding. Cash required to finance leasing activities is expected to remain substantial. Generally, the company obtains contractual commitments from large third-party leasing or finance companies to fund these transactions.

Due to projected cumulative losses through the third quarter of 1984, as well as continuing capital investment in new products, the company will continue to rely upon

borrowings to finance a portion of its 1984 activities. At year-end 1983, the company had borrowed $75 million under its $175 million revolving credit agreement. A recent amendment to the agreement restricts the availability of funds to $100 million until the company meets certain profitability and new production goals. The company anticipates meeting or exceeding these conditions, but failure to do so would adversely affect its ability to borrow under this line. The company has approximately $380 million other unused uncommitted short-term and long-term lines of credit available; these are largely dependent upon future financial performance. Management believes that the available lines of credit, as well as commitments from third-party leasing and financing sources will be sufficient to support its requirements throughout 1984; however, failure of the company to return to profitability would adversely affect its financial resources.

The company plans to spend approximately $65 million in 1984 for additions to property, plant and equipment. It is anticipated that part of these additions will be financed through sale-leaseback arrangements, with the remainder provided by operations and borrowings.

Considering the factors listed in SAS 59, what is your prediction as to this company's fate during 1984? What is the likelihood that the company will enter bankruptcy?

Company Identity: Storage Technology Corporation

Actual audit report: Clean opinion

Post-mortem:

This company entered Chapter 11 bankruptcy in November 1984. The company was in technical default and unable to reach new financing agreements.After spectacular growth, the company was hit by a sharp slide and was increasingly strapped for cash.

In fiscal 1984 the company suffered a net loss of $505 million, including $204 million in reorganization costs related to divestiture of certain assets and operations and termination or curtailment of certain operations. The net realizable value of certain assets was written down.

There was a material decline in the expected economic life of new products and significant continuing price reductions, based largely upon frequency and incremental improvement of new products.

The late introduction of the company's 3380 disk and IBM price reductions adversely affected the company's ability to compete.

CASE STUDY 2 (COMPANY E)

Description of company E:

Company E designs, manufactures, and sells specialized automation systems and equipment. A primary product has been equipment for the manufacture of floppy disks used in computer applications. Other products include custom machinery and automated material handling systems (such as a mail sorting system for the U.S. Postal Service) and computer-controlled order assembly systems for dispensing and packaging of items in broken case lots.

Results from logit model: Near 0.0 in all runs

1987 financial statements are provided with this case study.

Selected financial ratios for Company E, a bankrupt company (BR) and a nonbankrupt company (NBR) in similar businesses:

	Company E	BR	NBR
CA/CL	0.734	1.080	2.122
(Cash + STI + Net Rec)/CL	0.228	0.369	0.861
(ICO + DDA)/(CL + LTD)	-0.376	-0.179	0.433
(CL + LTD)/TA	1.164	0.899	0.490
(CA - CL)/TA	-0.309	0.058	0.412
ICO/TA	-0.487	-0.187	0.008
(ICO + Inc Tax + Int Exp)/TA	-0.447	-0.098	0.011
Net Sales/TA	1.922	1.195	1.208
RE/TA	-0.573	-0.198	0.494
CA/Net Sales	0.444	0.657	0.645
(CA - CL)/Net Sales	-0.161	0.048	0.341
CA/TA	0.853	0.785	0.778
(Cash + STI)/TA	0.024	0.028	0.016
Yrs of losses in last 3 yrs	2	2	0

CA = Current Assets, CL = Current Liabilities, STI = Short Term Investments, ICO = Income from Continuing Operations, DDA = Depletion, Depreciation, and Amortization, LTD = Long Term Debt, RE = Retained Earnings, TA = Total Assets

Dividends: None have been declared or paid since 1985.

Stock Traded: AMEX (Company is not in compliance with its requirements.) Shares authorized:10,000,000; Outstanding:1,983,286; Reserved:145,000

The company is in default on financial and other covenants imposed by its lenders. None of these has initiated legal recourse. If any lender elects to accelerate repayment as each is entitled to do, the company will not be able to repay without replacement refinancing. The company continues to seek waivers and time extensions.

For several years prior to 1986, a major portion of the company's revenue had been derived from sales of its equipment for the manufacture of 5-1/4 inch floppy disks. In 1986, there was a substantial decline in sales of this equipment due to the continued overall decline in that industry. Concurrently, demand for 3-1/2 inch micro diskette equipment increased. However, the company had not yet completed its development of this equipment.

Sales in 1986 decreased approximately 55.4% from the prior year. Such results were primarily attributable to the decreased sales of floppy disk equipment as well as the company not being able to obtain significant new contracts in the government and commercial machinery development areas. Losses were $5.2 million, principally attributable to reduced revenues.

Although in 1986 the company generated approximately $18.1 million in sales, the losses consumed a substantial

portion of its cash assets and caused the company to increase borrowings under one of its two revolving lines of credit.

In 1987 sales increased by 55%, but losses were $7.6 million. The 1987 negative gross margin reflects an increase of 64% in cost of sales compared to the prior year. There were also some changes in estimated total contract costs based on percentage of completion and inventory writedowns. Cash generated from operations was not adequate to satisfy working capital requirements. Additional financing provided only limited amounts of working capital. Working capital was further decreased by increases in amounts due to affiliates, accounts payable and accrued expenses of $5,180,000. The restructuring of a note payable to an affiliate from a short-term demand note to a long-term installment note partially offset increases in current liabilities.

The company has exhausted its borrowing limits under its two bank lines of credit. Management believes it is unlikely that the limits will be increased or that new loans will be made by these lenders. Because of the company's inability to make timely payments, certain vendors have obtained judgments against the company. Others have demanded payment and have advised the company that they are prepared to seek legal remedies. Borrowings are secured by substantially all of the company's assets, except assets of a wholy-owned subsidiary which is under a court order to keep its assets separate in conjunction with another lawsuit.

Management Discussion:

The company's performance in 1987 reflects a year of transition from reliance on custom machinery development to a more standardized product line offering. Many, if not all, of the challenges which enveloped the company in 1986

continued through 1987 and are still facing management in 1988.

To improve its performance, in 1987 the company implemented major changes to achieve greater product diversification to lessen the adverse effects of being dependent on a single industry. Cost reductions were implemented through increased budget controls and reductions in the work force, including an enhanced early retirement program and a 10% salary reduction for all salaried employees.

The company intends to continue working with its lenders and well seek appropriate waivers from defaults, extensions of time for payment and modification of other terms of the loans.

Plans are to focus resources on higher margin business and products, and to expand cost cutting programs. Cost-cutting measures include: relocation of the company's current offices to a facility which is more suitable to accommodate the lower level of business anticipated in 1988; substantial reductions in the work force; reductions in benefits; and wage freezes.

The company intends to focus its business away from government contracts in 1988 because of the higher costs and uncertainties involved.

The company intends to continue working with its suppliers and vendors in an attempt to receive materials and services as needed. This is expected to assist the company in increasing product inventory to reduce lead time in the production and shipment of products.

The shortage of working capital is continuing, and additional losses are expected to be sustained in 1988. The continued existence of the company is dependent upon several factors including the ability to secure sufficient new debt or equity financing. No assurance can be given that such

financing will be obtained, or that it can be obtained as and when needed and on terms favorable to the company. We are now focusing on a restructured company with much lower sales volume and related expenses with the anticipation of a return to profitability. The task is great at this point.

The company does have excellent machinery lines for the diskette and distribution industries which gives us the ability to become a strong company again if current and future cash needs are met.

Company Identity: Engineered Systems and Development

Actual audit report: Qualified in 1986 as being subject to the ultimate collectibility of the costs incurred in excess of the contract price on a government contract. Disclaimer in 1987 because of possible material effects of uncertainties in being able to secure sufficient new financing and obtaining waivers and extensions on obligations.

Post-mortem:

The company entered Chapter 11 bankruptcy in August 1988, citing a string of losses, poor sales, and higher than anticipated costs for certain projects. Banks refused to extend credit.

CASE STUDY 3 (COMPANY O)

Description of company O:

Manufactures, sells, services, finances, and insures manufactured homes. Also engaged in land development of mobile home communities which derive revenue from rental of spaces.

Overview:

In fiscal 1984, new home sales accounted for 96% of the company's sales. The company has experienced a consistent and steady growth in sales over the past three years. Management is optimistic about future prospects. As 41 million people approach the prime home purchasing age of 25-35 in the 1980's, only 2 out of 10 will be able to afford the median site-built price of $86,000 but the vast majority can afford a $17,000 home, Oakwood's average retail price.

Historically, the company has generated from operations most of the funds required for working capital, capital expenditures and other needs. Over the past three years, working capital provided by operations exceeded use of working capital by $1.2 million. In order to meet longer-term anticipated capital needs, the company in May 1983 concluded a public offering of common stock, gaining net proceeds of $9.8 million. Management believes these proceeds, along with funds generated from operations, will be adequate to meet most anticipated growth needs over the next several years.

At fiscal-year end of 1984, the company had unused lines of credit with several banks, amounting to $6 million.

Increase in inventory for 1984 over 1983 is primarily due to the opening and acquisition of new sales centers.

Dividends: Cash and stock dividends have been paid regularly for a number of years.

Logit analysis: Probability near 1.0 in all samples.

Financial statements are provided with this case study.

Selected financial ratios for Company O, a bankrupt company (BR) and a nonbankrupt company (NBR) in similar businesses:

	Company O	BR	NBR
CA/CL	4.389	0.905	2.861
(Cash + STI + Net Rec)/CL	2.196	0.426	1.721
(ICO + DDA)/(CL + LTD)	0.666	-0.254	0.319
(CL + LTD)/TA	0.184	0.897	0.353
(CA - CL)/TA	0.548	-0.064	0.449
ICO/TA	0.098	-0.262	0.097
(ICO + Inc Tax + Int Exp)/TA	0.183	-0.192	0.207
Net Sales/TA	1.501	3.474	1.469
RE/TA	0.280	-0.393	0.314
CA/Net Sales	0.473	0.176	0.470
(CA - CL)/Net Sales	0.365	-0.019	0.305
CA/TA	0.710	0.610	0.690
(Cash + STI)/TA	0.331	0.006	0.027
Yrs of losses in last 3 yrs	0	1	0

CA = Current Assets, CL = Current Liabilities, STI = Short Term Investments, ICO = Income from Continuing Operations, DDA = Depletion, Depreciation, and Amortization, LTD = Long Term Debt, RE = Retained Earnings, TA = Total Assets

Considering the factors listed in SAS 59, what is your prediction as to this company's fate during 1985? What is the likelihood that the company will enter bankruptcy?

Company Identity: Oakwood Homes

Actual audit opinion: Clean

Post-mortem: Company has continued to enjoy good financial health.

CASE STUDY 4 (COMPANY P)

Description of company:

Company P manufactures and distributes polymer and elastomer based specialty products such as PVC and other polymer compounds, film and sheeting, laminated and printed materials and precision-fabricated components for industry. Other products include precision metal/elastomer bonded components for information processing equipment, plasticized ferrite components for such appliances as microwave ovens, specialty magnetic materials, suspension components for front-wheel drive autos, insulation compounds for cable TV transmission systems, PVC film/sheeting for a variety of applications, and decorative wall-sheeting. Operations are concentrated in North America and Europe.

1982 financial statements are provided with this case study.

The company has available Federal income tax loss carryforwards of $2,300,000 and investment tax credit carryforwards of $112,000 expiring in 1997. Foreign subsidiaries have available reductions of future taxes based on carryforward losses of $784,000 which are available in decreasing amounts through 1987.

A long-term debt agreement requires a minimum working capital level and contains provisions that may limit further borrowings, investments and cash dividends. No retained earnings are available for dividends 12/31/82.

Logit analysis: Probability = 0.42 in full data set; probability = 0.46 in smaller data set.

Selected financial ratios for Company P and a bankrupt company (BR) in a similar business:

	Company P	BR
CA/CL	1.965	1.223
(Cash + STI + Net Rec)/CL	1.229	0.858
(ICO + DDA)/(CL + LTD)	0.062	-0.092
(CL + LTD)/TA	0.510	0.710
(CA - CL)/TA	0.294	0.090
ICO/TA	-0.020	-0.139
(ICO + Inc Tax + Int Exp)/TA	-0.011	-0.055
Net Sales/TA	1.746	1.452
RE/TA	0.229	0.135
CA/Net Sales	0.343	0.338
(CA - CL)/Net Sales	0.169	0.062
CA/TA	0.600	0.491
(Cash + STI)/TA	0.111	0.050
Yrs of operating losses in last 3 yrs	2	3

CA = Current Assets, CL = Current Liabilities, STI = Short Term Investments, ICO = Income from Continuing Operations, DDA = Depletion, Depreciation, and Amortization, LTD = Long Term Debt, RE = Retained Earnings, TA = Total Assets

Management's Discussion and Analysis:

Together with most manufacturing companies, our 1982 sales and earnings were severely affected by the deep recession in the U.S. While the picture was much brighter in Europe, our consolidated results produced the first full-year loss in over a decade. [NOTE: There were two consecutive years of losses from operations, but one was offset by a loss carryforward.]

