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THE INVESTMENT DECISION--AN ANALYSIS USING VERBAL PROTOCOLS

By

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ABSTRACT

THE INVESTMENT DECISION-AN ANALYSIS
USING VERBAL PROTOCOLS

By

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One of the major issues confronting accounting researchers, policymakers, and practitioners is the problem of information use. How information is to be used is one of the major criteria to be considered when the issues of what and how much information to produce are addressed. Knowledge of how information is used effectively circumscribes the feasible solutions to the above issues.

This research addresses the issue of information use using the methodology of verbal protocol analysis. The study involves the examination of a prospectus by four professional and four non-professional subjects. The objective is to allow subjects to do the analysis in a situation which stresses realism. The analysis involves using the verbal protocols to develop behavior graphs and elementary processing models.

Results of the study suggest that professionals as a group differ from nonprofessionals. This assessment is addressed in terms of strategies employed, operators and time used, information addressed and processing behavior. However, the results suggest that intra-group differences are also large.

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CHAPTER I

INTRODUCTION

A significant amount of the recent accounting literature has been concerned with the users of accounting information. Policy-making bodies, practitioners, and academics have all sought to define the users' role in the process of generating and disseminating accounting information. Most recently, the Financial Accounting Standards Board (FASB), in its conceptual framework project, has begun to address some of the relevant questions on this issue, including the following:

1. What user group(s) ought to be the primary focus of general purpose financial statements?
2. What types of information do users require?
3. For what purpose(s) are financial statements to be used?

Any responses to these questions are interrelated, as can be seen from the following quote from the Accounting Principles Board (APB) Statement No. 4 [1970, para. 43-47]:[1]

> Financial accounting information is used by a variety of groups and for diverse purposes. The needs... of users determines the type of information required.... Information prepared for a particular purpose cannot be expected to serve other needs well.... Improving financial accounting requires...research on...user needs, on the decision processes of users and on the information.

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[1]The quoted language appears to have been taken from the American Accounting Association's, A Statement of Basic Accounting Theory, [1966, pp. 19-21, 63].

The position taken by the FASB on these questions is outlined in Statement of Financial Accounting Concepts (SFAC) No. 1 [1978, para. 32]:

> The objectives... narrow (their) focus to investors' and creditors' primary interest in the prospect of receiving cash from their investment in or loans to business enterprises.... (They) finally focus on information about an enterprise's economic resources, the claims to those resources, and changes in them, ... that is useful in assessing the enterprise's cash flow prospects.

The preceding position is essentially similar to that adopted by the APB in its Statement No. 4.

The FASB does substantially depart from its predecessor policy-making bodies in that it attempts to characterize the users in particular ways. This can be shown by the following quote from SFAC No. 1 [para. 36]:

> (Users) understand to varying degrees the business... environment...and related matters. Their understanding of financial information and the way and extent to which they use and rely on it...may vary greatly.... Its use can be learned, however, and financial reporting should provide information that can be used by all -- nonprofessionals as well as professionals -- who are willing to learn to use it properly.

One possible interpretation of the above statement is that the FASB assumes that some users (presumably professionals) know how to use information properly and other users (nonprofessionals) do not. Such an interpretation is supported by the following quote from a recent literature survey by Dyckman, et al, [1978, p. 76] regarding the impact on users of alternative reporting methods:

> More sophisticated users...tend to rely more heavily on the accounting data supplied to them in financial reports.... Unsophisticated users...rely more on the nonaccounting data in the financial reports.

> Sophisticated users are more likely to be able to perceive economic realities underlying alternative reporting methods.

One implication of the above is that different users will tend to use different processing models in evaluating financial information.

The assumption of differential understanding and processing of information in the domain of the financial statement and investment analysis is addressed in this study. The objective of the research is to compare the problem-solving behavior of expert subjects (i.e., professional investors) with that of relatively naive subjects (i.e., nonprofessional investors). Prototypical subjects in each class of investors will be analyzed and models built on an individual basis. The models will be analyzed in terms of the following hypotheses:[2]

H1: Subject classes will differ in search strategies employed.

Research by Bouwman [1978, 1980] indicates that student subjects processed data in a sequential fashion. In contrast, professional subjects used a recursive processing strategy, moving back and forth in the data set. While the dichotomy between subject groups in this project is not as stark as that between Bouwman's subjects, the same general behavior differences are expected. This is primarily due to the fact that, presumably, professionals do analyses such as that in this study much more often.

H2: Subject classes will differ in amount of information attended to during the analysis.

Research employing both linear modeling and process tracing

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[2] These hypotheses will not be tested in the usual sense and either accepted or rejected. They will serve as guides in the coding and modeling process. Conclusions drawn regarding them will be done on a counting basis only; e.g., this type behavior was observed n times.

techniques suggests that the information used by professionals tends to differ from that used by nonprofessionals. Hofstedt [1972] found that professionals tended to use more quantitative data in general and less data as a whole than nonprofessionals (students). Ashton and Kramer [1980] found that cue weight magnitudes differed significantly between such groups, which implies different ranking schemes and information use in decision-making. Elstein, Shulman and Sprafka [1978] also found that experienced clinicians used different information than medical students or interns.

H3: Subject classes will differ in operators employed during the analysis.

Hypothesis 3 is based on Bouwman's research [1980]. He found that several types of data manipulations were never engaged in by the nonprofessionals in his study. This would imply a different use of operators by the different classes of subjects.

H4: Subject classes will differ in amount of time spent in analysis (both on specific items of information and overall time).

The time dimension was tested by Hofstedt [1972]. He found that nonprofessionals use significantly more time than professionals in analysis of annual report data.

As used here, a strategy implies "a pattern of decisions in the acquisition, retention, and utilization of information that serves to meet certain objectives" [Bruner, et al, p. 54]. Any differences found in the processing behavior between classes will be held to be tentative evidence that user sophistication is an important variable in the production of accounting information.

The importance of understanding the decision behavior of the users of accounting information has been well documented in the literature. In a recent study, for example, Libby [1975, pp. 476-477] developed a scenario demonstrating how an information set showing perfect predictability of (and therefore relevance to) an environmental event may not be useful. He points out that failure to consider the cognitive limitations of potential users may lead to ineffective use of the information due to information overload[3] or other constraints of the human system.

Other research has also generally supported the view that the individual user is an important consideration in any judgment drawn concerning the usefulness of information. McGhee, Shields, and Birnberg [1978, p. 682] hypothesized, based on research by San Miguel [1976] and others, that different users of accounting information may require particular information packages in order to demonstrate effective and efficient processing. Research by Payne [1976] (and replicated by Biggs [1979] in the accounting area) indicated that decision-makers tend to change their processing strategies as the information set changes. He found that increasing the environmental complexity by (1) increasing the number of choices available, or (2) increasing the number of information dimensions related to each choice, caused subjects to resort to simplifying heuristics to reduce cognitive load. It can be inferred from these findings that the usefulness of information cannot be defined without knowledge of the user and his decision process.

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[3]The concept of information overload is generally linked to the theory found in H.M. Schroeder, M.J. Driver, and S. Streufert, Human Information Processing, [1967, pp. 37-40].

Most of the previous research in accounting investigating information user behavior has followed the Brunswik Lens or Bayesian paradigms[4] (see Slovic and Lichtenstein [1971], Libby [1979a, 1979b], Ashton [1974, 1979], Swierenga, et. al., [1978]). It is generally accepted that models developed under these paradigms are paramorphic [Hoffman, 1960] in nature. That is, they are very effective in an outcome or predictive sense, but they are not explanatory. Different underlying behaviors may be well fitted by the same surface model. In fact, Dawes and Corrigan [1974] demonstrate that linear models will be good predictors in any situation in which there is (1) a monotone relationship between the criterion and the predictors and (2) there is error in the measurement of the criterion or predictor variables or both.

One proposed use of these models is as a normative guide for users in a given decision-making context. However, recent research has challenged this view in some cases. For example, in their review of the information processing literature, Slovic, Fischoff and Lichtenstein [1977, pp. 3, 8] cited findings demonstrating that (1) people probably do not make decisions in a Bayesian fashion, and (2) strategies other than linear additive ones are often employed. In addition, the research indicates that even teaching the users optimal information use is difficult and often the learned behavior does not generalize to new contexts [p.13]. One implication of these results

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[4]For reviews of this literature, see Libby and Lewis [1977]; Dyckman, Gibbins and Swierenga [1978]; and Snowball [1980].

is that in order to better understand human behavior, other techniques must be employed.

One such technique is protocol analysis,or process tracing, the proposed methodology of this study. The methodology involves having a subject verbalize or think aloud as a task is performed. These verbalizations or protocols[5] are tape recorded and transcribed. The protocols are then analyzed in a manner consistent with the theory outlined in Newell and Simon [1972].

An ultimate objective of most process tracing research is a specific mechanistic model of the individual human information processor in specific task environments. This modeling is based upon the following line of reasoning: people as information processors have several characteristics which can be closely approximated by machines -- especially the computer. For example, people have memories (of varying capacities). They have the ability to react adaptively to changes in their environment. They are able to learn, to think, and to perform tasks in a systematic fashion.

Most of these abilities and traits can be modeled or performed by the computer. The computer has a memory (limited capacity). It can be programmed to react adaptively (e.g., conditional actions). It can also be programmed to "think" and "learn" from its experiences. It is, without question, much faster, more efficient, and more reliable than humans, both temporarily and across time.

In this study, the methodology is used to assess the processing behavior of professional and nonprofessional subjects analyzing a

[5]A protocol is literally an original record or first draft of any output.

prospectus. Subjects were allowed as much or as little time as they desired to solve the problem. They were instructed to do whatever they normally did when analyzing a potential investment, assuming they were interested in the one at hand.

The process tracing approach to modeling behavior, though currently viewed as an exploratory procedure, is more and more being recognized as a potentially powerful analytical device. Though generally nonstatistical in nature, the methodology offers several validation procedures for modeling results. The most common of these can be interpreted as a type of face validity argument. That is, if such models do indeed represent what they purport to represent, then the observed processes of the models should approximate the processes of subjects doing the same tasks. This is the essential premise of what is referred to elsewhere in this paper as the Turing test [Clarkson, 1962].

1.1 Implications for Accounting

As stated earlier, research has amply demonstrated the need to consider users in describing the usefulness of accounting information. However, much of this research has been input-output analyses and either explicitly or implicitly assumed that decision-makers behaved in particular ways if observed decisions were adequately predicted by surrogate models. The question of whether the underlying behavior fit model assumptions generally was not addressed. Individual actions by subjects tended to be masked by averaging techniques used. The result of such procedures is that while assessments can be made of different weighting policies or perhaps of the extent of information use, the fundamental questions of how and why weighting policies differed across decision-makers remains unanswered. That is, one cannot really say how or why particular subjects arrived at their weighting policies. As a result, attempts to change or correct decision behaviors have been relatively unsuccessful [Slovic, Fischoff and Lichtenstein, 1977].