Demand was weak in most domestic markets. The strengthening of the U.S. dollar against European currencies caused foreign currency sales to be translated into lower dollar amounts.

The reduced volume of sales and resulting excess capacity caused a decrease in profit margins. Cost of sales as a percentage of sales rose during 1982, but overhead and personnel expenses were significantly reduced. These savings have been partially offset by an increase in charges to pre-tax earnings relating to certain doubtful accounts receivable.

Income before taxes in 1982 was favorably affected by a $716,000 gain from the sale of certain excess property. Net income was favorably affected by tax loss carryforwards.

We believe that we are on the right course and that the actions we have taken over the past three years to concentrate our assets and our management efforts on markets with the highest potential will return the company to a satisfactory level of profitability.

In 1982 the workforce was reduced in proportion to the decrease in sales, and substantial reductions were made in the number of salaried employees and in other overhead expenses. Working capital management was stressed. Inventory and accounts receivable were reduced by $9.7 million. Cash balances increased $4.3 million. Internal cash flow was used to finance all needed capital expenditures and acquire an additional manufacturing facility.

As part of long range strategy, a PVC resin plant in West Virginia was closed in 1982. This resin will be obtained from another producer through a long term supply contract. Certain other operations were consolidated. A plant was acquired in Minnesota to expand the core business of plastic and magnetic products. Management will continue to seek opportunities for further acquisitions which fit the corporate mission and meet return on investment goals.

In 1982 we made a major commitment to build the strength of our management organization through classroom instruction in participative management techniques. The goal is to

improve performance and increase productivity. Steps are also being taken to improve communications so that all employees will understand the competitive nature of the environment and that a maximum effort from everyone is necessary in order for the company to prosper. New union contracts were negotiated at four of the manufacturing locations which will have a favorable effect on our ability to remain competitive in the future.

Another component of management strategy is to expand present markets and develop new markets through the application of polymer expertise. Progress was made in this area in 1982.

The economic outlook for 1983 is uncertain. Management anticipates, at best, only a modest recovery in the U.S. and probably not until the second half of the year for basic industrial concerns. Management feels well positioned to participate in any recovery when it occurs. Based on $10 million of unused credit and on anticipated capital expenditure requirements, management considers liquidity to be adequate.

The company has lines of credit aggregating $15,900,000 from various banks, of which $10,000,000 are from U.S. banks. At December 31, 1982 the company had $2,163,000 outstanding from foreign banks under short-term lines of credit. The company has informally agreed with the U.S. banks to maintain compensating balances up to 5% of the line of credit plus up to 5% of borrowings.

Considering the factors listed in SAS 59, what is your prediction as to this company's fate during 1983? What is the likelihood that the company will enter bankruptcy?

Company Identity: Pantasote Inc.

Actual audit opinion: Clean

Post-mortem:

During fiscal 1983 the company had significant increases in sales and continued tight control of expenses, resulting in the the highest profit level in five years. Debt was reduced and the current ratio was improved. The economic climate was improving and the company perceived substantial changes for the better.

CASE STUDY 5 (COMPANY H)

Description of company:

Company H processes sugarbeets into refined sugar and sells sugarbeet seed and byproducts (beet pulp and molasses). Plants are located in Colorado, California, Montana, Wyoming, and Texas.

1984 Financial statements are provided with this case study.

Note the format of the income statement which places other income in the operating revenue section of the income statement. Other income consists primarily of gains on the sales of a closed plant and land. The costs of disposing of unsaleable equipment and lease cancellations are presented below the label "Income before closed operations".

Quarterly cash dividends of 25 cents per share were paid during fiscal 1984 and 1983.

During fiscal 1984, a cane sugar refinery was sold. The proceeds of the sale were essentially offset by disposal costs on non-saleable equipment and lease cancellation charges. Operations had been discontinued there since late fiscal 1982.

Some surplus land was sold in fiscal 1984.

During fiscal 1984, a contract was negotiated to sell the process machinery and equipment at the high fructose corn syrup facility for export. This facility had not operated since December 1981 and was not expected to operate in the future. Operations were deemed uneconomical because of design

problems. During fiscal 1983, carrying value of the machinery and equipment were reduced to estimated salvage value.

A logistic regression model was run on various samples from many different industries to classify companies as bankrupt or nonbankrupt. A rating between 0 and 0.50 classifies a company as bankrupt; a rating between 0.50 and 1.0 indicates nonbankruptcy. In a sample of 200 companies, the model rated Company H at 0.44 (marginal, bankrupt). In a smaller sample of 100 firms, Company H was rated at 0.71 (nonbankrupt). In another grouping of 98 companies, Company H received a rating of 0.04 (bankrupt).

Selected financial ratios for Company H and a bankrupt company (BR) in a similar business:

	Company H	BR
CA/CL	1.143	0.256
(Cash + STI + Net Rec)/CL	0.402	0.089
(ICO + DDA)/(CL + LTD)	0.116	0.187
(CL + LTD)/TA	0.568	1.342
(CA - CL)/TA	0.078	-0.964
ICO/TA	0.032	-0.211
(ICO + Inc Tax + Int Exp)/TA	0.071	-0.057
Net Sales/TA	1.847	1.230
RE/TA	0.346	-0.434
CA/Net Sales	0.336	0.269
(CA - CL)/Net Sales	0.042	-0.784
CA/TA	0.621	0.331
(Cash + STI)/TA	0.010	0.009
Yrs of operating losses in last 3 yrs	1	3

CA = Current Assets, CL = Current Liabilities, STI = Short Term Investments, ICO = Income from Continuing Operations, DDA = Depletion, Depreciation, and Amortization, LTD = Long Term Debt, RE = Retained Earnings, TA = Total Assets

Management's Discussion and Analysis:

Extensive capital improvement projects were in effect at all factories for the 1984 fiscal year. Company H achieved a corporate wide major reduction in unit manufacturing costs, in spite of adverse weather conditions and a shortage of sugarbeet acreage and higher production costs in certain districts.

At two factories, new natural gas contracts were negotiated which avoided fuel cost increases. In areas where the cost of natural gas is considered too high, fuel oil is used as the primary energy source. At two factories, conversions to coal fired boilers are in progress.

New seed varieties for California have increased sugar production per acre by about 15%. About half of the California acreage has been planted with these new varieties. Next year adequate seed supply will be available for all of the California fields. New seed varieties for other areas indicate potential sugar production increases of from 10% to 20%. Growers in these areas should benefit within two years. Research is continuing in seedling transplant technology.

Fiscal 1983 was the last year in which sales prices were adversely impacted by prior management's low-priced long-term sales contracts.

The company has broadened its customer base by targeting the retail segment and small-to-medium size industrial and institutional accounts. Such market areas provide the greatest average net return and are least likely to be impacted by alternative sweeteners.

During fiscal 1984 world sugar prices fluctuated from 5.6 cents to 12.75 cents per pound. At the end of the fiscal year, the price was below 6 cents per pound. Management anticipates that world sugar production will equal or exceed

consumption next year, so it is unlikely that prices will increase significantly.

Management defines liquidity as the ability to generate adequate funds to meet its operating and capital needs. Historically, such funds have been generated from operations, through short-term operating loans from commercial banks, and from private placement of long-term debt. It is management's belief that such sources will remain available and will adequately continue to serve the company's needs. There is available a $60,000,000 secured bank line of credit.

The secured bank line of credit was used only for a short period of time during fiscal 1984. Short-term borrowings from the Federal Commodity Credit Corporation bear interest at varying rates and are collateralized by beet sugar inventories.

Substantial demands on the company's working capital during fiscal 1984 and 1983 were due to the acquisition of outstanding stock.

Favorable weather at the beginning of the fiscal year 1985 permitted an earlier spring harvest and earlier planting of the fall crop. Management predicts an excellent crop with high yields and sugar content. Contracted acreage is about 40% higher than for fiscal 1984.

Considering the factors listed in SAS 59, what is your prediction as to this company's fate during 1985? What is the likelihood that the company will enter bankruptcy?

Company Identity: Holly Sugar Corporation

Audit opinion: Clean

Post-mortem: The company made a profit again in fiscal 1985.

APPENDIX E

CASE DISCUSSIONS

CASE S-1

In looking for negative trends, this expert wanted to study financial ratios over a period of time. In the financial statements was a series of ratios covering a seven-year period. The following paragraphs paraphrase his remarks.

Earnings per share looks a little bit worse than the net income trend because apparently they issued some new shares in 1982, so that while their income in 1982 was up a little bit, their earnings per share seemed to go down a bit. I think, looking at the page of ratios, there is nothing here that would say we have established a new trend in a negative direction. In other words, it's not a pattern of losses and the losses are becoming greater, and a pattern of deteriorating working capital and deteriorating ability to pay debts. So, as far as the negative trends go, I'd rate that about a 1 at most. I don't think that would be that significant for this company.

Now, for other indications of possible financial difficulty, I'm going to pick on a couple of items, and I'm going to rate this perhaps a 6, because here I notice that their inventory turnover ratio has gone way down. That one looks like a significant drop to me. My concern is, are they carrying at this time some inventory that is obsolete to try to keep that ratio from going even further down? That could turn out being a loss they're going to have to take in the near future. Then, another one that kind of disturbs me is

the accounts receivable turnover. Sales divided by receivables - it's been up as high as 5, and about the worst it's been is 3. All of a sudden this year it's down to about 2.2. And so I can see that sales have gone down a little bit, and that's going to make this ratio smaller, but still, that raises a question in my mind under other indications of financial difficulty, do they have receivables on the books that they're not likely to collect? Are they keeping receivables on the books instead of writing them off as they should? In other words, there is a risk that this company may be trying to mitigate this negative part by not writing off some of these receivables they should be writing off. [After examining a note to the financial statements pertaining to notes receivable and accounts receivable, the expert noted that the make-up of their sales is changing. "Okay, that satisfies me on that one then."] Sc, on other indications of possible financial difficulties, I'd downgrade that to maybe a 4, based on inventory considerations.

On internal matters, we don't have any information provided here. [When asked about possible substantial dependence on a project as related to the delay in getting the new disk model to market and also the scrapping of the mainframe computer project, he stated a belief that there is not enough information to try to project that into the future. After looking at the percentage breakdown of sales by products, he stated that the percentages do not indicate

dependence on a particular project; although if the new disks had been further delayed, the company could have been hurt.] So on internal matters, I would say I don't see a particular reason for alarm at this point.

For external matters, this one is where I would look at competitive circumstances. Is IBM leaving a niche open where they can adapt to regain some disk drive sales in the future or has IBM's new disk drive effectively closed the market to outside vendors? We don't have that information here. I'd have to talk to management about that. This is where an auditor would have an advantage over a financial analyst. Given the information we have, I'm going to have to call this one about a 2.

Considering all of these taken together, I would say that the company would not merit a going concern consideration. They would not be viewed as having a questionable ability to continue for another twelve months. On a scale of -1 to -10, the overall consideration would be about -6. [Negative beliefs (disbeliefs) are represented on a scale of negative numbers.]

SIGNIFICANCE RATINGS (S-1)

CONDITIONS AND EVENTS [Model trace on CONTRARY-INFO]

Negative Trends:

Overall 1 cf -50

Internal Matters:

None significant cf -50 cum cf -75

External Matters:

Other 2 cf -50 cum cf -88

Other Indications:

Other 4 cf 20 cum cf -85

Aggregate Effect:

Not harmful (-6) cf -50 cum cf -93

Expert's assessment of likelihood of bankruptcy at this point: 10%

When this expert's ratings were input to the model, it delivered a certainty of 93 that there is no information contrary to the going concern assumption.

MANAGEMENT PLANS

The expert sees no need to consider management's plans, since he sees no major problems. He would not disclose any of these problems in his auditor's report. "The only time I would disclose some of this would be if I were writing up a going concern paragraph."

When asked to state his certainty of belief in nonbankruptcy, the expert expressed it as 90.

The model predicted nonbankruptcy with a certainty of 90, which coincides exactly with the expert's estimate. This prediction by the model stems directly from the rule pertaining to the lower right cell of Table 3.3, where there are no significant unfavorable conditions and events and no management plans for dealing with problems. The certainty of 93 referred to above with respect to lack of information contrary to the going concern assumption can be converted to a certainty of -93 that there is such information. That is, there is a certainty of -93 of unfavorable conditions and events. The pertinent rule derived from Table 3.3 states that if the certainty of contrary information is less than 0, then there is a certainty of 90 that failure is not likely.

CASE S-2

Expert #2 contends that in this particular case, we don't have recurring operating losses. The company doesn't appear to have much of anything that is really a negative trend. For a computer-related company, the amount of their borrowing is not out of line at all. He sees this as a case of just being one bad year. Having a lot of projects in the works and being late is not unusual for this type of company. Ratings on items are shown below.

Management plans were considered difficult to evaluate. If we were considering a time frame of longer than one year, this expert would be more cautious in his statements, but he sees very little probability of bankruptcy within the next twelve months.

He would not disclose any problems in his audit report. It is his belief that attitude toward disclosure depends on the auditor's age and training. He believes that older auditors need an overwhelming amount of evidence of problems before they will qualify an opinion. He would be concerned about a qualified report on this company becoming a self-fulfilling prophecy.

SIGNIFICANCE RATINGS (S-2)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

None significant cf -50

Internal Matters:

Substantial dependence on a project 3

cf 15 cum cf -41

External Matters:

Legal proceedings 2

Loss of key franchise or license 2

cf -50 cum cf -71

Other Indications:

Denial of usual trade credit 1
(based on restrictions) cf -50 cum cf -86

Aggregate Effect:

Not harmful (-8) cf -50 cum cf -93

Likelihood of nonbankruptcy at this point: 90%

The model computed a certainty of 93 of lack of contrary information based on this expert's ratings.

MANAGEMENT PLANS

More borrowing may be possible, and some assets can be leased. The expert's assessment of nonbankruptcy remains at 90%.

The model computes a certainty of 90 for nonfailure.

CASE S-3

The comments of Expert #3 regarding Company S are paraphrased in the following paragraphs.

I would say this company has plenty of room for another year to try and get their new products off the ground. They have unused borrowing capacity, so they should be able to keep the creditors at bay for enough time to find out if they new products are going to work. If they don't, they're in trouble.

They have a heavy R&D effort. These companies are good from year to year. They look like they can scramble for a year. I would give them a clean opinion. Some new event would have to occur that was not necessarily predictable. A one-year loss in a high-tech company like that is quite typical. They had a bad year. That's not a trend. The loss does not concern me at all, but on the other hand, they could be put out of business in one month if a competitor comes out with a new product that makes theirs obsolete. This company has an obsolete product. An auditor can't predict whether their new products will be successful.

This company has $40 million in cash. Accrual losses, I think, are a long term predictor. If you have losses for a couple of years and expect to continue having them, at some point you're going to run out of money. Cash is a much more immediate indicator of a problem right now, and somebody has

created $40 million in cash. They can hardly be called a sick company, at least in the short term.

SIGNIFICANCE RATINGS (S-3)

CONDITIONS AND EVENTS [Model trace on CONTRARY-INFO]

Negative Trends:

None significant cf -50

Internal Matters:

Substantial dependence on a particular project 7

Need to revise operations 5
cf 35 cum cf -23

External Matters:

Loss of a principal customer or supplier 4
cf 20 cum cf -4

Other Indications:

None significant cf -50 cum cf -52

Aggregate Effect:

Not harmful (-8) cf -50 cum cf -76

Expert's assessment of likelihood of bankruptcy at this point: 20% (Using classical probability then, the probability of success is 80%)

Using these ratings the expert system delivered a certainty of 76 that there is no information contrary to the going concern assumption.

MANAGEMENT PLANS

None were marked as significant, but after some discussion the expert revised his estimate of bankruptcy downward to 15%. He would not disclose the problems in his audit report, but if they were disclosed, he believes that the probability of bankruptcy might increase by 10%, but only if it reflected information that was not obvious in the financial statements.

The model predicted nonbankruptcy with a certainty of 90. In view of the approximation of conditional probabilities to certainties, this compares favorably with the expert's final assessment of an 85% likelihood of nonbankruptcy.

CASE S-6

I think there is no immediate threat to this company. They may have some rough going, and it depends on whether they will be able to develop replacement products for the ones that seem to have slipped in the marketplace. There also is some exposure in the inventory. I assume that the inventory is not in excess of net realizable value. Inventory is up. There's a great deal in working process. I would need to know about the nature and length of the manufacturing process in order to get more comfortable with why there is so much in working process inventory. That just could be a soft spot. As an auditor, I would want to probe that.

But cash flow from operations was positive. There is no indication of any capital expenditure commitment. If operations the following year don't deteriorate terribly, they have enough room to pay the debt that is required to be repaid the following year. And there is credit available. They are under no imminent cash squeeze. So, unless their product lines really die and they have problems disposing of the inventory that they have, it seems to me that they could react to the shrinking of their sales base by reducing their sales force and doing other things. I would not worry about this company this year.

SIGNIFICANCE RATINGS (S-6)

CONDITIONS AND EVENTS [Model trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 5

Adverse ratios 5 (inventory)

cf 25

Internal Matters:

Substantial dependence on a particular project 7

Uneconomic long-term commitments 1

Need to revise operations 10
(new product development)

cf 50 cum cf 63

External Matters:

None significant cf -50 cum cf 26

Other Indications:

None significant cf -50 cum cf -32

Aggregate Effect:

Harmful 2 cf -50 cum cf -66

Expert's assessment of likelihood of bankruptcy at this point: 10%

The model predicted nonbankruptcy with a certainty of 90.

CASE E-1

The following paragraphs paraphrase the first expert's remarks about company E.

"This company is a basket case." Looking at negative trends, they have all of them. Recurring operating losses - they have two consecutive years of losses and anticipate a third. So this is a moderately significant trend. But the working capital deficiencies - I'd say that's a really significicant problem. And their negative cash flow is a really bad problem. Their adverse ratios are a bad problem.

Now, internal matters - there's no indication of labor difficulties. There is, it appears, still some dependence on a particular project. There is an indication that they are trying to diversify, but that one is hard to evaluate. There is no indication that they can diversify. There is no indication of long-term commitments, but the need to revise operations - obviously they're going the wrong direction. They have to do something.

Legal proceedings - I think it's very significant that they already have some creditors who are getting on their case. There is an indication here that they are in default on their loans and that if somebody does get on them that they have to replace it with somebody else, and that probably the only reason a whole bunch of people haven't sued them is because they figure this is a turnip, and you can't get blood

out of a turnip. The rest of this [external matters] there's no indication of these problems.

But for other indications of financial difficulties, apparently they are in default on some of their debt agreements. I'm going to call that a real problem. And denial of usual trade credit - this is a real one. Apparently from reading through this, there are a number of lenders that are just cutting off their water. There are no dividends in arrears that I can tell. And other indications - of course, they need to restructure their debt and they need new financing, but I'm not in a position to evaluate these with the information given. So for other indications of financial difficulties, I'd say the default and denial of trade credit are the really big ones. So at this point, I'd say their probability of bankruptcy is probably .9.

In considering management's plans, based on the information given here, if they try to dispose of assets, most of the assets are pledged as collateral. That is a restriction on disposal - probably a 7 or 8. Marketability of assets we don't know anything about, but benefit derived, I'm going to put about an 8, because any money derived from the sale would probably just go to pay off the loan associated with the asset. [In the model, this goes as -8, since this is a nonbenefit.]

Plans to borrow money or restructure debt - on this one, I'm going to put a 7 on sufficient collateral - they don't

have any. In your terms [for the model] that's a negative. If all of their assets are already pledged for debt, they can't gain anything by restructuring. Availability of financing - I would really question that. It would take strong evidence to convince me that they could get any money.

And plans for reducing or delaying expenditures - they've already done this. You get to the question of how much more is feasible.

On plans to increase ownership equity, the authorized but unissued shares available, I don't consider significant. That is simply a matter of corporate charter. You can amend the charter and come up with more shares that can be issued if you think it will help. The real question is the next one: could the shares be sold. If somebody looks at this company, I don't think the shares can be sold. Dividends can't be reduced, obviously, because they haven't paid any. Can cash inflow be accelerated? I'd have to have more specific information from management.

On the aggregate effect of management's plans, I don't see how they could have any plans that would help that much. I'd put that at -7. And likelihood of bankruptcy, I'm still going to say 90%.

I would disclose this in the audit report. I don't think this would have any effect on the probability of bankruptcy because I think a financial analyst would look at this stuff and know that this company is bad. So I don't think the

auditor saying something is going to make any difference in someone's assessment.

SIGNIFICANCE RATINGS (E-1)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 6

Working capital deficiency 8

Negative cash flows 8

Adverse ratios 8 cf 40

Internal Matters:

Substantial dependence on a project 6

Need to revise operations 7

cf 35 cum cf 61

External Matters:

Legal proceedings 8 cf 40 cum cf

Other Indications:

Default on loan 8

Denial of usual trade credit 9

cf 45 cum cf 87

Aggregate events 8 cf 40 cum cf 92

MANAGEMENT PLANS [Model trace on MITIGATING-FACTORS]

Plans to Dispose of Assets:

Restrictions on disposal 8

Benefit derived -8 cf -50

Plans to Borrow or Restructure:

Availability of financing -6

Sufficient collateral -7 cf -50 cum cf -75

Plans to reduce or delay expenditures:

None significant cf -50 cum cf -88

Plans to increase ownership equity:

None significant cf -50 cum cf -94

Aggregate effect: -7 cf -50 cum cf -97

The model produced a verdict of FAILURE-LIKELY with a certainty of 90.

CASE E-2

In considering Company E, Expert #2 expressed concern that losses could go from $5.2 million to $7.6 million while sales were increasing by 55%. He also questioned the accrued expense figure of $5.2 million.

On internal matters, substantial dependence on a particular product and the need to revise operations were considered problem areas. These were the same two items mentioned by Expert #1, with slightly different ratings. None of the external matters was considered significant. This is in contrast to Expert #1, who rated legal proceedings at 8.

As far as other indications of financial difficulties, Expert #2 rated default on loan and noncompliance with statutory capital requirements as significant. The ratings were lower than those given by Expert #1. Both experts agreed on the significance of the aggregate effect, giving it a rating of 8. Expert #2 gave an estimated likelihood of 89% of bankruptcy, compared with 90% by Expert #1.

When Expert #2 began to consider management's plans, he professed to have a real problem, because he couldn't see any plans. Mention is made of restructuring debt, lowering sales volume, reducing the work force, and switching to higher margin products. But these are nebulous terms. An auditor would need to talk to management to get more specific

information in order to evaluate possible effectiveness of the plans.

The expert concluded by saying he did not see much hope for Company E. They are in default and have used all their available credit. They don't have any source of money. They are in a very competitive industry, and such a company must have something going for it, or they're going to get hurt. "I'd say 89 chances out of a hundred, they're going to go under."

SIGNIFICANCE RATINGS (E-2)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 4

Working capital deficiency 5

Negative cash flows 6

Adverse ratios 6

Other 5 cf 30

Internal Matters:

Substantial dependence on a project 8

Need to revise operations 6 cf 40 cum cf 58

External Matters:

None significant cf -50 cum cf 16

Other Indications:

Default on loan 4

Noncompliance with capital requirements 4

cf 20 cum cf 33

Aggregate events 8 cf 40 cum cf 60

MANAGEMENT PLANS [Model trace on MITIGATING-FACTORS]

Plans to Dispose of Assets:

None significant cf -50

Plans to Borrow or Restructure:

None significant cf -50 cum cf -75

Plans to reduce or delay expenditures:

None significant cf -50 cum cf -88

Plans to increase ownership equity:

None significant cf -50 cum cf -94

Aggregate effect: -10 cf -50 cum cf -97

The model produced a verdict of FAILURE-LIKELY with a certainty of 80

CASE E-3

Expert #3 states that this company has problems. They have to pull a rabbit out of the hat or they're done. The likelihood of that happening in a one-product industry is slim. "I think I would qualify my opinion on these guys."

SIGNIFICANCE RATINGS (E-3)

CONDITIONS AND EVENTS [Model trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 7

Working capital deficiencies 8

Negative cash flows 8

Adverse ratios 7

Other 8 cf 40

Internal Matters:

Need to revise operations 7 cf 35 cum cf 61

External Matters:

None significant cf -50 cum cf 22

Other Indications:

Default on loan 10

Need to seek new financing 10
Need to dispose of substantial assets 10
cf 50 cum cf 61

Aggregate Effect:

Harmful 9 cf 45 cum cf 79

Expert's assessment of likelihood of bankruptcy at this point: 90%

MANAGEMENT PLANS [Model trace on MITIGATING-FACTORS]

Plans to dispose of assets:

Restrictions on disposal -1

Marketability of assets -1

Benefit derived -1 cf -50

Plans to borrow or restructure:

Financing available -9

Restructuring possible -9

Existing restrictions 9

Sufficient collateral -9 cf -50 cum cf -75

Plans to reduce or delay expenditures:

Reduce overhead -2

Postpone certain items 2

Lease some assets -2

Benefit derived -2 cf -50 cum cf -88

Plans to increase ownership equity:

Authorized but unissued shares 2

New shares marketable -2 cf -50 cum cf -94

Aggregate effect:

Not beneficial (-8) cf -50 cum cf -97

Estimated likelihood of bankruptcy is still 90%. Problems would be disclosed on the audit report. It is believed that this disclosure would have no effect on the probability of bankruptcy.