Newell and Simon [1972] have demonstrated that the task itself is a major determinant of observed behavior. In this study, observed behavior should be closely linked to the information set and task instructions. Therefore, findings of differences in information processing (assuming the differences are reliable and valid) would present tentative evidence relative to questions such as the following:

1. What is the nature of the divergence in behavior between the two subject classes?
2. When or where does the divergence in behavior tend to occur?
3. Can the divergence be related to the information set?
4. Assuming the professionals exhibit desirable behavior, how can nonprofessionals become better information processors?

The responses to these questions may have implications for the formation of the information set itself. Previous research utilizing both linear models and process tracing methodologies has examined differences in information processing between groups possessing varying levels of expertise in particular domains. The general nature of these findings, as related to the above questions, is as follows:

1. Professionals (CPA's) may have greater self-insight, are more linearly predictable, and differ in terms of cue weight magnitudes when compared to nonprofessionals (students) [Ashton and Kramer, 1980].

2. Professionals tend to use more quantitative data and spend less time in analysis than nonprofessionals [Hofstedt, 1972].
3. Professionals tend to process information in a recursive fashion, often switching back and forth between cues in the data. They also seem to possess a type of mental checklist which they apply to the data. This is contrasted with non-professionals (students), who tend to work in a sequential, front-to-back fashion, without such a checklist (Bouwman [1980]; Stephens, Shank, and Bhaskar [1980]; Elstein, Shulman, and Sprafka [1978]).
4. While some variance is usually exhibited across professionals, that from professionals to nonprofessionals is usually far greater [Bouwman, 1980].

The above results serve as useful guides in evaluations of how information may be processed in several contexts. The aim of this study (as stated by the hypotheses) is to assess these issues in a financial context which emphasizes external validity.

To the extent that these findings are relevant to (and replicated by) the analysis in this study, then such differences may imply several points at the individual level (as contrasted with the aggregate market) of information processing. For example, the order of presentation may become increasingly important as expertise decreases. Where a piece of information is may determine whether or not it will be attended to. Additionally, it may be inferred from such studies that particular combinations of data may be more appropriate for efficient processing. Finally, there is the pedagogical concern with how to change behavior. More detailed knowledge of how processing is done should permit an enhanced ability to change it. Such knowledge may also be used to design more effective man-machine systems.

A finding of no difference has fewer implications. Again, assuming the results are valid and reliable, it may be argued that such a finding is tentative evidence that the information set generally presented in such accounting contexts is not taxing the cognitive abilities of users. Another interpretation given the sample size is that the design simply did not allow investigation of a diverse enough population.

1.2 Scope and Limitations

The research question in this study is addressed in the following way: given a fixed information set, it is hypothesized that differential sophistication of users will result in differential perceptions of task complexity and, therefore, different processing models will be used. It is assumed that the task is complex enough to present a realistic and representative problem to the processors. The relative efficiency and efficacy of the processor's model are not addressed in this research.

This study will not attempt to judge the information set itself. The information set chosen is assumed to be realistic and representative. Other information sets could have been chosen. Additionally, there is no control over information use within the information set itself. In fact, one of the expected ways that programs may differ is in the amount of information used.

The concern here is with individual, not group, behavior. No attempt will be made to find average processes of the particular subject classes. While comparative statements may be made or particular subjects used as prototypes, no attempt will be made to develop models of an "average professional" or "average nonprofessional" subject at this stage of the modeling process.

Due to the limited sample sizes to be used, the generalizability of the results is limited. However, to the extent it can be demonstrated that some task characteristics are invariant, (i.e., that other processors will also have to deal with those characteristics to process similar problems), it is expected that observed behaviors should be repeated in such future contexts by processors possessing similar abilities to those in this study.

It should be noted that recent research, especially that of Nisbett and Wilson [1977] has questioned the ability of subjects to relate, in a reliable manner, their thoughts relative to performance of a task. In fact, Nisbett and Wilson conclude that many of the mental processes are inaccessible to conscious control, hence cannot be reported on.

While it is generally held that as particular behaviors become well learned they are less likely to be reported on in any introspective verbal report, Nisbett and Wilson's work has limited applicability when applied to process tracing work. First, Nisbett and Wilson reported on retrospective verbal reports. Concurrent verbal reporting is the mode used by current protocol researchers [Ericcson and Simon, 1979]. Secondly, none of the studies cited by Nisbett and Wilson were specifically designed to test verbal reporting. Conclusions drawn about verbalizations generally come from debriefing sessions, which generally lack the controls of the experimental session itself [Ericcson and Simon, 1979].

CHAPTER II

LITERATURE REVIEW

2.0 Introduction

The technique of process tracing has been concurrently developed in the disciplines of psychology and artificial intelligence/engineering systems. Though the research in each area has proceeded in different directions (behavior analysis versus simulation models, respectively), in terms of emphasis, this conjunction of knowledge for development purposes is logical if intelligence is defined in terms of human cognition. Specific applications of the technique for research purposes has covered areas as diverse as physics and medicine. This chapter is concerned with the use of process tracing in accounting contexts. The implications of prior research for this study is addressed. Finally, a synopsis of other applications of the methodology is provided.

2.1 Pertinent Literature

Most of the research in the process tracing area is based on the definitive theory outlined in Newell and Simon's work, Human Problem Solving [1972]. The methodology has been applied to a wide variety of what Ungson, Braunstein and Hall [1981] refer to as "ill-structured" problems, as well as to well-defined ones. Kleinmutz [1968] modeled the decision processes used by clinical psychologists in the course of evaluating patients. Montgomery [1976] used the methodology to test

Tversky's finding of intransitivity of preferences by subjects evaluating simple gambles. Newell and Simon [1972]described problem-solving behavior in logic, cryptarithmetic and chess. Payne, Carroll and Braunstein [1978] investigated the decision processes involved in apartment selection. Bhaskar and Simon [1978] used protocol analysis to assess problem-solving behavior in the domain of engineering thermodynamics. There are numerous other works investigating such domains as algebra, consumer decision-making in various contexts, education and learning, and medical diagnosis of various types of disease entities [Simon, 1979].

The earliest work in the financial area was done by Clarkson [1962]. Clarkson studied the decision processes used by a bank trust investment officer in the course of selecting portfolios for clients. The task chosen was important in that the behavior of the officer was well constrained by both legal fiduciary and firm-specific considerations. As a result, the set of possible search lists that the officer might have used in portfolio selection was reduced to a fairly predictable, probable set. The problem reduced to looking at the desired needs of the client, e.g., current income versus long-term growth, or some combination, over a set of firms surviving the screen formed by the legal and firm-specific constraints. Clarkson was able to produce a computer simulation model of the trust officer which was capable of selecting portfolios of five to eight stocks which, at most, differed from those of the officer by two.[6] The basic model consisted

[6]The computer also tended to differ from the officer in dollar amounts invested in each firm. The differences tended to be quite small, generally less than $100, out of portfolios of $5,000 or more.

of a discrimination net (decision tree) which looked for presence-absence of selected criteria in terms of building suitable lists of investment vehicles. From such lists, the model then matched the goals of the investor subject with the available investment instruments.

Clarkson validated his model by means of several tests. Model output was compared to random number selection processes and to naive models. In addition, Clarkson used a modified Turing test, suggested by Newell and Simon. The test is based on the following premise: given that a model purports to be the representation of some process or processor, then the model should perform as the process or processor. A neutral observer should be unable to distinguish the model output and processes from those of the human counterpart, down to some prescribed level of detail. Clarkson notes that the model and human output need not be in the same order; merely the overall content should be equivalent. The model performed well in all of these procedures. However, Clarkson did not cross-validate his model, nor was its test-retest reliability assessed. Both of these criticisms have been applied to much of the work done in the process tracing area.[7]

Accounting researchers have used protocol analyses in two basic areas -- model building and hypothesis testing. Stephens [1978] did preliminary work which combined both areas in a study of decision processes used by bank loan officers making credit decisions. He found tentative evidence that bank loan officers tend to process financial information in the same ways across companies, regardless of

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[7]Much of this criticism stems from the fact that the methodology was developed primarily in the computer science/artificial intelligence area, not psychology. Validation procedures reflect this.

changes in the lines of business or accounting techniques. That is, the officers tended to use the same general program for problem solution in spite of changes in accounting variables or industries.[8] The study was designed in terms of specific hypotheses concerning the issues. The hypotheses were not accepted or rejected in the general statistical sense. Support for, or the lack of support of, each hypothesis was developed by demonstrating protocol evidence relative to each specific hypothesis.

Bhaskar and Dillard [1979a, 1979b] examined two problem areas in the accounting area. In their 1979a study, they investigated the concept of knowledge representation in the accounting domain. They sought to show that knowledge is organized by accountants in particulare groupings based on relationships between assets and equities, in conjunction with certain revenue recognition schemes. They were able to demonstrate that their proposed representation was sufficient to delineate required knowledge and procedures at the level necessary to solve problems taken from an intermediate accounting text. They also demonstrated the use of a semi-automatic protocol scoring machine which improves the reliability of operator assignment across scorers.

In their 1979b study, Bhaskar and Dillard essentially extended their previous study. They addressed the problem of becoming skilled in a domain requiring non-trivial amounts of knowledge, or in their terminology, one that is semantically rich. Their preliminary finding indicates that skill acquisition may be a process of unit building.

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[8]This result would seem to conflict with Newell and Simon's contention that the program adopted is a function of the problem itself. However, Stephens' firms were very similar in size and industry. That is, inclusion of firm(s) from very different industries and/or of different size may have resulted in different processing approaches.

This is similar to the chunking hypothesis in memory research [Newell and Simon, p. 792]. That is, as an individual becomes more familiar with data it is remembered in larger and larger cohesive units. For example, a zip code is generally one piece or "chunk" of information, not five. Bhaskar [1978] has also developed a computer model which explores the decision processes observed in the solution of certain classes of problems in the cost accounting domain.

Bouwman [1978, 1980] has directly addressed the problem of financial statement analysis. Bouwman assumed that the decision process used in financial analysis tasks was similar to the type of analysis done by medical diagnosticians when confronted by a patient. He constructed case studies, each containing a particular "problem." Subjects were then given a fixed amount of time to find the hidden "ailment" in each case study firm. Using CPA's and students, he developed computer models of the financial diagnostic process. Bouwman validated his model by means of the comparison of model and subject output. Additionally, he demonstrated that the model approximated to a high degree the intermediate stages and processes that the subjects engaged in along the solution path.

Bouwman effectively established that financial statement analysis is a semantically rich domain that is amenable to the process-tracing methodology. The task is sufficiently well-structured that strategies employed by processors can be delineated, analyzed, and modeled.