The model predicted bankruptcy with a certainty of 80 based on this expert's ratings.

CASE E-4

Right off, when I see equipment for making floppy disks - that market has gone to the devil. Recurring losses are definitely present. There have been two years of them and they're getting larger. The problem with this, too, is that these are inter-related. If it were recurring losses but the others weren't present, that would be helpful. But in this case, they've got all of them. They have working capital deficiencies and negative cash flows, large ones. They have $1 million provided by operations in 1987, but it was more than offset by financing. It's been negative for two years and breakeven at best in 1985, so we've got what looks like an accelerating trend of negative cash flows. The ratios are definitely adverse. In most cases, they're worse than the ratios of the comparable bankrupt company, virtually all the way down.

At least half of their projects are in a business that is going down the tubes. The other is connected with government contracts. Their contract with the post office terminates in June of 1988. That's apparently the only business they've got that's worth anything. The need to revise operations is very important. . . . There are some legal proceedings, but they don't seem to be particularly troublesome. . . . Loss of a principal customer is severe. The contract with the post office is the only thing they've got that's profitable.

They are in default on loans. That's not good. Dividends in arrears is no problem. Denial of usual trade credit is present. They need to restructure debt. They are not in noncompliance. They definitely need new financing. They can't dispose of substantial assets - they don't seem to have any.

The aggregate effect is in the upper area of the harmful range. I would say that bankruptcy is pretty likely. At this point, I would not be willing to say, unless management can convince me otherwise, that they can continue in business for at least a year.

Among the things I would ask management, one of the most critical is, what are the chances of landing another post office contract? Number two, how far along are they in the equipment to manufacture 3-1/2 inch disks? Number three and probably one of the most important, what about the noncompliance with loan agreements? The banks can call these loans at any time, then what do they do?

Management has no plans to dispose of assets. They plan to move out of their office, but that's leased. . . . Plans to borrow money - now this is critical. The financing apparently is not available. That right now is the most significant thing. Restructuring possible - it doesn't look like it. That's very significant. Obviously they do not have sufficient collateral.

Overhead can probably be reduced, but I don't think that's going to be highly significant. Certain items can probably be postponed, but again, the significance is marginal. Some benefit can be derived, but the significance is low because they're not going to be around to get it.

They can always authorize more shares, but the significance is minimal because they can't sell them.

The aggregate effect of plans is marginally helpful. I still say bankruptcy is 80% possible. I would disclose the problems. Anybody reading those statements should see the likelihood of bankruptcy.

SIGNIFICANCE RATINGS (E-4)

CONDITIONS AND EVENTS [Model trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 7

Working capital deficiencies 8

Negative cash flows 8

Adverse ratios 9 cf 45

Internal Matters:

Substantial dependence on a project 5

Need to revise operations 8 cf 40 cum cf 67

External Matters:

Legal proceedings 5

Loss of a principal customer 9 cf 45 cum cf 82

Other Indications:

Default on loan 8

Denial of usual trade credit 8

Restructuring of debt 5

Noncompliance with capital requirements 8

Need to seek new financing 8 cf 40 cum cf 89

Aggregate Effect:

Harmful 8 cf 40 cum cf 93

MANAGEMENT PLANS [Model trace on MITIGATING-FACTORS]

Plans to dispose of assets:

None significant cf -50

Plans to borrow or restructure:

Financing available -10

Restructuring possible -10

Existing restrictions 2

Sufficient collateral -8 cf -50 cum cf -75

Plans to reduce or delay expenditures:

Reduce overhead 3

Postpone certain items 3

Lease some assets -3

Benefit derived 3 cf 15 cum cf -71

Plans to increase ownership equity:

Authorized but unissued shares 2

New shares marketable -8

Dividends can be reduced -2

Cash inflow can be accelerated 2
cf -50 cum cf -86

Aggregate effect: 2 cf -50 cum cf -93

The model predicted bankruptcy with a certainty of 90.

CASE E-5

Uh-oh! Floppy disks!

Things don't look good on the ratios. . . . They're not in compliance with AMEX requirements. . . This is just all bad and getting worse. They have recurring losses and the losses are huge. They have every problem in the world. Labor will be a problem if they can't pay their help.

They need to revise operations or do something. They need to try to restructure debt. I don't think they have any assets they can get rid of.

Bankruptcy is likely.

Diversifying products requires creativity. The 10% pay cut will cause discontent. . . I don't think they're going to be able to get any more financing. It looks like they've already reduced what they can. Shares are available, but who would buy them? In the aggregate, the plans are not that helpful. I'm really pessimistic about these guys. Bankruptcy is pretty likely.

SIGNIFICANCE RATINGS (E-5)

CONDITIONS AND EVENTS [Model trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 8

Working capital deficiencies 10

Negative cash flows 10

Adverse ratios 5 cf 50

Internal Matters:

Substantial dependence on a project 10

Uneconomic long-term commitments 8

Need to revise operations 10 cf 50 cum cf 75

External Matters:

Legislation (AMEX) 10

Loss of a principal customer 1 cf 50 cum cf 88

Other Indications:

Default on loan 10

Denial of usual trade credit 10

Restructuring of debt 10

Noncompliance with capital requirements 10

Need to dispose of substantial assets 5

cf 50 cum cf 94

Aggregate Effect:

Harmful 10 cf 50 cum cf 97

MANAGEMENT PLANS [Model trace on MITIGATING-FACTORS]

Plans to dispose of assets:

Benefit derived -1 cf -50

Plans to borrow or restructure:

Financing available -10

Restructuring possible 10 cf 50 cum cf 0

Plans to reduce or delay expenditures:

Reduce overhead -10

Postpone certain items -8

Lease some assets -1

Benefit derived -8 cf -50 cum cf -75

Plans to increase ownership equity:

Authorized but unissued shares -8

New shares marketable -10

Dividends can be reduced -1

Cash inflow can be accelerated -10

cf -50 cum cf -88

Aggregate effect: -7 cf -50 cum cf -94

The model predicted bankruptcy with a certainty of 90.

The auditor would disclose the problems

CASE O-1

The following paragraphs paraphrase the expert's remarks about company O.

As far as negative trends go, they don't have any. From the description of the case, they are dependent on a particular product. There is no indication of labor difficulties or uneconomic long-term commitments, and there is no indication for a need to revise operations, so for internal matters, my only possible concern would be that they derive substantially all of their revenue from one product. So, if that one product went bad, then they could have problems, but there is no indication that this will happen. As far as external matters, there is no indication of any problems. They are obviously not in default; dividends are not in arrears; there is no denial of credit. They have no apparent need to restructure debt or seek new financing or dispose of assets, so I see no problems there.

So the likelihood of bankruptcy at this point, I would say, is .05 or less. Then, if we look at management plans to avoid bankruptcy, since their probability of bankruptcy is so small, these plans are not necessary. This part of SAS 59 assumes that they have a problem. Here, there is no indication that the company has a problem, so we don't need to consider management's plans.

[This expert stated that if an auditor's overall perception as he performs the audit is that this company is

very healthy, he will not explicitly address the factors mentioned in SAS 59 unless he wants to list them for documentation purposes. Since the going concern judgment is subjective, the auditor would probably just write down his observation that the company is obviously in good health. He might want to mention the dependence on one product. But there would be no need to go through the entire model.]

SIGNIFICANCE RATINGS (0-1)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

None significant cf -50

Internal Matters:

Substantial dependence on a project 7
cf 35 cum cf -23

External Matters:

None significant cf -50 cum cf -62

Other Indications:

None significant cf -50 cum cf -81

Aggregate events -8 cf -50 cum cf -91

The model predicted "nonbankrupt" with a certainty of 90.

CASE O-2

Comments of Expert #2 with respect to Company O are paraphrased in the following paragraphs.

What are the geographical sales territories of this manufacturer? The condition of real estate markets and housing in general may have a bearing on the prosperity of such a company. An auditor's analysis would depend on the condition of the market in his area.

With this one, I don't see any negative trends. I think an analysis of the housing market would show there is a much stronger growth in modular housing than in single-family dwellings just because of the dollar values.

They look like they've got plenty of money. It doesn't look like they've got any debt. It appears from the ratios that they're in a good strong position. I really don't see any problems at this time that would cause me to do an analysis. With a good strong company, an auditor wouldn't even look at SAS 59. [This was an echo of the sentiments of Expert #1 on this case.]

I don't think there is a possibility in the world this company can go bankrupt during the next year. They would have to do some awful stuff, and then it would take more than one year.

When the model is processed with all items given a significance rating of zero, the cumulative certainty of CONTRARY-INFO is -97, and the certainty of nonfailure is 90.

CASE O-3

Expert #3 says "This is a nice little company." It would take a major catastrophe to cause problems. Since there are no problems, consideration of management plans is not applicable. [No items were rated, since no problems were perceived.]

As with Expert #2, the model predicted nonbankruptcy with a certainty of 90.

CASE P-1

The following paragraphs paraphrase the first expert's remarks about company P.

I don't feel that they have a problem with working capital deficiencies or negative cash flows or adverse ratios. The operating losses are a little disturbing.

On uneconomic long-term commitments, there may be a potential problem here in that there is this long-term debt agreement which could limit further borrowings - that is a little bit troublesome.

On external matters, legislation or legal proceedings could be a problem for this company because they are associated with PVC products which the environmentalists get on from time to time.

My feeling is that the aggregate effect of conditions and events is harmful, I would say about 2. But bankruptcy is not too likely.

I would look at management's plans. The fact that financing is available is significant, and existing restrictions may be significant. The company has already reduced some overhead. The big thing for management is that they do have a line of credit available. The aggregate effect of management plans, I would say, is helpful.

I would say bankruptcy is not likely. So I would not disclose the problems. If disclosed, I think the bankruptcy probability would be increased. An analyst would think the

restrictions on borrowing would more than offset the line of credit, or think "the auditor knows something I don't know." Probability of bankruptcy would be 30% or less. It would become 50%, I think, if we disclosed problems.

SIGNIFICANCE RATINGS (P-1)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 7 cf 35

Internal Matters:

Uneconomic long-term commitments 7

cf 35 cum cf 58

External Matters:

Legislation 6 cf 30 cum cf 71

Other Indications:

None significant cf -50 cum cf 42

Aggregate events 2 cf -50 cum cf -14

The model produced a verdict of FAILURE-LIKELY with a certainty of -90, which translates to a certainty of 90 for nonfailure

CASE P-4

This company does have a rather large loss for 1982. And the trend of income is down, but 1982 was the first net loss. I didn't see an explanation about the restrictions on borrowing. Based on what's here, I don't see that the firm should have difficulty staying in business for one more year.

Recurring operating losses - I would say that is insignificant since there has not been a large history of it. They don't have a working capital deficiency. Negative cash flow - that is a concern, but not bad. Adverse ratios are not really that significant.

Uneconomic long-term commitments - their leases are actually very minimal. Need to revise operations - they have closed a plant. They have foreign earnings. I didn't notice anything in external matters. They have unused credit lines.

I, as the auditor, would have no problems signing an audit statement without including a going concern opinion. I would not be looking in detail at management plans.

SIGNIFICANCE RATINGS (P-4)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 2

Negative cash flows 3

Adverse ratios 3 cf 15

Internal Matters:

Uneconomic long-term commitments 3

cf 15 cum cf 58

External Matters:

None significant cf -50 cum cf -31

Other Indications:

None significant cf -50 cum cf -66

Aggregate events -5 cf -50 cum cf -83

The model produced a verdict of FAILURE-LIKELY with a certainty of -90, which translates to a certainty of 90 for nonfailure.

CASE P-6

I really don't see any problems that are significant. Their business is off, but absent any indicator that this is chronic, I think they have the wherewithal to get through it. They seem to be a lot less susceptible than Company S to the "big bang."

If management cannot refit the level of the organization to the new level of sales, they need to demonstrate that the downturn is cyclical and that they can ride it out. They have a fairly broad-based manufacturing operation, a number of markets, a number of products, and apparently a number of customers in different industries. The year 1982 was a bad year in some parts of the country. They had adequate financial resources, and they sound like they're doing the right things in terms of shrinking their work force and getting their overhead in line.

SIGNIFICANCE RATINGS (P-6)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 7

Working capital deficiencies 2

Negative cash flows 2

Adverse ratios 1 cf 35

Internal Matters:

Labor difficulties 1

Substantial dependence on a project 1

Uneconomic long-term commitments 1

Need to revise operations 5 cf 25 cum cf 51

External Matters:

Legal proceedings 1

Legislation 1

Loss of key franchise or license 1

Loss of principal customer/supplier 1

Underinsured catastrophe 1 cf -50 cum cf 2

Other Indications:

None significant cf -50 cum cf -49

Aggregate events -5 cf -50 cum cf -75

The model produced a verdict of FAILURE-LIKELY with a certainty of -90, which translates to a certainty of 90 for nonfailure. The expert assessed a likelihood of 10% for failure.

CASE H-1

That's a terrible income figure. They also seem to be very, very low on cash. Recurring operating losses - I'm going to say that has turned around. That is not a problem.

I'm going to say they are dependent on a particular project - sugar, very, very heavily. No matter what the product, that is significant.

I'm having trouble with deferred tax benefits and prepaid expenses - that is such a large part of current assets. Their inventories have been going up a little bit for things like raw materials and stock in process.

They're counting some things here as current assets that maybe should be down here under other assets. Their cash and temporary investments seem low, and some of this, particularly deferred tax benefits, although it's not that great, but I question how much of that should go under current assets. Their inventories, I'd like to see their inventory turnover ratio. Let's see, . . . 8 times a year, that's not bad.

Now, here's something that's also disturbing. Other income, which includes gains on fixed assets sales, that accounts for the great bulk of their net income. When you have gains on fixed asset sales, this is something that is not necessarily recurring. In other words, they include that gain this year. Now it's partially offset by closed plant expenses. As an auditor, I would question whether they

should put this $8.8 million up here in the revenue section. My inclination would be that it ought to go down here under what we would call other income and loss. I'd put it down here next to the closed plant expenditures. What that would do, it would pull this income, this operating figure down, because to my mind, that's not really operating income. And so that one kind of disturbs me the way they're presenting this. I would certainly not put that up here with sales. It would be much better accounting practice, I think, to put it in the other section. The auditor should suggest that. This should be questioned very heavily on grounds of disclosure. I think that is not proper disclosure. When you say the financial statements are presented fairly, they are supposed to be presented in a form which aids the user's understanding, and I view this format as misleading. If someone just looks at this income before closed plant expenses, they're going to say, "Hot dog, look at what they did on just a very modest increase in sales," and they really didn't do all that hot. Now, if you look at the earlier years, they're not doing all that hot on similar sales volume. So I think when you rearrange that, that indicates a problem.

This skews all ratios which are based on operating income. They're not looking that great compared to a bankrupt company, but then when you figure that income from operations number is puffed up, that would make them even

worse. And over here, income as a percentage of total assets, that's going to drop down a bit.

Based on the aggregate conditions and events, I would say they're harmful on a significance of about 3. And I'm going to go ahead and state that I view this as misleading. That causes me to question the integrity of management, which causes me to question the reliability of this financial data, which causes me to think that the ratios may be worse than what they say they are.

I would say that bankruptcy is perhaps 30% probable.

Management doesn't see any problems, apparently. I would not disclose the problems, but if I did, I think the probability of bankruptcy would be increased to about 50-60%. If the auditor discloses when there's no apparent problem, then I think people are going to react much, much more strongly than if the auditor discloses when there is an obvious problem.

SIGNIFICANCE RATINGS (H-1)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

None significant cf -50

Internal Matters:

Substantial dependence on a project 4

cf 20 cum cf -38

External Matters:

None significant cf -50 cum cf -69

Other Indications:

Misleading form of statements 10

cf -50 cum cf -85

Aggregate events 3 cf 15 cum cf -82

The model predicted nonbankruptcy with a certainty of 90.

CASE H-4

I wonder what could have caused such a big difference [in the probabilities from the logit model.] There must have been substantial differences in the nature of the companies involved.

Obviously, with respect to negative trends, 1982 was a bad year and 1983 was worse. But 1984, they had positive income, but most of that can be attributed to their gains on the sale of fixed assets which is really not going to be helpful to them in the long run. Even then, they would still have roughly a million dollars of income if you eliminated that. So they've come well back from the problem they had in 1982 and 1983.

They've had recurring operating losses, but it appears that that has ended. They don't have a working capital deficiency. Current assets to current liabilities is still better than 1 to 1, so I don't consider that to be troublesome. They didn't have negative cash flows this year. They had decreases to working capital again in 1982 and 1983, but not in 1984. But again, if you take that gain on the sale off, it could have been negative that year too.

I would rather see that not be done [putting the gain on the upper part of the financial statement.] As long as it's not very big, it doesn't hurt anything, but it was pretty substantial in 1984. I think so long as what they're talking about is sales of property in the normal course of business

(like they replace a machine and they get something for it) that is really operating. But when they start talking about closing whole plants, then that gets to be something else.

Negative cash flows, I'm going to rate that a 3, but primarily because of what it was prior to this most recent year. I really don't see anything unfavorable in the ratios. I'd like to see a little higher current ratio. They're dependent on a particular product, sugar, which in itself is a problem because those companies have had serious problems.

Leases don't seem to be out of line. . . I didn't like to see that litigation pending. Fifty-five million would do them in. . . They're not in default and dividends are not in arrears.

The loans are secured by refined beet sugar inventory. All you have to do to pay them is let them have the sugar. So notes payable does not seem to be a problem. Financing is not a problem.

Based on the assertion that we're talking about its ability to be in business one year later, I have no problem at all giving them a statement without any reservations.

One of the things I would be aware of is the condition of the sugar beet industry. In this case, it was not difficult to make the decision, because the company is definitely sound enough to last another year, and that's what SAS 59 is gearing to. There has been a severe problem with the sugar industry and it's been going on since the 1970s. There are

too many countries producing a large amount of sugar. If I could foresee that the market, as poor as it is, was going to get substantially worse, I would be concerned. On the other hand, how does this particular firm compare to other firms in that industry? That's another important thing. If they are much better off than the others and the others go out of business, then these people are helped.

SIGNIFICANCE RATINGS H-4)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 2

Working capital deficiencies 2

Negative cash flows 3

Adverse ratios 2 cf 15

Internal Matters:

None rated significant cf -50 cum cf -41

External Matters:

Legal proceedings 4 cf 20 cum cf -26

Other Indications:

None significant cf -50 cum cf -63

Aggregate events -10 cf -50 cum cf -82

The model predicted nonbankruptcy with a certainty of 90.

CASE H-5

Inventories are up substantially. . . They've explained why they had those losses. There is a decrease in cash and receivables.

Does substantial dependence on a project relate to sugar? . . . The IRS has some questions on their returns.

I think they're okay. I don't see any problem for the next 12 months. I don't see bankruptcy happening. I would not analyze management's plans.

SIGNIFICANCE RATINGS (H-5)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses	1		
Working capital deficiencies	1		
Negative cash flows	6		
Adverse ratios	4	cf 30	
Internal Matters:			
None rated significant		cf -50	cum cf -29
External Matters:			
Legal proceedings	8	cf 40	cum cf 15
Other Indications:			
None significant		cf -50	cum cf -41
Aggregate events	-5	cf -50	cum cf -71

The model predicted nonbankruptcy with a certainty of 90.

CASE H-6

This is a strange one. This is a company that has virtually no debt and lots of hard assets, but they have no permanent type financing on them. . . . The only red light that goes off is this $11 million of raw materials and stock in process, which at the end of its natural business year shouldn't be there. So I would wonder why they have so much. The litigation mentioned here is somewhat troublesome. The $55 million is somewhat of an exposure.

But offhand, I don't see anything in their financial condition or in their historical operation which would get me to a qualification.

The worry here is what goes on in the world-wide commodity markets and the way prices swing up and down. An individual supplier in the U.S. doesn't have a whole lot of control over his destiny in some cases. That's what kicked my probability up to a .2. But this company is very strong financially and could withstand lots.

SIGNIFICANCE RATINGS (H-6)

CONDITIONS AND EVENTS [Model Trace on CONTRARY-INFO]

Negative Trends:

Recurring operating losses 1

Working capital deficiencies 1

Negative cash flows 1

Adverse ratios 1 cf -50

Internal Matters:

Labor difficulties 1

Substantial dependence on a product 7

Uneconomic long-term commitments 1

Need to revise operations 1 cf 35 cum cf -23

External Matters:

Legal proceedings 7

Legislation 1

Loss of key franchise or license 1

Loss of principal customer/supplier 1

Other (Worldwide commodity markets) 7

cf 35 cum cf 16

Other Indications:

None significant cf -50 cum cf -40

Aggregate events Harmful 5 cf 25 cum cf -20
(Principally external market factors)

The expert's prediction of bankruptcy is 20% (80% for nonfailure)

The model predicted nonbankruptcy with a certainty of 90.

APPENDIX F

RULE BASE

Rule Group COMPANY-RULES

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RULE001 [COMPANY-RULES]
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IF: CERTAINTY CONTRARY-INFO >= 80
  AND CERTAINTY MITIGATING-FACTORS >= 80
THEN: FAILURE-LIKELY CF 21


RULE002 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 80
  AND CERTAINTY MITIGATING-FACTORS >= 50
  AND CERTAINTY MITIGATING-FACTORS < 80
THEN: FAILURE-LIKELY CF 50


RULE003 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 80
  AND CERTAINTY MITIGATING-FACTORS >= 0
  AND CERTAINTY MITIGATING-FACTORS < 50
THEN: FAILURE-LIKELY CF 85


RULE004 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 80
  AND CERTAINTY MITIGATING-FACTORS < 0
THEN: FAILURE-LIKELY CF 90


RULE005 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 50
  AND CERTAINTY CONTRARY-INFO < 80
  AND CERTAINTY MITIGATING-FACTORS >= 80
THEN: ! FAILURE-LIKELY CF 85

RULE006 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 50
  AND CERTAINTY CONTRARY-INFO < 80
  AND CERTAINTY MITIGATING-FACTORS >= 50
  AND CERTAINTY MITIGATING-FACTORS < 80
THEN: FAILURE-LIKELY CF 40
```

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RULE007 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 50
  AND CERTAINTY CONTRARY-INFO < 80
  AND CERTAINTY MITIGATING-FACTORS > 0
  AND CERTAINTY MITIGATING-FACTORS < 50
THEN: FAILURE-LIKELY CF 75


RULE008 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 50
  AND CERTAINTY CONTRARY-INFO < 80
  AND CERTAINTY MITIGATING-FACTORS < 0
THEN: FAILURE-LIKELY CF 80


RULE009 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 0
  AND CERTAINTY CONTRARY-INFO < 50
  AND CERTAINTY MITIGATING-FACTORS >= 80
THEN: ! FAILURE-LIKELY CF 90


RULE010 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 0
  AND CERTAINTY CONTRARY-INFO < 50
  AND CERTAINTY MITIGATING-FACTORS >= 50
  AND CERTAINTY MITIGATING-FACTORS < 80
THEN: FAILURE-LIKELY CF 21


RULE011 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 0
  AND CERTAINTY CONTRARY-INFO < 50
  AND CERTAINTY MITIGATING-FACTORS >= 0
  AND CERTAINTY MITIGATING-FACTORS < 50
THEN: FAILURE-LIKELY CF 40
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RULE012 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO >= 0
  AND CERTAINTY CONTRARY-INFO < 50
  AND CERTAINTY MITIGATING-FACTORS < 0
THEN: FAILURE-LIKELY CF 60


RULE013 [COMPANY-RULES]
-------

IF: CERTAINTY CONTRARY-INFO < 0
THEN: ! FAILURE-LIKELY CF 90 AND PRINT "There is little or
  no evidence contrary to the going concern assumption."


RULE014 [COMPANY-RULES]
-------

IF: CERTAINTY FAILURE-LIKELY >= 50
THEN: NEED-TO-DISCLOSE AND PRINT "Since there is substantial
  doubt concerning this firm's continued existence, you
  should add an explanatory paragraph to your report
disclosing your doubt."


RULE015 [COMPANY-RULES]
-------

IF: CERTAINTY FAILURE-LIKELY >= 20
  AND CERTAINTY FAILURE-LIKELY < 50
THEN: NEED-TO-DISCLOSE CF 25 AND PRINT "Since there is still
  some likelihood of failure, consider disclosure of the
  problems."


RULE016 [COMPANY-RULES]
-------

IF: CONTRARY-INFO AND ! FAILURE-LIKELY
THEN: NEED-TO-DISCLOSE CF 25 AND PRINT "There was information
  contrary to the going concern assumption, but after
consideration of mitigating factors, failure was deemed
unlikely.  Consider the need of disclosing your initial
doubts."
```