Biggs [1979] and Biggs and Mock [1978] have used the technique for the purpose of hypothesis testing. In his 1979 study, Biggs sought to categorize the underlying process model of the decision processes utilized by financial analysts in the course of evaluating the earning power of several companies. He sought to show that the processes could be categorized in terms of the conjunctive, additive difference, additive compensatory or elimination by aspects models, or some combination of them. His results, which were consistent with those reported by Payne [1976], indicated that the decision-makers could be classified in terms of the models or combinations of them. Biggs also tested the reliability of his protocol scoring technique across coders using simple proportion of agreement between scorers and also by using the Kappa Coefficient, which removes the effect of chance agreement between scorers.

Biggs and Mock used the technique to analyze the decision processes used by auditors in the course of making audit program decisions. Using a task validated as to its realistic nature by Mock and Turner [1979], they examined the information search patterns employed by four senior auditors. They found that the auditors used two essential types of information search strategies -- systematic and directed (essentially a breadth-first versus depth-first analysis). Further, information used in the making of the task decision was quite similar if one controlled for the <u>amount</u> of information used on a particular cue dimension.

In a 1980 study, Shields used a process tracing technique to analyze the information search strategies employed by senior managers reading cost variance reports. The study utilized information boards and manipulated the complexity of the reports. The analysis was done relative to four hypotheses, and the search patterns were categorized using the same models as Payne [1976] and Biggs [1979]. The basic hypothesis under test in the study was that processing would change as task complexity, as represented by the number of units presented and information per unit, increased. The null hypothesis of no effect was not rejected for any case, even though effects were in the appropriate direction. Shields posited that this finding may possibly have been due to the familiarity of his subjects with such reports. That is, they no longer needed to search to make decisions. Finally, it should be pointed out that some researchers have cautioned that the use of explicit search techniques such as information boards, by requiring an act that subjects normally would not undertake (walking back and forth), may themselves serve to alter decision processes [Olshavsky, 1979].

Process tracing research to date in accounting has generally tackled well-defined problems. The findings of these studies indicate that accounting data is handled in fairly predictable ways by processors. Essentially, they serve to establish that the use of process tracing techniques in accounting contexts is feasible. However, they do demonstrate that care must be taken since in general, statistical controls are absent. The usual solution to this difficulty itself involves the choice of issue to address. By tackling well-defined questions, routes to solution were easily assessed for veridicality. The problem itself served as a control for behavior assessed.

The problem addressed in this study is not generally well-defined. As Ungson, Braunstein, and Hall [1981] point out, this is generally the case in realistic settings. This study involves what can be characterized as a case study assessing a security investment decision. This approach is advocated by Payne [1980] and Ebbesen and Konecni [1980].

The objective is to stress the external validity of the study.

As alluded to earlier, most studies in the process-tracing area have been criticized for the lack of cross-validation and reliability procedures. One reason for this deficiency is the basic Freudian premise of the theory that human behavior at the individual level is somewhat deterministic [Newell and Simon, 1972, p. 10]. Another is the generally large time requirements for process-tracing research. There is also the previously cited belief that the validation procedures established at present, such as the Turing test, are adequate. This study attempts to provide partial cross-validation and retest reliability assessments.

CHAPTER III

METHODOLOGY-CONCEPTS AND CONSTRUCTS

3.0 Introduction

This chapter is concerned with the methodology as used in this study. The chapter is organized as follows. First, a general description of the technique and some associated problems is provided. The chapter then proceeds with a discussion of the human information processing system, a task analysis, and other issues related to the study, such as sample selection.

3.1 The Problem Solving Approach

The methodology proposed in this study is verbal protocol analysis. The technique involves having subjects think aloud as they perform a task. These "think aloud" protocols are recorded and the transcript coded. The coded protocols are used to develop a problem behavior graph (PBG) for the subject. The PBG is, in turn, used to develop the model of the decision-making process. The resultant model is proposed as explanatory regarding the process. To the extent that one is able to show the limits of the human processor, and to demonstrate that the behavior model conforms to the proposed limits, one can say that the model is sufficient in describing the behavior, given the limitations [Simon, 1979].

The PBG is a dynamic representation of the subject solving the problem. It consists of a series of knowledge states about the problem and operators which change a given knowledge state. This is depicted below in Figure 1 [Newell and Simon, p. 173].

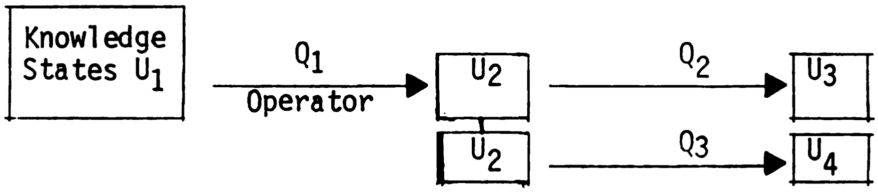

Figure 1. Illustration of a Problem Behavior Graph

The result of applying an operator Q is the new knowledge state U at the head of the arrow. Return to a knowledge state is depicted by a solid line from the particular state to a node below it. Time in the PBG runs from left to right, then down. Movement in this PBG is from U_1 to U_2 to U_3, back to U_2, and then to U_4.

The coding process consists of two general phases: (1) breaking the transcript of protocols into short phrases and (2) encoding the phrases in terms of operators, knowledge states, etc. Each phrase represents "a naive assessment of what constitutes a single task assertion or reference" [Newell and Simon, p. 166]. The phrasing process is designed to facilitate later references. The extraction of meaning from the protocols depends on the task itself. For this reason, it is important that the researcher has explicit knowledge of the task.

The extraction of meaning from protocols and the coding process is not standardized. Few well-defined procedural rules have been developed. Since, in addition, there are generally few statistical controls applicable to the technique, researchers have been concerned about the reliability of findings. However, in studies reporting reliability measures, intercoder reliabilities have been comparable to those reported in other types of behavioral research. Biggs [1979] reported intercoder reliabilities averaging .67 and .72. In their 1978 study, Payne, Braunstein, and Carroll cite two studies reporting reliabilities averaging .87 and .95. They conclude that additional research is needed in this area and propose that researchers try approaches such as the following:

1. Automating the coding process as much as possible.
2. Using different techniques to measure the same behavior such as protocols and eye movement data.
3. Clearly stating hypotheses in conjunction with building PBG's.

In this study, subjects were given unlimited time to study a prospectus and make a decision about whether they would or would not invest in the particular company. The only constraint was that the subjects had to verbalize the entire process. The objective was to make the decision process conform as closely as possible to the one that the subject normally uses. Work done by other researchers indicates that the decision process should take from one to five hours [Bouwman, 1979; Biggs, 1979]. This study employed two coders.

3.2 The Human Information Processing System

This paper is concerned with problem-solving in the investment domain. As used here, a problem exists whenever an individual wants something and does not know immediately how to get it [Newell and

Simon, 1972, p. 72]. Problem-solving, then, is the directed activity related to resolution of the want expressed in the preceding definition.

The theory proposed by Newell and Simon rests on four essential propositions [Newell and Simon, 1972, pp. 788-789], as follows:

1. A few, and only a few, gross characteristics of the human information processing system (IPS) are invariant over task and problem solver.
2. These characteristics are sufficient to determine that a task environment is represented (in the IPS) as a problem space, and that problem-solving takes place in a problem space.
3. The structures of the task environment determine the possible structures of the problem space.
4. The structure of the problem space determines the possible programs that can be used for problem-solving.

Some of the points raised above can be illustrated by the following simplified example:

Calculate ending inventory given the following:

Beginning Inventory: $100 Purchases: $500

Cost of Sales: $400

To solve this problem requires the following:

1. Reading ability--both syntactic and semantic skills.
2. Knowledge of inventory and relationships: a method.
3. Mathematical ability--algebra.

The subject must be able to read the information provided and understand the question asked. Knowledge of the relationship between beginning inventory, purchases, cost of sales and ending inventory is essential for solution. The processor must be able to retain, either in short-term or external memory, the relationships above long enough to manipulate them to obtain a solution. While the cognitive limits of the individual is not addressed, the necessary elements for solution can be inferred. The above solution procedures (including substitutions, additions, etc.) together comprise the necessary components of a problem space.

The invariant features of the human information processor (HIP) are the following [Newell and Simon, pp. 791-792]:

1. The size, access characteristics and read-and-write times of the various human memories -- long-term memory (LTM), short-term memory (STM) and external memory (EM).
2. The HIP system is essentially serial in nature, and processes information at fixed rates.
3. The organization of the problem-solving process (the program used) is production-like in character, and goal oriented.

Functionally, STM consists of the set of symbols currently being attended to. Its capacity is about five to seven chunks of information. Its read or access time is virtually immediate. LTM has virtually infinite capacity and is generally held to be a node link structure with an index. Its character is associative. That is, structures are related in various ways. Remembering Dick may evoke memories of Jane and Sally and Spot...till the entire family structure is complete. The read time of LTM is on the order of a few hundred milliseconds. The write time is about 5K to 10K seconds per chunk, where K is the number of familiar subpatterns in the new chunk. This write time (fixation in LTM) is the main reason that Newell and Simon [p. 794] hypothesize that little learning occurs in problem-solving. EM consists of those things in foveal view (being looked at) or that one has otherwise retained (such as a sheet of formulas) or written down. The write time of EM is about a second for overlearned symbols, but increases drastically as familiarity decreases. The access time depends on whether one knows exactly where what one is looking for is located. Its capacity is limited by the size of the instrument used, such as the size of a sheet of paper for taking notes during a lecture.

People tend to process information one piece at a time, especially as complexity increases (an exception is routinized processes). This is contrasted with parallel processing, in which two (or more) items may be simultaneously processed. Formally, a processor is serial in nature if the time to solution of problems is proportional to the number of problems. To test this assertion, one might simultaneously attempt to multiply 293 by 37 while also multiplying 691 by 72. Additionally, the rate at which such processes can be carried out is invariant.

A production is a system which consists of two types of statements: conditions and actions. If the conditions are satisfied, the action occurs. The production may be conjunctive or disjunctive in nature. In the conjunctive case, all conditions must be satisfied for the action to occur; in the disjunctive case, the action occurs if any one of the conditions is met.

Goal-directed behavior in the human IPS implies some type of test structure to determine if the goal is being met. Further, it implies that the behavior of the processor will have some rational relationship with the goal. Patterns should exist in the trace which are discernible and explainable by the data and goal structure implied. As used here, rational means that if the goal is accepted, relevant activity should be directed toward reducing differences between the present state and the goal state.

In general, the theory posits that the human can be described as an adaptive production system whose problem-solving occurs in a problem space. The problem space is the internal representation by the problem solver of all relevant aspects of the problem. It includes not only the information heeded by the subject, but also all possible realistic solution paths the subject may think about, reject or otherwise have available. This implies that some general knowledge about the problem must be assumed. Thus, the problem space will consist of some set of methods, including operators and their related operands, or other heuristics designed to achieve the goal at hand. The formal definition of the problem space follows.

3.3 The Problem Space

According to Newell and Simon [1972, p. 810], the problem space consists of:

1. A set of elements, U, which are symbol structures, each representing a state of knowledge about the task.
2. A set of operators, Q, which are information processes, each producing new states of knowledge from existing states of knowledge.

3. An initial state of knowledge, u, which is the knowledge about the task that the problem-solver has at the start of problem-solving.
4. A problem, which is posed by specifying a set of final, desired states, G, to be reached by applying operators from Q.
5. The total knowledge available to a problem-solver when he is in a given knowledge state, which includes (ordered from most transient to most stable):
   (a) Temporary dynamic information created and used exclusively within a single knowledge state.
   (b) The knowledge state itself--the dynamic information about the task.
   (c) Access information to the additional symbol structures held in the LTM or EM (the extended knowledge state).
   (d) Path information about how a given knowledge state was arrived at and what other actions were taken in this state if it has already been visited on prior occasions.
   (e) Access information to other knowledge states that have been reached previously and are now held in LTM or EM.
   (f) Reference information that is constant over the course of problem-solving, available to LTM or EM.

The problem space, as applied to particular problems or tasks, is not unique. Different subjects may choose to represent the same facts or data structures in different ways. Nonetheless, Newell and Simon's research indicates that in most cases the number of potential problem spaces is quite low. Their work indicates that the problem space selected is likely to be a function of the task itself, not the subject.

As an illustration of the concept, one might consider a possible problem space in the domain of financial statement analysis. The elements are data structures attended to during the analysis. These include such things as management, net income, ratios, etc. Note that each datum potentially constitutes a knowledge state. The operators are allowable transformations or data manipulations, e.g., mathematical operations such as addition, division, or comparisons or any act which causes a change in the knowledge state via additional data manipulation. These are likely to be repeated during the task. The extended knowledge state consists of all possible knowledge in the problem space which can be extracted simply by knowing what is in the current knowledge state in STM or foveal view. This knowledge must be accessible by the problem-solver. For example, one might apply an operator which evaluates management. Just knowing whether management is good or bad will have implications for many or perhaps all previously visited knowledge states. The knowledge state consists of what one knows about the task at any point in time, i.e., the contents of STM and what is in foveal view. The final state arrived at is the decision point. The solution path is the route taken to the decision point. Strictly speaking, it does not include wrong turns taken in the solution process.

Perhaps a more intuitive example in accounting is the evaluation of accounts receivable as part of the overall assessment of internal control. Here, the invoices and company personnel are the elements.

Operators would be possible tests--i.e., inquiring, observing, scanning or walk through of documents, etc.--compliance tests. Task invariants are those things which any audit program evaluating this aspect of internal control would be expected to contain--accounts receivable, the audit tests, the planned level of assurance desired. There is also some initial knowledge state which depends on the past audit relationship and where the evaluation of accounts receivables fits in the current evaluation of internal control. The goal state is related to the judgment to either rely or not rely on the internal control system of the client, given the desired level of audit assurance.

The above description contains the necessary components of a problem space. Note that problem-solving involves a series of knowledge states (i.e., elements being attended to). This result follows from a consideration of the access and write times of the various memories, especially LTM and EM. Since LTM has a write time of 5K and 10K seconds, and the empirical evidence indicates that problem-solvers do not spend a large amount of time fixating items in LTM, one should observe a series of knowledge states. The situation is analogous in EM. STM itself lacks the capacity to hold a growing knowledge state [Newell and Simon, 1972].

3.4 <u>Task Analysis - The Conceptual Viewpoint</u>

The task analysis involves delineating the necessary moves or decisions one must make to perform the task. In this study, the relevant question for the task analysis is the following: how does one assess risk and return, given an information set about a possible investment vehicle?

The task in this study is the analysis of a prospectus[9] in order to make an investment decision. The prospectus will be constructed to reflect a "proven" company (i.e., one with a track record of five to six years) going public on the over-the-counter (OTC) market. This is done to ensure that the problem can be structured fairly well while still retaining its realistic aspects. Additionally, in such a situation, one would expect the value of accounting information to be enhanced [Grant, 1980].

The choice of company context is also important for market implications. Research by Reilly and others [Reilly, 1979, pp. 173-174] indicates that in the case of companies going public for the first time, the market is not likely to unambiguously settle on a stock price immediately. The findings imply that if the stock is bought at the offering price, it is possible to gain excess profits by superior forecasting and proper buy-sell decisions. Given the general lack of analyst attention to such companies, the accounting information is likely to be the source of many of the inputs for the price forecast models. Reilly's results indicated that relative imbalances in the price structure may persist for up to a week. Finally, work by Rosenberg and Guy [1976] and Bowman [1980] suggests that accounting data may be used to update estimates of, or to

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[9]The data set also included some national market and industry data, based on the cues used in the study by Ebert and Kruse [1978].

construct surrogates for, market beta. The relationship between market returns and accounting data is well laid out in the literature [Reilly, 1979].

The problem addressed here is not portfolio selection, however, we are peripherally concerned with the question of present holdings of the subjects. Economic and behavioral theories indicate that the willingness of an investor to enter into any investment is likely to be a function of his present portfolio composition, his wealth, and risk preference structure [Reilly, 1979]. This point will be addressed via a demographic profile and sample selection. Participants are assumed to desire a change in their present portfolio.

Most studies employing the process-tracing paradigm have tackled what Newell and Simon call well-defined problems. That is, some test exists, performable by the information processor, which will tell him when or if a solution has been reached [Newell and simon, 1972]. This area is somewhat problematic in the present study. The correctness of the "solution", the decision to either invest or not invest is not verifiable in the usual sense. The solution test occurs only when the internal criteria of the problem-solver are met. This may occur at any point in the decision process. While one may, as an observer, make judgments relative to the route taken to the decision, observations about the correctness of the decision cannot be easily drawn without knowledge of the utility structure of the processor, and ex post data regarding the stock's performance. As a result, analysis of the problem-solver's behavior will be somewhat incomplete in that it is virtually impossible to verify that observed behavior demonstrates goal acceptance.[10]

A focal issue in this study is representation. Few problems that we encounter are solved directly. In most cases, we find that directly attacking a problem is too costly, too time consuming, or otherwise too difficult. In general, we build some representation or model that is analogous to the problem in its essential aspects and "solve" the model first. For example, suppose that we have the problem of building a more fuel efficient car. One could proceed directly to an appropriate assembly line, and start to produce a car, correcting it as necessary to attain the objective of good fuel efficiency. In such a situation, one would expect problems to develop; stoppages and reassessments may be made continually. Ultimately, the product may even be no longer produced. Typically, such a scenario would never occur. Instead, careful blueprints are drawn up. Mathematical models of the proposed car are developed and tested. Prototypes of the car may be built and tested for performance and problems. After this process is completed, the car may or may not be built, depending on the outcome of the testing process.

The situation posed in this study in the investment domain presents the same type of problem. The issue is whether or not to invest in a particular company. Ideally, the prospective investor would like to see what is being acquired. However, visual analysis is

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[10]It is implicitly assumed in this research that the risk-return paradigm will be adopted by the subjects. Within this paradigm, episodes of behavior can be assessed. An episode is a sequence of behavior associated with attainment of a particular goal. It ends either when the goal is achieved or the processor faces a problem that he cannot solve. For example, the analysis of return on investment would be an episode of behavior.

virtually impossible in the investment domain. The cost in time and money would be prohibitive. Instead, we tend to solve the problem by constructing some type of model of the firm using financial or other data. Using the techniques of fundamental or other appropriate analyses, we attempt in some way to assess either the value of the firm or the expected level of future returns to potential investors.

There must also be some type of structure assumed involving the financial knowledge necessary. Firm risk level and expected returns must be assessed. The items associated with risk might include business risk, financial risk and liquidity risk, while the return category might include measures such as dividends or earnings.[11] The information assumed in the structure follows the method of fundamental analysis outlined by Reilly [1979, pp. 260-368].

In essence, then, the task analysis involves delineating an expected problem representation and solution paths. The researcher must assess qualitatively the semantic knowledge required for problem solution. In this study, subjects must know what a prospectus is and its purpose; some knowledge of algebra and statistics is necessary. Such an analysis allows the researcher to anticipate behavior and be prepared to analyze it.

Further, there are other constraints embedded in the problem. One would not expect subjects to assess short-term dividend levels since the company, by definition, needs funds. The analysis should address either long- or short-term capital appreciation, given the context of the problem. For example, one might expect to see concerns

[11]For example, business risk might be measured in terms of operating leverage or sales volatility.

about such variables as the stability and growth of the firm, its profits, and cash flow. The liquidity position may be important, as well as risk measures; management should be assessed. Judgments that are made should be relevant to the issue of survivability of the firm, that is, the relevant questions should relate to present and future prospects for the firm.

3.5 General Study and Sample Demographic Issues

The study was done in three stages:

1. The development of the task and the task analysis.
2. A pilot study.
3. The experiment.

The pilot study and the sample sizes are both related to the fact that protocols produce a large amount of data. Researchers in the area generally feel that a pilot study is a prerequisite for a successful experiment. The pilot in this study involved four students who had successfully completed at least one investments course. Small sample sizes are a necessity due to the large time requirements of such analysis, the data overload problems due to the volume of information produced.

The expert sample in this study consisted of professional analysts. Such subjects should, by virtue of their training, exhibit the same general quality of problem-solving skill.

Criteria used in selecting the professionals were as follows: (1) They should hold the designation Certified Financial Analyst, if possible; (2) They should be familiar with initial offerings; and (3) They should be familiar with the industry of the prospectus company.

These points become important in improving external validity since the sample size is small.

The nonprofessional investors were selected with the following criteria in mind: (1) they should be investors who generally make their own investment decisions; (2) they should be cognizant of the industry of the prospectus company so that the exercise is not a guessing game with respect to industry data; and (3) the investors should be matched as well as possible with respect to present holdings, investment experience, and educational level. In the optimal case, one would prefer investors covering the entire range of these variables and randomization for control. Again, due to the sample considerations, the aim is to have the subjects be as similar as possible to assure that the observed behavior stems from the task constraints, not from demographic variables. One criterion which overrides the sample demographics is the fact that the research is aimed at investigating decision behavior, not learning. For this reason alone, subjects should be experienced in investment analysis.

The subjects in this study were paid $20. No attempt was made to adequately compensate the individuals involved. Research by Orne [1973] indicates that even small amounts of compensation such as $1.00 are adequate to ensure that subjects are serious with respect to a research project. As a final note, most of the participants returned all or part of the compensation offered.