Rule Group EVENTS-RULES

```
RULE017 [EVENTS-RULES]
-------

IF: NEGATIVE-TRENDS = RECURRING-LOSSES
  OR NEGATIVE-TRENDS = WORKING-CAPITAL-DEFICIENCIES
  OR NEGATIVE-TRENDS = NEGATIVE-CASH-FLOWS
  OR NEGATIVE-TRENDS = ADVERSE-RATIOS
  OR NEGATIVE-TRENDS = OTHER
THEN: CONTRARY-INFO CF 50

RULE018 [EVENTS-RULES]
-------

IF: NEGATIVE-TRENDS != RECURRING-LOSSES
  AND NEGATIVE-TRENDS != WORKING-CAPITAL-DEFICIENCIES
  AND NEGATIVE-TRENDS != NEGATIVE-CASH-FLOWS
  AND NEGATIVE-TRENDS != ADVERSE-RATIOS
  AND NEGATIVE-TRENDS != OTHER
THEN: ! CONTRARY-INFO CF 50

RULE019 [EVENTS-RULES]
-------

IF: INTERNAL-MATTERS = LABOR-DIFFICULTIES
  OR INTERNAL-MATTERS = DEPENDENCE-ON-A-PROJECT
  OR INTERNAL-MATTERS = UNECONOMIC-COMMITMENTS
  OR INTERNAL-MATTERS = NEED-TO-REVISE-OPERATIONS
  OR INTERNAL-MATTERS = OTHER
THEN: CONTRARY-INFO CF 50

RULE020 [EVENTS-RULES]
-------

IF: INTERNAL-MATTERS != LABOR-DIFFICULTIES
  AND INTERNAL-MATTERS != DEPENDENCE-ON-A-PROJECT
  AND INTERNAL-MATTERS != UNECONOMIC-COMMITMENTS
  AND INTERNAL-MATTERS != NEED-TO-REVISE-OPERATIONS
  AND INTERNAL-MATTERS != OTHER
THEN: ! CONTRARY-INFO CF 50

RULE021 [EVENTS-RULES]
-------

IF: EXTERNAL-MATTERS = LEGAL-PROCEEDINGS
 OR EXTERNAL-MATTERS = LEGISLATION
 OR EXTERNAL-MATTERS = LOSS-OF-FRANCHISE-OR-LICENSE
 OR EXTERNAL-MATTERS = LOSS-OF-PRINCIPAL-CUSTOMER-OR-SUPPLIER
 OR EXTERNAL-MATTERS = UNDER-INSURED-CATASTROPHE
 OR EXTERNAL-MATTERS = OTHER
THEN: CONTRARY-INFO CF 50
```

```
RULE022 [EVENTS-RULES]
-------

IF: EXTERNAL-MATTERS != LEGAL-PROCEEDINGS
  AND EXTERNAL-MATTERS != LEGISLATION
  AND EXTERNAL-MATTERS != LOSS-OF-FRANCHISE-OR-LICENSE
  AND  EXTERNAL-MATTERS  !=
LOSS-OF-PRINCIPAL-CUSTOMER-OR-SUPPLIER
  AND EXTERNAL-MATTERS != UNDERINSURED-CATASTROPHE
  AND EXTERNAL-MATTERS != OTHER
THEN: ! CONTRARY-INFO CF 50


RULE023 [EVENTS-RULES]
-------

IF: OTHER-INDICATIONS = DEFAULT-ON-LOAN
  OR OTHER-INDICATIONS = DIVIDENDS-IN-ARREARS
  OR OTHER-INDICATIONS = TRADE-CREDIT-DENIED
  OR OTHER-INDICATIONS = DEBT-RESTRUCTURED
  OR OTHER-INDICATIONS = CAPITAL-NONCOMPLIANCE
  OR OTHER-INDICATIONS = NEW-FINANCING-NEEDED
  OR OTHER-INDICATIONS = DISPOSAL-OF-SUBSTANTIAL-ASSETS
  OR OTHER-INDICATIONS = OTHER
THEN: CONTRARY-INFO CF 50


RULE024 [EVENTS-RULES]
-------

IF: OTHER-INDICATIONS != DEFAULT-ON-LOAN
  AND OTHER-INDICATIONS != DIVIDENDS-IN-ARREARS
  AND OTHER-INDICATIONS != TRADE-CREDIT-DENIED
  AND OTHER-INDICATIONS != DEBT-RESTRUCTURED
  AND OTHER-INDICATIONS != CAPITAL-NONOCOMPLIANCE
  AND OTHER-INDICATIONS != NEW-FINANCING-NEEDED
  AND OTHER-INDICATIONS != DISPOSAL-OF-SUBSTANTIAL-ASSETS
  AND OTHER-INDICATIONS != OTHER
THEN: ! CONTRARY-INFO CF 50


RULE025 [EVENTS-RULES]
-------

IF: AGGREGATE-EVENTS
THEN: CONTRARY-INFO CF 50

RULE026 [EVENTS-RULES]
-------

IF: ! AGGREGATE-EVENTS
THEN: ! CONTRARY-INFO CF 50
```

Rule Group MANAGEMENT-PLANS-RULES

```
RULE027 [MANAGEMENT-PLANS-RULES]
-------

IF: DISPOSAL-PLANS = DISPOSAL-UNRESTRICTED
  AND DISPOSAL-PLANS = ASSETS-MARKETABLE
  AND DISPOSAL-PLANS = BENEFIT-DERIVED
THEN: MITIGATING-FACTORS CF 50


RULE028 [MANAGEMENT-PLANS-RULES]
-------

IF: DISPOSAL-PLANS != DISPOSAL-UNRESTRICTED
  OR DISPOSAL-PLANS != ASSETS-MARKETABLE
  OR DISPOSAL-PLANS != BENEFIT-DERIVED
THEN: ! MITIGATING-FACTORS CF 50


RULE029 [MANAGEMENT-PLANS-RULES]
-------

IF: BORROW-OR-RESTRUCTURE = FINANCING-AVAILABLE
  AND BORROW-OR-RESTRUCTURE = FREE-FROM-RESTRICTIONS
  AND BORROW-OR-RESTRUCTURE = SUFFICIENT-COLLATERAL
  OR BORROW-OR-RESTRUCTURE = RESTRUCTURING-POSSIBLE
THEN: MITIGATING-FACTORS CF 50


RULE030 [MANAGEMENT-PLANS-RULES]
-------

IF: BORROW-OR-RESTRUCTURE != FINANCING-AVAILABLE
  OR BORROW-OR-RESTRUCTURE != FREE-FROM-RESTRICTIONS
  OR BORROW-OR-RESTRUCTURE != SUFFICIENT-COLLATERAL
  AND BORROW-OR-RESTRUCTURE != RESTRUCTURING-POSSIBLE
THEN: ! MITIGATING-FACTORS CF 50


RULE031 [MANAGEMENT-PLANS-RULES]
-------

IF: REDUCE-OR-DELAY = CAN-REDUCE-OVERHEAD
  OR REDUCE-OR-DELAY = CAN-POSTPONE-ITEMS
  OR REDUCE-OR-DELAY = CAN-LEASE-ASSETS
  AND REDUCE-OR-DELAY = BENEFIT-DERIVED
THEN: MITIGATING-FACTORS CF 50
```

```
RULE032  [MANAGEMENT-PLANS-RULES]
-------

IF: REDUCE-OR-DELAY != CAN-REDUCE-OVERHEAD
   AND REDUCE-OR-DELAY != CAN-POSTPONE-ITEMS
   AND REDUCE-OR-DELAY != CAN-LEASE-ASSETS
   OR REDUCE-OR-DELAY != BENEFIT-DERIVED
THEN: ! MITIGATING-FACTORS CF 50


RULE033 [MANAGEMENT-PLANS-RULES]
-------

 I F :    I N C R E A S E - E Q U I T Y    =
AUTHORIZED-BUT-UNISSUED-SHARES-AVAILABLE
   AND INCREASE-EQUITY = MARKET-FOR-NEW-SHARES
   OR INCREASE-EQUITY = PLAN-TO-REDUCE-DIVIDENDS
   OR INCREASE-EQUITY = CAN-ACCELERATE-CASH-INFLOW
THEN: MITIGATING-FACTORS CF 50


RULE034 [MANAGEMENT-PLANS-RULES]
-------

IF:   INCREASE-EQUITY   !=
AUTHORIZED-BUT-UNISSUED-SHARES-AVAILABLE
   OR INCREASE-EQUITY != MARKET-FOR-NEW-SHARES
   AND INCREASE-EQUITY != PLAN-TO-REDUCE-DIVIDENDS
   AND INCREASE-EQUITY != CAN-ACCELERATE-CASH-INFLOW
THEN: ! MITIGATING-FACTORS CF 50


RULE035 [MANAGEMENT-PLANS-RULES]
-------

IF: AGGREGATE-EFFECT
THEN: MITIGATING-FACTORS CF 50


RULE036 [MANAGEMENT-PLANS-RULES]
-------

IF: ! AGGREGATE-EFFECT
THEN: ! MITIGATING-FACTORS CF 50
```

Parameter Group COMPANY-PARMS

COMPANY-NAME [COMPANY-PARMS]

TRANSLATION: (the name of the company)
PROMPT: (What is the name of the company?)
ASKFIRST: YES
TYPE: SINGLEVALUED
EXPECT: SINGLE-LINE-INPUT

CONTRARY-INFO [COMPANY-PARMS]

TRANSLATION: (information contrary to the going concern assumption)
CERTAINTY-FACTOR-RANGE: FULL
TYPE: YES/NO
USED-BY: RULE009 RULE013 RULE016 RULE001 RULE002 RULE005 RULE006 RULE003 RULE004 RULE007 RULE008 RULE010 RULE011 RULE012
UPDATED-BY: RULE017 RULE018 RULE019 RULE020 RULE021 RULE022 RULE023 RULE024 RULE025 RULE026

FAILURE-LIKELY [COMPANY-PARMS]

TRANSLATION: (failure of this company is likely)
CERTAINTY-FACTOR-RANGE: FULL
TYPE: YES/NO
USED-BY: RULE014 RULE015 RULE016
UPDATED-BY: RULE009 RULE013 RULE001 RULE002 RULE005 RULE006 RULE003 RULE004 RULE007 RULE008 RULE010 RULE011 RULE012

MITIGATING-FACTORS [COMPANY-PARMS]

TRANSLATION: (mitigating factors)
CERTAINTY-FACTOR-RANGE: FULL
TYPE: YES/NO
USED-BY: RULE009 RULE001 RULE002 RULE005 RULE006 RULE003 RULE004 RULE007 RULE008 RULE010 RULE011 RULE012
UPDATED-BY: RULE027 RULE028 RULE029 RULE030 RULE031 RULE032 RULE033 RULE034 RULE035 RULE036

NEED-TO-DISCLOSE [COMPANY-PARMS]

TRANSLATION: (there is a need to disclose information relevant to the going concern issue)
CERTAINTY-FACTOR-RANGE: FULL
TYPE: YES/NO
UPDATED-BY: RULE014 RULE015 RULE016

Parameter Group EVENTS-PARMS

AGGREGATE-EVENTS [EVENTS-PARMS]

TRANSLATION: (events in the aggregate which are contrary to the going concern assumption)
PROMPT: (In the aggregate, are there significant events which are contrary to the going concern assumption?)
CERTAINTY-FACTOR-RANGE: FULL
TYPE: YES/NO
USED-BY: RULE025 RULE026

EXTERNAL-MATTERS [EVENTS-PARMS]

TRANSLATION: (a significant external matter relating to the going concern issue)
PROMPT: (Please indicate the significance of the following external matters as they impact on the going concern issue.)
CERTAINTY-FACTOR-RANGE: POSITIVE
TYPE: ASK-ALL
EXPECT: (LEGAL-PROCEEDINGS LEGISLATION
L O S S - O F - F R A N C H I S E - O R - L I C E N S E
LOSS-OF-PRINCIPAL-CUSTOMER-OR-SUPPLIER
UNDERINSURED-CATASTROPHE OTHER)
USED-BY: RULE021 RULE022

INTERNAL-MATTERS [EVENTS-PARMS]

TRANSLATION: (a significant internal matter relating to the going concern issue)
PROMPT: (Please indicate whether each of the following internal matters has a significant impact on the going concern issue for this company.)
CERTAINTY-FACTOR-RANGE: POSITIVE
TYPE: ASK-ALL
EXPECT: (LABOR-DIFFICULTIES DEPENDENCE-ON-A-PROJECT UNECONOMIC-COMMITMENTS NEED-TO-REVISE-OPERATIONS OTHER)
USED-BY: RULE019 RULE020

NEGATIVE-TRENDS [EVENTS-PARMS]