The generalizability of the results of this study is limited due to the sample sizes and the resultant nonstatistical nature of the research. However, Newell and Simon's [1972] indicates that the task itself is a major determinant of task-related behavior. Thus, to the extent that processors engage in tasks similar to that reported in this study, it is expected that the results reported here should be repeated. That is, processors attempting to assess risk and return are expected to engage in the same types of activity. While individuals may differ as to particular aspects of risk and return assessed, the overall behavior should be similar.

CHAPTER IV

EXPERIMENTAL RESULTS: DERIVATION OF MODELS

4.0 Introduction

There were three stages in the prospectus analysis task reported here. Following task development and analysis, a pilot study consisting of four students was run. These sessions were done over a two-week period and were used to refine techniques related to the methodology, including the coding process. The actual experiment consisted of eight subjects--four professionals and four nonprofessionals, ranging in age from 22 to 56. The experiment was run over a four-week period due to time constraints of the subjects.

Professional subjects for the experiment were contacted by a two-wave mailing to CFA members of the Financial Analysts Federation within 80 miles of East Lansing, Michigan. The final four professionals consisted to two chartered financial analysts and two non-chartered professionals. Of these latter two, one was a senior partner of a regional investment firm and the other held a Ph.D. in finance and managed several portfolios. All of these subjects were male.

The nonprofessionals consisted of four subjects with varied backgrounds. Subjects were, in order, a vice president of a bank trust department (operations officer), a manager in a manufacturing concern, a State of Michigan civil servant, and an entrepreneurial house-wife student. All had personal portfolios; additionally, two belonged to investment clubs. These subjects were contacted via newspaper advertisements and flyers within the Lansing-East Lansing area.

All of the nonprofessionals were selected with several demographic criteria in mind. These criteria, developed from the extensive body of research carried out by Lewellyn, Lease, and Schlarbaum [1976], profile a prototypic individual who is likely to do his own investment research and decision making. According to their findings, the average individual would be (1) a male, (2) married with children, (3) between approximately 40 and 55 years of age, and (4) have relatively high income. Of the final nonprofessional participants in this study, only one met the age criterion. All were relatively high-level management people; one was single and one was female. The data of the female was ultimately discarded due to technical equipment and data contamination problems. Table 1 contains summary demographic data on the remaining experimental subjects; S denotes subject.

TABLE 1

PROFILE OF SUBJECTS USED

	Age	Investment Experience	Educational Level	Professional Certification
Professionals				
S1	31	9	BA	CFA
S2	44	16	Ph.D.	-
S3	51	23	MBA	CFA
S4	56	26	MBA	-
Nonprofessionals				
S5	24	3	MBA	-
S6	33	5	BA	-
S7	42	10	MBA	-

The experiment was run in the following manner: each subject was placed in a room and given a training exercise to familiarize them with the thinking aloud technique. The training exercise consisted of two cryptarithmetic problems. Subjects were given twenty minutes to attempt solutions and familiarize themselves with the thinking aloud technique. They were then given a complete prospectus of a real-life firm which had been disguised. Changes to the prospectus included the following: name of firm and its principals, capital structure (to simple capital structure), origin of stock sold (all from the company instead of selling shareholders), and size of firm. The last change consisted of multiplying all financial data by .6. Otherwise, the material was exactly as it appeared in the company prospectus. In addition, the information packet contained several pieces of supplemental information, based on the studies by Ebert and Kruse [1978] and Pankoff and Virgil [1970]. This information consisted of a forecast of gross national product, forecasted inflation levels, and several industry items: beta, profit margins and return on assets. The industry of the selected firm was specifically chosen to be one projected to have better-than-average future growth - computer technology. The firm's sales during the period covered in the prospectus ranged from approximately one to fifteen million dollars.

The nonprofessional subjects were instructed to perform whatever analysis they normally did, assuming that they had found an attractive possible investment vehicle. The professionals were divided into two groups of two, one of which was told to perform an analysis designed for potential clients. The other professional group was instructed in the same manner as the nonprofessionals. Subjects were supplied with pencils, paper, and a calculator, and instructed to talk during their analyses. Their statements were recorded (and later transcribed). Subjects were given as much time as they desired. This process was later repeated for S4, as part of the validation procedure.

After completing their analyses, each subject responded, in writing, to a debriefing questionnaire. This involved questions on the particular subject's experience in investing and other demographic data such as age and education. Other questions were concerned with information perceived to be most (and least) important in dealing with the firm, the realism of the exercise, and the investment strategy and/or goal of the subject in real life. The packet of materials used in the experiment is available from the experimenter.

4.1 Subject Models

Bouwman [1978, p. 9] cites two requirements for a successful transformation of verbal protocols into a model of the processing behavior of a subject: (1) it (the model) must be unambiguous and (2) it must contain "all" relevant information. He points out that these criteria are difficult to operationalize. However, it is important to note that any model is a representation, not a duplication, of reality. It is extremely rare, for example, to develop a model which is perfectly descriptive or predictive of any behavior. Generally, we cannot model every aspect of a particular problem, leading to some unreliability in the model. The true test of a model is whether or not it adequately describes or predicts in a given set of circumstances. In this study, the models are used as a vehicle for comparing the processing behavior of two types of problem-solvers. No claim is made that the models are general models of the subject. The claim is made that the behaviors depicted by the models are representative in the specific context of this study and as such are amenable to analysis.

Models developed in process tracing studies are generally assessed from either or both of two perspectives. One approach involves the construction of a working computer model of the processor. The principal aim of such research is to produce a model which mimics the actions of the processor in great detail. Generally, the model is approached from a systems, rather than psychological, orientation. An example of such research in accounting is Bouwman's 1980 work, cited earlier in this study. The second approach involves devising tasks and modeling the decision processes used in task processing and solution. No attempt is made to "program" the actions of the processor. Instead, discrimination nets (decision trees) are constructed and assessed from a psychological frame of reference. Examples of such work in accounting include that of Biggs [1979] cited earlier, and Shields [1980]. Research that involves both approaches includes that done by Bhaskar, Shank and Stephens [1980], also cited earlier in this study. The approach adopted in this study principally follows the psychological orientation, although some preliminary aspects of the computer model perspective will also be developed.

Two models were developed for each subject in this study. The first model consisted of placing the knowledge elements assessed by each subject (from the PBG) in a flow diagram, along with the output characterization assigned by the processor. This model, which is denoted the protocol model, is simply a list, in processing boxes, of what the subject did. The second model, which is denoted the derived model, was developed as outlined below, and is a more general version of the first model. The second or derived model is a device for summarizing and categorizing the behaviors exhibited in the first, or protocol, model in order to facilitate analysis and inferences drawn. Thus, if a subject appeared, based on the protocol evidence, to be using a particular type of processing behavior, the derived model was constructed using the general class of behavior indicated.

Neither model is presented as an explicit characterization of the subjects' decision process(es) in a general sense; they are considered representative of the decision process(es) used in this specific context. The basic design of this research (essentially a one-shot case study) does not permit the derivation of benchmarks, break points, or other decision criteria employed by subjects.[12] It is principally for this reason that the models are not considered general in nature.

The derived version of the first model was developed in the following manner. (1) Each knowledge element assessed was grouped with others on the same topic, i.e., all sales characterizations on a particular aspect of sales were grouped together. For example, the origin of sales would be related to customer types, whereas the

[12] In the general case, one would need choices over the entire range of variables assessed in order to derive break points.

level of sales addresses growth. (2) Each such element category was placed in the general model as a cue (decision criterion). (3) The output characterization of each knowledge element was considered to be made at the margin. That is, if sales growth in the data set averaged 15 percent and the subject described this as good, sales growth less than 15 percent would be denoted as "bad" in the derived version of the subject's model. Thus, the level or state of each knowledge element in the provided information set (along with any protocol or debriefing information), if processed, was used as arbitrary decision points for each subject. Again, it is noted that the models were primarily constructed for analysis of behavior. This approach, while clearly not generally representative, does fit the data in the present context. (4) Binary, yes-no decisions were placed in the model if the processor demonstrated this type of decision was being made. (5) Data characterizations were assigned only if the processor demonstrated, at least in part, such activity in the protocols. As stated earlier, it was assumed that subjects had adopted the risk-return paradigm from a fundamental perspective. This perspective served as a general guide as to which elements a subject was likely to attend to, as well as for the development of categories in the models. In essence, it describes the rules expected to be followed as the processors attended to the problem. In general, one expects those things which increase return or decrease risk to be positive in effect. Conversely, those things which increase risk or decrease return were expected to be negative in impact on the

processor. This notion of risk and return is well accepted in the literature.[13]

The decision processes analyzed in this study actually involved two decisions. The first decision is one regarding the firm itself. As such, it depends on firm specific characteristics. The second decision involves deciding whether to buy the particular stock or not. This latter decision is a function not only of the firm itself, but also its prospects relative to other available investment opportunities of the processor. The second decision also dependes on the pecuniary state and the present holdings of the processor. This study is concerned only with the first decision--the processor's view of the subject firm. The models developed for each subject appear in the Appendix I of the dissertation.

4.2 Coding

The coding scheme adopted in this study follows that used by Bouwman [1978, 1980]. This choice was made for several reasons. (1) Comparison of the transcripts of the processors indicates that the same general type of behavior is found in both the above-cited works and this study. This suggests that the problem space adopted by processors are similar. (2) The problem addressed is similar. Both this study and Bouwman's work is concerned with the analysis of financial and other data about particular firms. Newell and Simon's work [1972, p. 789] indicates that problem spaces employed are dependent on task, not subject, characteristics. (3) The processors

[13]Other potential perspectives include technical or charting analysis and the efficient market hypothesis. However, both of these techniques are generally used at the aggregate market or portfolio level and depend on historical track records.

(subjects) in the studies are similar. The CFA's and other professional and nonprofessional subjects participating in this research have similar backgrounds to the students and CPA's used in Bouwman's work. (4) It is important to demonstrate that the methodology in general and the coding process in particular is amenable to standardization. Since, as previously stated, the coding process is somewhat problem-dependent, generalizability is likely for any particular class of problems, such as those involving financial information use.

The coding and model-building processes involve several stages, each of which embodies a different representation of the processing behavior of subjects. Each stage consists of applying certain criteria to the subjects' verbalizations of the processing behaviors employed. Bouwman's work includes the following set of representations (not all of which need be utilized in a particular study), after the procedure outlined by Waterman and Newell [1971, 1976]: (1) the audio tape representation, (2) the lexical representation, (3) the topic representation, (4) the element representation, (5) the group representation, (6) the problem behavior graph and (7) the trace. This research develops the first six representations for each subject. Additionally, flow chart models are developed for each subject.

The tape representation is simply the audio tape itself. The lexical representation consists of the transcriptionist's and/or the researcher's interpretation of what is on the audio tape. Not only are the spoken words important, but also contextual meanings--pauses, periods, et cetera. Basically, this representation entails applying linguistic rules to the data, as well as detailing prosodic (emphasis) features and timing. Successful development of this representation is crucial to later representations. The task is non-trivial due to several logistical problems--the tendency of subjects to lapse into silence or low tones, or to mumble, and the tendency of the transcriber to suffer lapses in acuity as the length of the processing episode increases. Solutions to the above problems include telling the processor(s) to continue talking or to walk around or take short breaks.

The topic representation involves splitting the lexical representation into short phrases, each of which is concerned with a single task topic. These phrases are called topic segments, and they become the units of analysis. This backup of the protocols is achieved by applying grammatical and linguistic rules to the transcript. In this study, the following set of rules were used to define topic segments: (1) any single phrase having a subject and verb, (2) any phrase which does not modify its preceding phrase (using normal English grammatical rules), or a subsequent phrase, and/or contains new or different information. In cases where doubt exists, no new segment rather than a new segment will be coded. (3) Phrases which have implied subjects and/or verbs due to idiomatic or contextual use will be coded as topic segments. (4) Any phrase which stands alone contextually, regardless of structure, will be coded as a topic segment. The above rules follow those used by Waterman and Newell [1971]. An example of a partial transcript in topic segment form appears in Figure 2.

The element representation is the first in which meaning is extracted from the protocols. Problem space relationships or occurrences are detailed. Knowledge elements (i.e., things the subject

Figure 2

Topic Segments from the Protocol of S4

95. I was offered four new (+) supposedly "hot" issues this morning.

96. And I haven't (+) ... done anything about any of them... (+) ..

97. The only one--there are two of them on here..(+)..

98. Well, there are four on here,...

99. Obviously (+) two of them are...computer related..(+)..

100. One's related to cable (+) television,

101. One's--one is DeLorian Motors..(+) ..

102. I don't know whether you've seen one of those new DeLorian cars,

103. But they are super-looking (+) cars, if you like that kind of thing....

104. I think the damned thing--(+) the stock will probably bomb out,

"+" denotes the passing of 5 seconds of time.

knows) and operator elements (i.e., data transformation mechanisms) are identified. In general, knowledge elements are the in- or outputs of operator elements. A third class of element specifies the relationship(s) between operator and knowledge elements, such as which type(s) of knowledge element(s) is (are) associated with a particular operator element. These relation-specifying elements are known as indicator elements. A list of operators employed in this study appears below in Table 2. The operators are defined in section 4.4.

TABLE 2

LIST OF OPERATORS USED

Type	Operation or Manipulation
Examine	Search
Tag 1	Impression (nonquantitative)
CI	Impression (quantitative)
Compute	Calculation
Increase	Comparison (qualitative)
CA	Comparison (quantitative)
Trend	Comparison (quantitative)
Formulate Relation	Linking
Formulate Problem	Summarization
---	--- ---
Coding Devices	
Reading	Reading
Tag 2	Paraphrasing, talking, etc.

One of the critical issues of coding in a process tracing framework involves the identification of operators. That is, how is an operator identified? As defined earlier, an operator is any manipulation which produces additional or new information, where "new" implies not directly available currently in the problem space. Note that this definition excludes the act of reading as an operator. That is, the assertion is made that reading per se does not necessarily involve data manipulation, rather, data absorption. Thus, a subject reading, "...sales are $6 million," differs substantially from an assertion that "sales are increasing." The latter statement implies that a comparison has been made (i.e., data manipulated); the former merely reiterates a value given. While the former statement or identification of the sales level may prove to be important, it is the subject's actions which must demonstrate this fact. Evidence of such importance may be given by repetition, a slowdown in processing speed, or direct statements by the processor. At any rate, it is the task-related information in the protocols that indicates that new knowledge has been produced that allows the inference of operator application. Instead of asking the subject about x or how x was done, the subject is merely asked to do x while speaking aloud. All conclusions are drawn from the transcribed protocols. As stated by Simon, the leeway offered the researcher in this situation is not great [Simon, 1979].

The next representation consists of analyzing operator and knowledge elements in terms of which inputs are associated with which operators and its output. The combination of an operator element with its in- and output knowledge elements is called an operator group. Cases in which the research hypothesizes a relationship early on in the analysis is known as a protogroup [Waterman and Newell, 1971]. Operator groups become the nodes in the next representation--the problem behavior graph.

As previously stated, the problem behavior graph is a dynamic representation of the processor attempting to solve the problem.

The trace is the outline of the algorithm or program imitating the processing behavior as characterized by the problem behavior graph. Additionally, the set of representations could be expanded to include the problem space, which is a necessary structure of the theory for analysis.

4.3 Problem Space

Adoption of Bouwman's coding scheme implies that the general problem space adopted by subjects in this study is equivalent to that used by subjects in Bouwman's work. Both casual and definitive examination of the protocols indicates that this implication receives reasonably strong support. Except for several differences which were explained earlier in the discussion of coding, Bouwman's operators were sufficient to describe most of the processing behavior of subjects. The differences are mainly related to the fact that computations (which are a form of programmed or algorithmic activity) were allowed in this study, whereas Bouwman computed all figures. Additionally, in the present research, more qualitative data was presented to subjects than in Bouwman's study. The result of these differences was the addition of a computer and tag operator in this study and the elimination of Bouwman's remember operator.

The problem space was earlier defined as the processor's internal representation of the task environment, in which all problem-solving activity occurs. It consists of all knowledge available to the processor during the task, as well as means for obtaining new knowledge, given what the processor already knows. This combination of knowledge (inputs) and means (operators) thus serves as a boundary and, therefore, limits what the processor can come to know in a given task [Waterman and Newell, 1971]. It is important that the operator set be complete, since it determines what behaviors the model can describe, ex post. In general, the problem space is not unique. That is, two or more processors may operate in different problem spaces. This implies that more than one problem solution approach generally exists.

The knowledge aspect of the problem space depends on both the background of the processors as well as the information presented to the processors in the task. Each subject comes to the task with a certain amount of education, training or experience which influences his approach to tasks such as that of this study. Previous research indicates that such factors are in fact important predictors of the decision outputs of individuals [Ashton and Kramer, 1980]. To the extent that subjects are similar along these dimensions then, the more likely is the observation of the use of similar processing behavior, including the use of a particular problem space.

The operators employed in a problem-solving task are behaviors engaged in by the processor as he or she moves through the problem space. Only those behaviors related to the assigned task are relevant. These include behaviors for the selection of elements for analysis, the subsequent analysis, and decisions as to the ultimate disposition of both items analyzed and the results of analysis. Elements selected for analysis may be extracted from the provided information set or derived by the processor by transforming presented information.

Analysis itself may involve internal or external comparisons, computations or the assignment of qualitative tags. Disposition behaviors relate to the decision to either discard an element, store (remember) it, or to continue analysis, as appropriate. Since these behaviors cannot be observed prior to the time they are actually engaged in by the processor, development of the problem space as an analytical device occurs ex post. Descriptive operators and other problem-space elements are developed jointly with other analyses. However, given knowledge of the task and prior research findings and/or theory, the researcher is able to develop a fairly precise list of expected operators and elements.

Operators are used by the processor to move through the problem space. This movement, or path, is along a series of knowledge states resulting from the application of the operators. Various definitions have been posited for a knowledge state. Newell and Simon [1972] demonstrate, as shown earlier, that the knowledge state is of limited size. Waterman and Newell [1971] define the knowledge state as the set of currently active nodes along the lowest branch of the PBG. This definition implies that the <u>result</u> of more than one operator application may be contained in a knowledge state, a point consistent with research results concerning the size of STM [Newell and Simon, 1972]. Bouwman's operational definition of a knowledge state [Bouwman, 1980, p. 7] also follows this result: "A knowledge state consists of a collection of facts (symptoms), relations between those facts, problem hypotheses and leads." As used in this study, a knowledge state minimally implies (1) an operator, (2) the result of at least the previous knowledge state (unless there is a break in the PBG, i.e., the subject change), (3) some path information, (4) some knowledge of the present position relative to the desired position or goal (which may not be apparent to the researcher) and (5) some background knowledge based on past experiences (which again may not be apparent to the researcher). Information relative to the last two components may not become apparent until the subject decides to summarize processing activity near the end of the analysis.

Finally, it should be noted that, while the knowledge state is a useful theoretical concept, it is extremely difficult to operationalize. The size of the knowledge state or time spent at each knowledge state was not addressed in this study for the following reasons. First, there is no definitive set of rules regarding the composition of the knowledge state. Newell and Waterman's above definition as the lower, still open, arm of the problem behavior graph is problematical since (1) there is no general criterion that assures that the lower arm of one PBG is equivalent to that of another and (2) in the absence of definitive tests, we have no way of knowing if the above PBG criterion is complete; i.e., there is no criterion, other than Miller's number,[14] to suggest the appropriate size. When the chunking phenomenon is added, the problem appears to be greater than any added advantage of looking at the number of knowledge states. The breakdown of the PBG into such segments in the absence of explicit tests designed to assess this aspect of processing is arbitrary at

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[14]Miller's [1956] number is seven, plus or minus two.

best, and certainly is misleading. Finally, this feature is of questionable value since it is not necessary for analysis, and adds a dimension of uncertainty to the results.

4.4 The Element Representation: Derivation of Operators

The element representation was developed with two objectives in mind: (1) to demonstrate what operators are used and how they are extracted from the data and (2) to demonstrate the sufficiency of Bouwman's operator set as applied to this study. The representation was developed as follows:

1. All topic segments from a particular processor's protocols were listed sequentially and analyzed for knowledge elements.
2. Each knowledge element was then analyzed to determine if any data transformation occurred involving it. This determination was made by assessing whether information in the protocols concerning each tested knowledge element appeared explicitly in the provided information set. Any output not explicitly provided was deemed evidence of an operator being applied.
3. Any transformation was detailed, i.e., listed explicitly. Knowledge elements were determined to be either in- or outputs of the transformations detected.
4. Data transformations were coded by reference to Bouwman's basic and augmented sets as detailed below.
5. Exceptions were used to develop new operators or expand the scope of existing operators as defined. Exceptions were

> grouped by similarity of transformation involved in particular situations, including in- and output knowledge elements. Each class of transformation is coded as an operator.

The process is essentially iterative and each knowledge element mentioned by the processor is considered a potential application of an operator. The final determination of such an application depends upon the protocol evidence of input, output, and transformation involved.

The operators developed by Bouwman included the following: examine, remember, formulate relation, and formulate problem [Bouwman, 1980]. This set is augmented in this study by compute and tag operators. Each operator is examined in turn in this section. The remember operator was not included in the operator set in this study.