TRANSLATION: (a significant negative trend)
PROMPT: (Please indicate the significance of each of the following negative trends as it relates to the going concern issue.)
CERTAINTY-FACTOR-RANGE: POSITIVE
TYPE: ASK-ALL
EXPECT: (RECURRING-LOSSES WORKING-CAPITAL-DEFICIENCIES NEGATIVE-CASH-FLOWS ADVERSE-RATIOS OTHER)
USED-BY: RULE017 RULE018

```
OTHER-INDICATIONS [EVENTS-PARMS]
-----------------
TRANSLATION:  (there are other significant indications
  related to the going concern issue)
PROMPT:  (Please indicate the significance of these other
  indications related to the going concern issue.)
CERTAINTY-FACTOR-RANGE:  POSITIVE
TYPE:  ASK-ALL
EXPECT:  (DEFAULT-ON-LOAN DIVIDENDS-IN-ARREARS
  TRADE-CREDIT-DENIED DEBT-RESTRUCTURED CAPITAL-NONCOMPLIANCE
  NEW-FINANCING-NEEDED DISPOSAL-OF-SUBSTANTIAL-ASSETS OTHER)
USED-BY:  RULE023 RULE024
```

Parameter Group MANAGEMENT-PLANS-PARMS

AGGREGATE-EFFECT [MANAGEMENT-PLANS-PARMS]

TRANSLATION: (aggregate effect of management's plans)
PROMPT: (When considered in the aggregate, are management's plans helpful in alleviating the company's financial problems?)
TYPE: YES/NO
CERTAINTY-FACTOR-RANGE: FULL
USED-BY: RULE035 RULE036

BORROW-OR-RESTRUCTURE [MANAGEMENT-PLANS-PARMS]

TRANSLATION: (plan for borrowing money or restructuring debt)
PROMPT: (If management is considering borrowing or restructuring debt, please indicate the significance of the following:)
EXPECT: (FINANCING-AVAILABLE RESTRUCTURING-POSSIBLE FREE-FROM-RESTRICTIONS SUFFICIENT-COLLATERAL)
TYPE: ASK-ALL
CERTAINTY-FACTOR-RANGE: FULL
USED-BY: RULE029 RULE030

DISPOSAL-PLANS [MANAGEMENT-PLANS-PARMS]

TRANSLATION: (a plan for disposing of assets)
PROMPT: (If management is planning to dispose of assets, please indicate the significance of the following:)
EXPECT: (DISPOSAL-UNRESTRICTED ASSETS-MARKETABLE BENEFIT-DERIVED)
TYPE: ASK-ALL
CERTAINTY-FACTOR-RANGE: FULL
USED-BY: RULE027 RULE028

INCREASE-EQUITY [MANAGEMENT-PLANS-PARMS]

TRANSLATION: (plan to increase ownership equity)
PROMPT: (If management has plans to increase ownership equity, please indicate the significance of the following:)
EXPECT: (AUTHORIZED-BUT-UNISSUED-SHARES-AVAILABLE MARKET-FOR-NEW-SHARES PLAN-TO-REDUCE-DIVIDENDS CAN-ACCELERATE-CASH-INFLOW)
TYPE: ASK-ALL
CERTAINTY-FACTOR-RANGE: FULL
USED-BY: RULE033 RULE034

```
REDUCE-OR-DELAY [MANAGEMENT-PLANS-PARMS]
----------------
TRANSLATION:  (plan to reduce or delay expendentures)
PROMPT:  (If management has plans to reduce or delay
  expenditures, please indicate the significance of the
  following:)
EXPECT:  (CAN-REDUCE-OVERHEAD CAN-POSTPONE-ITEMS
CAN-LEASE-ASSETS BENEFIT-DERIVED)
TYPE:  ASK-ALL
CERTAINTY-FACTOR-RANGE:  FULL
USED-BY:  RULE031 RULE032
```

Parameter Group FRAMETYPES

```
COMPANY [FRAMETYPES]
-------


TRANSLATION:  (This is a demonstration system reflecting a
  portion of the auditor's going concern decision)
OFFSPRING:  (EVENTS MANAGEMENT-PLANS)
IDENTIFIER:  "COMPANY-"
RULEGROUPS:  (COMPANY-RULES)
PARMGROUP:  COMPANY-PARMS
DISPLAYRESULTS:  YES
GOALS:  (FAILURE-LIKELY NEED-TO-DISCLOSE)
INITIALDATA:  (COMPANY-NAME)

EVENTS [FRAMETYPES]
------
DISPLAYRESULTS:  YES
IDENTIFIER:  "EVENTS-"
RULEGROUPS:  (EVENTS-RULES)
PARMGROUP:  EVENTS-PARMS
PARENTS:  (COMPANY)
PROMPTEVER:  (This section considers conditions and events
  which might be contrary to the going concern assumption)


MANAGEMENT-PLANS [FRAMETYPES]
----------------
TRANSLATION:  (consideration of management's plans for
  alleviating difficulties)
DISPLAYRESULTS:  YES
IDENTIFIER:  "MANAGEMENT-PLANS-"
RULEGROUPS:  (MANAGEMENT-PLANS-RULES)
PARMGROUP:  MANAGEMENT-PLANS-PARMS
PARENTS:  (COMPANY)
PROMPT1ST:  (Would you like to consider management's plans
  for overcoming the financial difficulties?)
```

System parameters

```
COMPANY-RULES [RULEGROUPS]
--------------
SVAL:  (THE COMPANY)
FRAME:  (COMPANY)
VALUE:  RULE001 RULE002 RULE003 RULE004 RULE005 RULE006
  RULE007 RULE008 RULE009 RULE010 RULE011 RULE012 RULE013
  RULE014 RULE015 RULE016

EVENTS-RULES [RULEGROUPS]
-------------
SVAL:  (THE EVENTS)
FRAME:  (EVENTS)
VALUE:  RULE017 RULE018 RULE019 RULE020 RULE021 RULE022
  RULE023 RULE024 RULE025 RULE026

MANAGEMENT-PLANS-RULES [RULEGROUPS]
----------------------
SVAL:  (THE MANAGEMENT-PLANS)
FRAME:  (MANAGEMENT-PLANS)
VALUE:  RULE027 RULE028 RULE029 RULE030 RULE031 RULE032
  RULE033 RULE034 RULE035 RULE036
```

System parameters

```
COMPANY-PARMS [PARMGROUPS]
--------------
VALUE:  COMPANY-NAME CONTRARY-INFO FAILURE-LIKELY
MITIGATING-FACTORS NEED-TO-DISCLOSE

EVENTS-PARMS [PARMGROUPS]
-------------
VALUE:  AGGREGATE-EVENTS EXTERNAL-MATTERS INTERNAL-MATTERS
  NEGATIVE-TRENDS OTHER-INDICATIONS

FRAMETYPES [PARMGROUPS]
----------
VALUE:  MANAGEMENT-PLANS EVENTS COMPANY

MANAGEMENT-PLANS-PARMS [PARMGROUPS]
----------------------
VALUE: AGGREGATE-EFFECT BORROW-OR-RESTRUCTURE DISPOSAL-PLANS
  INCREASE-EQUITY REDUCE-OR-DELAY
```