The examine operator can be visualized as an impression formation tool. The behaviors exhibited by processors using this operator are oriented toward answering questions concerning which, what, when, where and why. It is an umbrella operator for several specific types of processing behaviors, each of which Bouwman denoted as a basic operator.[15] The behaviors typically include observations about what is observed in the data, as well as processes which select the next item of information to be attended to. The observations are usually qualitative characterizations of data provided in the information set. The set of basic operators include the increase, trend, CA, C, CI, compute, and tag 1.

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[15]Basic operators are a minimal set of operators which, given the task and instructions, will adequately describe the behaviors necessary to process the problem [Newell and Simon, 1972, p. 146].

The increase operator is used to qualitatively assess the movement in the magnitude of a knowledge element across time in a very general sense. The use of the operator implies that a comparison has been made of the level of the element assessed for at least two periods. The output is a determination of whether or not an element's value in year x is greater than, less than, or equal to the value for year (x - 1). For example, the processor may state that "sales increased". This implies a comparison of at least two years' sales.

The trend operator also assesses the movement of the magnitude of an element across time, again qualitatively. However, in the trend case, some time period is selected as an explicit benchmark for comparison purposes, similar to horizontal analysis in financial statement analysis. Use of this operator implies a deeper level of analysis than does the increase operator; it is also less likely to be employed by the processor. It is likely to be used in situations where the data is not clear-cut, such as either very large or volatile changes of any kind [Bouwman, 1978, p. 168]. In this study, use of the trend operator is implied when (1) the processor explicitly calculates period-to-period changes (this includes situations in which a growth rate for an entire period greater than two years is calculated), or (2) the processor states that such a comparison is made. An example of the use of this study would entail statements such as "sales growth was 20% each year," implying computations across time.

The CA operator involves the comparison of a firm-specific value of a data item with an industry value, e.g., the current ratio. This operator may be used in conjunction with other operators, such as the increase. In general, it tends to be applied to the most recent year's data. It can be contrasted with the C operator, which entails the comparison of the realized value of a firm data element with the internal enterprise forecast (or budget amount) of the particular datum. This operator is not used in this study since no such internal data appears in the prospectus. It is included here for completeness since at least one subject voiced a concern for some internal data.

The CI operator is implied when the processor compares a firm data item with some personal standard or heuristic. For example, one comment of subjects in this study was that government (defense, etc.) contracts had low or limited margins, a potentially negative feature. Such a statement implies that some internalized value has been used to make a comparison. If the data did not fit the preconceived notion (or heuristic benchmark) a search was generally undertaken for the explanation. Use of this operator is implied when the processor uses data for comparative purposes that is not supplied in the information set or derivable from the supplied information. For example, a statement that the current cost of goods sold is low would not be a use of this operator since the implication is that a comparison is being made to prior periods, not to some internal value.

The compute operator was, as stated before, added to the set used in this study. Strictly speaking, computation is a programmed activity. However, computations are often engaged in by decision-makers as part of the overall decision-making process and are thus arguably part of the basic processes. Use of the compute operator is implied in this study when the processor engages in an explicit calculation of any kind, at the earliest topic segment in which such indication of calculation is given. All subsequent topic segments dealing with calculations, including process output, is also coded as a use of the compute operator.

Two classes of behavior are coded as "tag" in this study. In the first case, the processor assigns a qualitative label to a knowledge element. This operation is included in the set of basic operators. Generally, the label assigned is the processor's assessment of the impact of the given knowledge element on his or her overall characterization of the subject firm. This assessment includes instances in which the subject uses either negative or positive words to describe a situation. For example, the processor may describe the debt level as "good". Such usage was taken as evidence of the impact of the element. Any such assignment activity was coded "tag 1" in this study.

In the second class of behavior, the processor is essentially involved with checking the data, with no particular or necessary label being attached. This activity, like reading, is not considered an operator in this study since data is not transformed or overtly manipulated in any way. For example, a processor might note that the firm has no inventory. This assigns no necessary implication to the knowledge element; it merely highlights it as a part of the information set. Such statements, in the absence of qualitative labels, are coded as "tag 2" in this study. In general, the activity subsumed by this coding device includes (1) selecting a next step in analysis (i.e., next element to be attended to), (2) output of other operators when removed from the topic segment(s) in which the operator is applied, (3) paraphrasing of the information set provided, (4) statements relating the impact of elements not actually assessed or included in the information set, or, (5) statements of the opinion of the processor about future conditions or amounts of particular elements where such statements are not tied to present levels of particular elements of the information set provided.

The formulate relation operator is concerned with behaviors the subject engages in as he or she starts to piece together an internal representation of the subject firm. It is essentially a confirmatory device used when the subject's characterization of the firm does not seem to fit together at some juncture. Different elements are linked to each other in attempts to explain perceptions of the data presented. As used in this study, the formulate relation operator is implied if: element 1 is linked to element 2 by the processor, as either explaining, supporting, or clarifying a particular result (element). The linkage must be explicit.

The formulate problem operator is closely related to the preceding operator. However, it appears near the end of analysis and is a summarization device. The operator involves the establishing of the central or derived impression of the subject firm and may be either negative or positive in nature. It is implied by (1) listing activity by the subject of features of the firm, along with qualitative labels, (2) the processor stating that he or she is summarizing, or, (3) the processor stopping analysis and announcing the problem(s), or the lack of problem(s).

This study also utilized a trivial assignment device - reading. Reading occurs if the protocol of a subject follows the text of the provided information set.

The remember operator was dropped from the operator set for several reasons. Among these were the following:

1. Protocol evidence of remembering must be inferred from other protocol segments coupled with ex post debriefing data. There is no evidence that suggests such a remembered list would be complete. Nisbett and Wilson's [1980] results suggest incompleteness.
2. Presence or absence from the list may indicate more than one problem. For example, one difficulty may be a failure to remember. Another difficulty is that, as constructed, this operator's use implies importance. Other trivial items not relative to the "big picture" may be remembered. Thus, the operator may be a source of misspecification of the model.
3. By definition, if a knowledge element is being attended to, it becomes part of the current knowledge state. Such attention implies an implicit ranking and labels an element

as probably important. This would argue against an explicit ranking scheme.

In general, the element representation involves the establishing of a classification scheme. While this may seem novel, it is quite common to research. Most empirical research which involves more than one sampling unit generally involves some such scheme, at some level of specification. The process itself becomes fairly well defined, as long as the strata involved are sufficiently explained.

4.5 The Problem Behavior Graph (PBG)

The problem behavior graph is a dynamic representation of the processor solving the problem. It details the path the problem-solver takes through the problem space. As such, it consists of a linked string of operator groups.

The PBG is derived through an iterative process. Once the elements have been identified, the PBG is pieced together by following the path identified by the protocols. The process is essentially one of appending each operator group identified to the growing end of the graph.

The PBG is the central vehicle for the building of an explicit model of a subject, as well as the springboard for analysis. It is here that the researcher is able to identify the regularities (or irregularities) in a processor's behavior or begin to explain how or why a processor chose to engage in particular actions. Also, the PBG, along with the protocols, helps the researcher to identify ways in which the processor applied the operators implicit in PBG formation.

Finally, it is at this stage that the research is able to probe issues such as: (1) how does the processor select an operator for application; (2) how does the processor decide which element to analyze next and (3) how does the processor decide to continue, stop or revise analysis at a particular juncture.

4.6 <u>Reliability and Validation Procedures</u>

The analysis adopted in this research is primarily from the psychological perspective. Validation and reliability measures reflect this orientation. Model reliability is often not addressed in protocol studies due to the time constraints involved and the availability of subjects for second sessions. In this study, validation procedures included the following. First, a second case was developed. This was then presented to one of the subjects who agreed to participate in the cross-validation. From this session, a second set of protocols was obtained and analyzed as described earlier. The decision made and the formation of the model(s) was compared to the original model(s) and the decision that would have been made using the old model in the context of the new case. This procedure results in a simultaneous retest reliability and cross-validation of the old model. The obtained models appear in Appendix II and are analyzed in Chapter 5.

Inter-rater reliability was also assessed in this study, using both simple proportion of agreement and the Kappa coefficient [Cohen, 1960]. The Kappa coefficient removes the effect of chance agreement between raters. The coefficient is computed by subtracting the statistically derived proportion of chance agreement from the numerator and denominator of the ratio obtained by placing the proportion of simple agreement over one. The results of this computation appears in Chapter 5.7.

CHAPTER V

ANALYSIS AND REVIEW OF THE MODELS AND PROCESSING BEHAVIOR

5.0 Introduction

In a 1981 article appearing in Administrative Science Quarterly, Ungson, Braustein, and Hall posited that "...problem settings in organizations are typically ill-structured,[16] and decision aids developed from studies of well-structured problems (lab studies) may not be applicable." They further stated "... We recommend the use of computerized simulations over time for studying ill-structured problems..." [pp. 125, 128]. The present research is viewed as a first step in such a simulation process. However, the primary goal of this research is the examination of the processing behavior of subjects in this taks domain.

The models developed in this study can be assessed from a process tracing perspective as follows: As stated earlier, subjects were assumed to have adopted the risk-return paradigm using fundamental analysis as a frame of reference. Given this orientation, traditional measures of risk and return ought to be important to the processors. In each specific case, the subject's model can be viewed as being a series of tests of items drawn from an internalized list of variables related to risk and return. Thus, for example, the model of S4 can be

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[16]An ill-structured problem is (one) in which the problem-solver contributes to the definition and resolution, using information generated from (experience) [Simon, H. and J.R. Hayes, 1976, p. 277].

viewed as a test of a list containing the topics: origin of shares sold, uniqueness of product, relationship of product to competition's products, income progression, auditor's report, legal statement, and presence/absence of a venture capital firm. Each item on the list is processed and assigned some designation. This set of designations is somehow summarized and a decision made.

Given the above orientation regarding the models, this chapter proceeds in the following manner. First, each of the hypotheses stated in Chapter 1 is analyzed. Second, the overall behavior of the subjects is addressed. Third, model reliability and inter-rater reliability is assessed.

5.1 Hypothesis One: The Assessment of Strategies

H1: Subject classes will differ in search strategies employed.

Strategies employed by subjects during processing were not unambiguous. The nature of the study itself made it very difficult to assess strategies employed on a systematic basis. For example, analyzing whether a subject was involved in depth-first or breadth-first analysis, or intradimensional versus interdimensional probing is virtually impossible in a single firm, case study situation. In general, such characterizations involve choices among or between several alternatives, rather than the analysis of one item. While general observations can be made about specific patterns or incidences, no general classification is possible. Previous research in this area has solved this problem by looking at strategies from the standpoint of what the process did, in a literal, descriptive sense [Bouwman, 1978, 1980], as the processing proceeded. This approach is adopted here.