APPENDIX G

PLAYBACK FILE AND RULE TRACE

```
=== USER ENTRY === : ( COMPANY-1 COMPANY-NAME ) = (E-4 10.)
Setting parameter  : ( COMPANY-1 COMPANY-NAME ) = E-4 cf 100
End tracing parameter: ( COMPANY-1 COMPANY-NAME )
Trace the following goals : FAILURE-LIKELY NEED-TO-DISCLOSE
Tracing parameter  : ( COMPANY-1 FAILURE-LIKELY )
Try the rules that deduce ( COMPANY-1 FAILURE-LIKELY ) :
  RULE009 RULE013 RULE001 RULE002 RULE005 RULE006 RULE003
  RULE004 RULE007 RULE008 RULE010 RULE011 RULE012
Testing rule premise : ( COMPANY-1 RULE009 )
Tracing parameter  : ( COMPANY-1 CONTRARY-INFO )
Try the rules that deduce ( COMPANY-1 CONTRARY-INFO ) :
  RULE017 RULE018 RULE019 RULE020 RULE021 RULE022 RULE023
  RULE024 RULE025 RULE026

Frame EVENTS-1 created under COMPANY-1
Trace the following goals : ()
Testing rule premise : ( EVENTS-1 RULE017 )
Tracing parameter  : ( EVENTS-1 NEGATIVE-TRENDS )
=== USER ENTRY === : ( EVENTS-1 NEGATIVE-TRENDS ) =
  (RECURRING-LOSSES 70) (WORKING-CAPITAL-DEFICIENCIES 80)
  (NEGATIVE-CASH-FLOWS 80) (ADVERSE-RATIOS 90)
Setting parameter  : ( EVENTS-1 NEGATIVE-TRENDS ) =
  RECURRING-LOSSES cf 70
Setting parameter  : ( EVENTS-1 NEGATIVE-TRENDS ) =
  WORKING-CAPITAL-DEFICIENCIES cf 80
Setting parameter  : ( EVENTS-1 NEGATIVE-TRENDS ) =
  NEGATIVE-CASH-FLOWS cf 80
Setting parameter  : ( EVENTS-1 NEGATIVE-TRENDS ) =
  ADVERSE-RATIOS cf 90
End tracing parameter: ( EVENTS-1 NEGATIVE-TRENDS )
Applying rule action : ( EVENTS-1 RULE017 )
Setting parameter : ( COMPANY-1 CONTRARY-INFO ) = YES cf 45
Testing rule premise : ( EVENTS-1 RULE018 )
Rule premise fails  : ( EVENTS-1 RULE018 )
Testing rule premise : ( EVENTS-1 RULE019 )
Tracing parameter  : ( EVENTS-1 INTERNAL-MATTERS )
=== USER ENTRY === : ( EVENTS-1 INTERNAL-MATTERS ) =
  (DEPENDENCE-ON-A-PROJECT 50) (NEED-TO-REVISE-OPERATIONS 80)
Setting parameter  : ( EVENTS-1 INTERNAL-MATTERS ) =
  DEPENDENCE-ON-A-PROJECT cf 50
Setting parameter  : ( EVENTS-1 INTERNAL-MATTERS ) =
  NEED-TO-REVISE-OPERATIONS cf 80
End tracing parameter: ( EVENTS-1 INTERNAL-MATTERS )
Applying rule action : ( EVENTS-1 RULE019 )
Setting parameter  : ( COMPANY-1 CONTRARY-INFO ) =
  YES cf 40 cum-cf 67
Testing rule premise : ( EVENTS-1 RULE020 )
Rule premise fails  : ( EVENTS-1 RULE020 )
Testing rule premise : ( EVENTS-1 RULE021 )
```

```
Tracing parameter     : ( EVENTS-1 EXTERNAL-MATTERS )
===  USER ENTRY  === : ( EVENTS-1 EXTERNAL-MATTERS ) =
  (LEGAL-PROCEEDINGS 50)
  (LOSS-OF-PRINCIPAL-CUSTOMER-OR-SUPPLIER 90)
Setting parameter      : ( EVENTS-1 EXTERNAL-MATTERS ) =
LEGAL-PROCEEDINGS cf 50
Setting parameter     : ( EVENTS-1 EXTERNAL-MATTERS ) =
  LOSS-OF-PRINCIPAL-CUSTOMER-OR-SUPPLIER cf 90
End tracing parameter: ( EVENTS-1 EXTERNAL-MATTERS )
Applying rule action : ( EVENTS-1 RULE021 )
Setting parameter     : ( COMPANY-1 CONTRARY-INFO ) =
  YES cf 45 cum-cf 82
Testing rule premise : ( EVENTS-1 RULE022 )
Rule premise fails    : ( EVENTS-1 RULE022 )
Testing rule premise : ( EVENTS-1 RULE023 )
Tracing parameter     : ( EVENTS-1 OTHER-INDICATIONS )
===  USER ENTRY  === : ( EVENTS-1 OTHER-INDICATIONS ) =
  (DEFAULT-ON-LOAN 80) (TRADE-CREDIT-DENIED 80)
  (DEBT-RESTRUCTURED 50) (CAPITAL-NONCOMPLIANCE 80)
  (NEW-FINANCING-NEEDED 80)
Setting parameter     : ( EVENTS-1 OTHER-INDICATIONS ) =
  DEFAULT-ON-LOAN cf 80
Setting parameter     : ( EVENTS-1 OTHER-INDICATIONS ) =
  TRADE-CREDIT-DENIED cf 80
Setting parameter     : ( EVENTS-1 OTHER-INDICATIONS ) =
  DEBT-RESTRUCTURED cf 50
Setting parameter     : ( EVENTS-1 OTHER-INDICATIONS ) =
  CAPITAL-NONCOMPLIANCE cf 80
Setting parameter     : ( EVENTS-1 OTHER-INDICATIONS ) =
  NEW-FINANCING-NEEDED cf 80
End tracing parameter: ( EVENTS-1 OTHER-INDICATIONS )
Applying rule action : ( EVENTS-1 RULE023 )
Setting parameter     : ( COMPANY-1 CONTRARY-INFO ) =
  YES cf 40 cum-cf 89
Testing rule premise : ( EVENTS-1 RULE024 )
Rule premise fails    : ( EVENTS-1 RULE024 )
Testing rule premise : ( EVENTS-1 RULE025 )
Tracing parameter     : ( EVENTS-1 AGGREGATE-EVENTS )
===  USER ENTRY  === : ( EVENTS-1 AGGREGATE-EVENTS ) =
  (YES 80)
Setting parameter     : ( EVENTS-1 AGGREGATE-EVENTS ) =
  YES cf 80
End tracing parameter: ( EVENTS-1 AGGREGATE-EVENTS )
Applying rule action : ( EVENTS-1 RULE025 )
Setting parameter     : ( COMPANY-1 CONTRARY-INFO ) =
  YES cf 40 cum-cf 93
Testing rule premise : ( EVENTS-1 RULE026 )
Rule premise fails    : ( EVENTS-1 RULE026 )
No rules left for     : ( COMPANY-1 CONTRARY-INFO )
End tracing parameter: ( COMPANY-1 CONTRARY-INFO )
Rule premise fails    : ( COMPANY-1 RULE009 )
```

```
Testing rule premise : ( COMPANY-1 RULE013 )
Rule  remise fails   : ( COMPANY-1 RULE013 )
Testing rule premise : ( COMPANY-1 RULE001 )
Tracing parameter    : ( COMPANY-1 MITIGATING-FACTORS )
Try the rules that deduce ( COMPANY-1 MITIGATING-FACTORS ) :
  RULE027 RULE028 RULE029 RULE030 RULE031 RULE032 RULE033
  RULE034 RULE035 RULE036

Frame  MANAGEMENT-PLANS-1  created  under  COMPANY-1
Trace the following goals :  ()
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE027 )
Tracing parameter    : ( MANAGEMENT-PLANS-1 DISPOSAL-PLANS )
===  USER ENTRY  === : ( MANAGEMENT-PLANS-1 DISPOSAL-PLANS )
  =  ()
End tracing parameter: ( MANAGEMENT-PLANS-1 DISPOSAL-PLANS )
Rule premise fails   : ( MANAGEMENT-PLANS-1 RULE027 )
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE028 )
Applying rule action : ( MANAGEMENT-PLANS-1 RULE028 )
Setting parameter    : ( COMPANY-1 MITIGATING-FACTORS ) =
  YES cf -50
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE029 )
Tracing  parameter           :  (  MANAGEMENT-PLANS-1
BORROW-OR-RESTRUCTURE )
===  USER ENTRY  === : (MANAGEMENT-PLANS-1
  BORROW-OR-RESTRUCTURE ) =  (FINANCING-AVAILABLE -100)
  (RESTRUCTURING-POSSIBLE -100) (FREE-FROM-RESTRICTIONS -20)
  (SUFFICIENT-COLLATERAL -80)
Setting parameter    : ( MANAGEMENT-PLANS-1
  BORROW-OR-RESTRUCTURE ) = FINANCING-AVAILABLE cf -100
Setting parameter    : ( MANAGEMENT-PLANS-1
  BORROW-OR-RESTRUCTURE ) =  RESTRUCTURING-POSSIBLE cf -100
Setting parameter    : ( MANAGEMENT-PLANS-1
  BORROW-OR-RESTRUCTURE ) = FREE-FROM-RESTRICTIONS cf -20
Setting parameter    : ( MANAGEMENT-PLANS-1
  BORROW-OR-RESTRUCTURE ) = SUFFICIENT-COLLATERAL cf -80
End tracing parameter: ( MANAGEMENT-PLANS-1
  BORROW-OR-RESTRUCTURE )
Rule premise fails   : ( MANAGEMENT-PLANS-1 RULE029 )
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE030 )
Applying rule action : ( MANAGEMENT-PLANS-1 RULE030 )
Setting parameter    : ( COMPANY-1 MITIGATING-FACTORS ) =
  YES cf -50 cum-cf -75
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE031 )
Tracing parameter    : ( MANAGEMENT-PLANS-1 REDUCE-OR-DELAY)
===  USER ENTRY  === : ( MANAGEMENT-PLANS-1 REDUCE-OR-DELAY)
  =  (CAN-REDUCE-OVERHEAD 30) (CAN-POSTPONE-ITEMS 30)
  (CAN-LEASE-ASSETS -30) (BENEFIT-DERIVED 30)
Setting parameter    : ( MANAGEMENT-PLANS-1 REDUCE-OR-DELAY)
  =  CAN-REDUCE-OVERHEAD cf 30
Setting parameter    : ( MANAGEMENT-PLANS-1 REDUCE-OR-DELAY)
  =  CAN-POSTPONE-ITEMS cf 30
```

```
Setting parameter    : ( MANAGEMENT-PLANS-1 REDUCE-OR-DELAY)
  =  CAN-LEASE-ASSETS cf -30
Setting parameter    : ( MANAGEMENT-PLANS-1 REDUCE-OR-DELAY)
  = BENEFIT-DERIVED cf 30
End tracing parameter: ( MANAGEMENT-PLANS-1 REDUCE-OR-DELAY)
Applying rule action : ( MANAGEMENT-PLANS-1 RULE031 )
Setting parameter    : ( COMPANY-1 MITIGATING-FACTORS ) =
  YES cf 15 cum-cf -71
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE032 )
Rule premise fails   : ( MANAGEMENT-PLANS-1 RULE032 )
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE033 )
Tracing parameter    : ( MANAGEMENT-PLANS-1 INCREASE-EQUITY)
===  USER ENTRY  === : ( MANAGEMENT-PLANS-1 INCREASE-EQUITY)
  =  (AUTHORIZED-BUT-UNISSUED-SHARES-AVAILABLE 20)
  (MARKET-FOR-NEW-SHARES -80) (PLAN-TO-REDUCE-DIVIDENDS -20)
  (CAN-ACCELERATE-CASH-INFLOW 20)
Setting parameter    : ( MANAGEMENT-PLANS-1 INCREASE-EQUITY)
  =  AUTHORIZED-BUT-UNISSUED-SHARES-AVAILABLE cf 20
Setting parameter    : ( MANAGEMENT-PLANS-1 INCREASE-EQUITY)
  =  MARKET-FOR-NEW-SHARES cf -80
Setting parameter    : ( MANAGEMENT-PLANS-1 INCREASE-EQUITY)
  =  PLAN-TO-REDUCE-DIVIDENDS cf -20
Setting parameter    : ( MANAGEMENT-PLANS-1 INCREASE-EQUITY)
  = CAN-ACCELERATE-CASH-INFLOW cf 20
End tracing parameter: ( MANAGEMENT-PLANS-1 INCREASE-EQUITY)
Rule premise fails   : ( MANAGEMENT-PLANS-1 RULE033 )
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE034 )
Applying rule action : ( MANAGEMENT-PLANS-1 RULE034 )
Setting parameter    : ( COMPANY-1 MITIGATING-FACTORS ) =
  YES cf -50 cum-cf -86
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE035 )
Tracing parameter    : ( MANAGEMENT-PLANS-1 AGGREGATE-EFFECT)
===  USER ENTRY  === : ( MANAGEMENT-PLANS-1 AGGREGATE-EFFECT)
  =  (YES 20)
Setting parameter    : ( MANAGEMENT-PLANS-1 AGGREGATE-EFFECT)
  =  YES cf 20
End tracing parameter: ( MANAGEMENT-PLANS-1 AGGREGATE-EFFECT)
Rule premise fails   : ( MANAGEMENT-PLANS-1 RULE035 )
Testing rule premise : ( MANAGEMENT-PLANS-1 RULE036 )
Applying rule action : ( MANAGEMENT-PLANS-1 RULE036 )
Setting parameter    : ( COMPANY-1 MITIGATING-FACTORS ) =
  YES cf -50 cum-cf -93
No rules left for    : ( COMPANY-1 MITIGATING-FACTORS )
End tracing parameter: ( COMPANY-1 MITIGATING-FACTORS )
Rule premise fails   : ( COMPANY-1 RULE001 )
Testing rule premise : ( COMPANY-1 RULE002 )
Rule premise fails   : ( COMPANY-1 RULE002 )
Testing rule premise : ( COMPANY-1 RULE005 )
Rule premise fails   : ( COMPANY-1 RULE005 )
Testing rule premise : ( COMPANY-1 RULE006 )
Rule premise fails   : ( COMPANY-1 RULE006 )
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Testing rule premise : ( COMPANY-1 RULE003 )
Rule premise fails   : ( COMPANY-1 RULE003 )
Testing rule premise : ( COMPANY-1 RULE004 )
Applying rule action : ( COMPANY-1 RULE004 )
Setting parameter    : ( COMPANY-1 FAILURE-LIKELY ) =
  YES cf 90
Testing rule premise : ( COMPANY-1 RULE007 )
Rule premise fails   : ( COMPANY-1 RULE007 )
Testing rule premise : ( COMPANY-1 RULE008 )
Rule premise fails   : ( COMPANY-1 RULE008 )
Testing rule premise : ( COMPANY-1 RULE010 )
Rule premise fails   : ( COMPANY-1 RULE010 )
Testing rule premise : ( COMPANY-1 RULE011 )
Rule premise fails   : ( COMPANY-1 RULE011 )
Testing rule premise : ( COMPANY-1 RULE012 )
Rule premise fails   : ( COMPANY-1 RULE012 )
No rules left for    : ( COMPANY-1 FAILURE-LIKELY )
End tracing parameter: ( COMPANY-1 FAILURE-LIKELY )
Tracing parameter    : ( COMPANY-1 NEED-TO-DISCLOSE )
Try the rules that deduce ( COMPANY-1 NEED-TO-DISCLOSE ) :
  RULE014 RULE015 RULE016
Testing rule premise : ( COMPANY-1 RULE014 )
Applying rule action : ( COMPANY-1 RULE014 )
Setting parameter    : ( COMPANY-1 NEED-TO-DISCLOSE ) =
  YES cf 100

Since there is substantial doubt concerning this firm's
  continued existence, you should add an explanatory paragraph
  to your report disclosing your doubt.
No rules left for    : ( COMPANY-1 NEED-TO-DISCLOSE )
End tracing parameter: ( COMPANY-1 NEED-TO-DISCLOSE )

Failure of this company is likely  (90%)

There is a need to disclose information relevant to the going
  concern issue
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(" Consultation record for:  going concern"
"the name of the company                    :: E-4"
"a  significant  negative  trend                          ::
RECURRING-LOSSES:70%          WORKING-CAPITAL-DEFICIENCIES:80%
NEGATIVE-CASH-FLOWS:80%  ADVERSE-RATIOS:90%"
"a    significant    internal    matter    relati...     ::
DEPENDENCE-ON-A-PROJECT:50%  NEED-TO-REVISE-OPERATIONS:80%"
"a    significant    external    matter    relati...     ::
L E G A L - P R O C E E D I N G S : 5 0 %
LOSS-OF-PRINCIPAL-CUSTOMER-OR-SUPPLIER:90%"
"there    are    other    significant    indicati...     ::
DEFAULT-ON-LOAN:80%          TRADE-CREDIT-DENIED:80%
DEBT-RESTRUCTURED:50%          CAPITAL-NONCOMPLIANCE:80%
NEW-FINANCING-NEEDED:80%"
"events in the aggregate which are co... :: YES:80%"
"consideration of management's plans ... :: YES"
"a plan for disposing of assets          :: unknown"
"plan    for    borrowing    money    or    restruct...     ::
FINANCING-AVAILABLE:-100%          RESTRUCTURING-POSSIBLE:-100%
FREE-FROM-RESTRICTIONS:-20%  SUFFICIENT-COLLATERAL:-80%"
"plan    to    reduce    or    delay    expendentures       ::
CAN-REDUCE-OVERHEAD:30%          CAN-POSTPONE-ITEMS:30%
CAN-LEASE-ASSETS:-30%  BENEFIT-DERIVED:30%"
"plan    to    increase    ownership    equity              ::
A U T H O R I Z E D - B U T - U N I S S U E D - S H A R E S - A V A I L A B L E : 2 0 %
MARKET-FOR-NEW-SHARES:-80%      PLAN-TO-REDUCE-DIVIDENDS:-20%
CAN-ACCELERATE-CASH-INFLOW:20%"
"aggregate effect of management's plans  :: YES:20%")

EVENTS-1  CONCLUSIONS:


MANAGEMENT-PLANS-1  CONCLUSIONS:


COMPANY-1  CONCLUSIONS:
Failure of this company is likely  (90%)

There is a need to disclose information relevant to the going
  concern issue
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