Bouwman [1980, p. 23] found that his less-experienced subjects followed the strategy of proceeding through the provided data set in a straight-forward, front-to-back fashion. Very little deviation was found to this pattern. Professional subjects, on the other hand, often moved back and forth through the data, as if marking off an inherent checklist, developing linkages and chained relationships among processed knowledge elements.

These results were partially replicated in this research, but there are notable differences, some of which can be attributed to the following reasons. First, the nonprofessional subjects, in this study, were not students, but experienced, older investors. Second, all of these subjects were university graduates with responsible business positions. Such training and experience, in and of itself, ought to provide the subjects with greater maturity and increased evaluation skill when compared to Bouwman's subjects. These factors ought to diminish the differences between groups in this study.

The nonprofessional subjects in this study did, in general, follow a sequential, "straight through", strategy. However, all of them also engaged in some type of oscillating or linking behavior. For example, consider these excerpts from the protocols of S5 and S7.

> S5: "I'm going back to the table of contents, keying in on certain areas I'm looking for..."
>
> "I'll have to find... I'm searching... through the prospectus... for some kind of explanation for... the extraordinary item..."
>
> S7: "... fixed costs... are being absorbed by a similar amount of sales with lower profit. So... I'll have to look at why that is..."

"It doesn't say here whether or not they qualified their statement... So until I see it later, I'll assume that it is an unqualified opinion..."

These statements are used to illustrate the diverse approaches taken by subjects during processing. S5 clearly did not follow a straightforward, front-to-back approach. At numerous points in the data, he back-tracked, paused to assess his progress, and figured out where he wanted to go next. S7, before analysis, briefly looked at the table of contents and skimmed briefly through the prospectus. And while S7 did exhibit more front-to-back behavior, the reasoning appears to differ from Bouwman's subjects. When something did not fit, he merely assumed that it had to be a certain way and that corroboration (or disavowance) would come later in the data. S6 followed an almost exclusive front-to-back strategy, moving through the data with only minor deviations.

The nonprofessionals in this study also clearly seemed to be using some type of checklist. This is alluded to above in the statements by S5. However, perhaps the strongest evidence of all is the fact that most subjects (both professional and nonprofessional) not only exhibited behavior from which the existence of a checklist could be inferred, they also made comparative statements to other specific firms similar to that in the prospectus. For example, consider the following excerpts from the protocols of S5 and S7:

S5: "... I can't think of the specific company that does this right now..."

S7: "Companies who are merely assembling, as these folks are, such as Amdahl or Memorex..., have run into some real problems..."

These statements would suggest that the subjects are comparing the presented firm to enterprises they are familiar with. In order to do this, some "outline" of the comparison firm, salient features, etc., must be available. From this, it can be inferred that this "salient features 'list'" was used to highlight similarities and differences between the firms. And even S6, who made fewer references of this kind, commented that "the firm's situation was similar to that of Prime Computer's several years ago. And today, his bank (place of employment) used Prime's computers..."

The nonprofessionals in this study also engaged in fairly elaborate linking behavior pertaining to relationships found in the data. For example, consider the following excerpts from the protocols of S5, S6, and S7:

> S5: "The large costs incurred from that is probably due to selling these systems... as opposed to maintaining them. And that's why, as the maintenance aspect increases... cost of sales decreased..."
>
> S6: "...the percentage of growth experienced was greater than expected...experienced.... Obviously, that would explain also why there wasn't any inventory..."
>
> S7: "1981, the use of capital has restricted their ability to earn apparently and caused the costs to go up..."

Such behavior was repeated several times by each of the nonprofessionals. In fact, this finding occurred most often with the nonprofessionals. Only one of the professionals, S1, engaged in this behavior to any degree at all. This type of behavior seemed to be a function of the amount of time used and the depth of processing employed. Most of the professionals felt that close analysis was simply not worthwhile. This viewpoint is addressed later in this chapter.

The professional subjects were much more explicit in describing and carrying out their processing activities, especially the more experienced ones. S4 used the following to describe his processing, which clearly describes a checklist:

> S4: "... particularly looking at... where the stock is coming from.... Find out what the company does... look at legal matters... I'm not much interested in dilution... see if there is... some... venture capital firm involved..."

S2 described his approach as follows:

> S2: "First thing I would normally do when a stock has not come to market is to take a quick look at the prospective PE ratios for similar companies in the industry... I would make a quick analysis of the rate of growth..."

S3 also clearly had some representation in his mind that he was checking the data set, and the firm, against. For example, consider this excerpt from his protocols:

> S3: "It's supposed to say in one of these prospectus what... who's selling it, the selling stockholders, and it doesn't seem to..."

S3 had overlooked certain paragraphs in the beginning of the prospectus which contained the relevant information. It is clear from his comments that the information was not only expected, but important to the decision to be made. Further evidence of this importance is given by the fact that S3 spent several minutes tracking down the desired information.

One essential difference between this study and Bouwman's which may cause the processors to act in particular ways is the context. In this study, the presented company should be relatively free of major problems. The analysis involves essentially a spot check at a particular point in time -- somewhat analogous to an annual physical for an individual already subjected to previous screening (S.E.C. rules, etc.). In contrast, Bouwman's subjects expected a problem. This situation is somewhat analogous to the patient who tells the doctor, "I'm sick, tell me what I have." In the latter context, it is probably more likely that the physician-processor will engage in explicit search behavior, linking facts together, in attempting to find and diagnose the problem. In the former case, the likelihood of a serious problem should be lower since the firm knows that its securities will be competing in the marketplace with other securities and investment opportunities. In such a scenario, one would expect a high emphasis to be placed on demonstrating above average results.

As stated above, the professionals did not, in general, ascribe great importance to detailed analysis of the firm. While all of them used the accounting data from the firm to assess its future prospects, they indicated that this was only part of a total process. This position was most clearly articulated by S1, who did the most detailed analysis: "... looking at past numbers alone isn't necessarily going to give you a good clue as to the future. The fact that they've had a pretty good record is really no guarantee that it's going to continue..." S4 going further, stated that often a stock just might be "the right stock at the right time, but not the best stock." He pointed out that he purchased stock from Prab Robotics even though he thought that IBM and Cincinnati Milacron made a better product. But since robotics was a current buzzword, probably any good company's stock would go up. The stock was purchased without benefit of financial data. (However, knowledge of the parent company was obtained.)

None of the professional subjects followed a sequential processing strategy. S1 and S2, who read most of the prospectus, often jumped back and forth in the data set. S3 and S4 used a relatively small list of topics for analysis and simply entered the data set and extracted those elements. This point is demonstrated by the following quote from S4's protocols: "Everything that I'm interested in could be put in about four pages, and the rest of it you can throw in the wastebasket."

As demonstrated by the earlier quotes, the professionals all appeared to use some type of checklist. Like the nonprofessionals, most of them also had some firm whose circumstances they considered similar to the subject firm's. S1 considered Amdahl to be similar. S2 spoke of Applied Digital Data Systems. S3 likened the firm to Cascade Data. S4 used no comparison firm.

The results of the analysis of the strategies employed by subjects were not clear-cut. The findings can be interpreted in several ways, given the protocol evidence. For example, a surface analysis of sequential analysis might suggest that it is likely to be employed by naive subjects. Yet, as evidenced by S7, it might also be simply due to the belief that everything important will be covered, eventually. And while none of the professionals employed a strict sequential process, much of the processing of those who reviewed all of the prospectus (S1 and S2) was sequential in nature. This result is not surprising since material tends to be read in the order in which it is laid out. Additionally, while S1 and S2 did engage in sequential episodes,they also tended to be much more selective in terms of items selected for closer attention.

The existence of a checklist was evident across both groups of processors, but clearly stronger for the professionals. This result seemed to be related to experience and/or age. However, S5, who also presented strong protocol evidence of such a checklist, was the youngest and least experienced of all processors.

While the small sample sizes and the contect of this research is limiting, some inferences can be drawn from the results for accounting policy-makers and researchers. One possible research inference from the data is that much of an observed subject strategy may be a function of experience and the degree of detail engaged in by the processor. As a processor investigates data items more closely (increases the degree of detail), the greater is the likelihood that things that do not "fit" will be discovered. The subsequent examination of such relationships is likely to result in linking behavior, and, most likely, non-sequential behavior. This assumes, of course, that the processor recognizes items which do not fit the overall pattern. This assumption simply may not have been valid for Bouwman's students [1980]. As a result, they did not engage in linking behavior.

It should be noted that linking behavior always occurred when something was perceived to be wrong in the data set. Thus, the absence of such behavior likely implies that the processor perceives that observed relationships are "correct" or that a more detailed analysis is unnecessary. The latter view seemed to be operative in this study, especially for professional subjects.

One implication which can be derived is that observed decision behavior may be a function of task instructions and the experimental demand characteristics, as well as the variables ex-

plicitly manipulated. Care should be taken in analyzing observed behavior relative to what the subjects were instructed to do. That is, if a subject is told to do "x", care should be taken in determining what behavior is necessary to do "x", apart from the experiment itself, and what behaviors may be induced by the experiment. This point is also made by Ebbesen and Konecni [1980].

An objective of policy-making is the effective dissemination of information. The FASB, in its SFAC No. 1, stated "... the benefits of information provided should be expected to at least equal the cost involved" [1978, p. 10]. One way in which the potential benefits of financial information may be enhanced is placement. It may be advantageous for policy-makers to decide, a priori, that certain information is more important than other information, based on theory or other appropriate guidelines, and to make sure the selected data is displayed early in prescribed communications to users (such as the annual report). The results of this research indicates that some users will not simply select appropriate information early on in analysis. By strategic placement, policy-makers may encourage more cost-effective use of provided information.

5.2 Hypothesis Two: Information Use Assessment

H2: Subject classes will differ in amount of information attended to during the analysis.

Information processed by subjects was assumed to bear some relationship to the assessment of risk and return. If a broad perspective is taken, this relationship can be construed for most data concerning any particular enterprise. However, most finance texts

[Reilly, 1979] address risk from a fundamental perspective in terms of three areas: business risk, financing risk, and liquidity risk. Business risk is derived from the nature of the business the enterprise is engaged in. It is generally measured as a function of sales or earnings volatility. Financing risk is derived from the method of financing investments, i.e., the makeup of an enterprise's capital structure. It is usually enumerated in terms of the degree of debt financing. Liquidity risk is related to the ease of convertibility of an investment to cash in a reasonable amount of time without having to make concessions. It is generally measured as the difference between purchase price and the expected selling price at any particular point in time [Reilly, 1979, pp. 16-18]. The return from an investment is generally measured in terms of dividends and capital appreciation. In the context of this experiment, where no market stock price exists, subjects are forced to use surrogates for the expected levels of the stock price -- earnings and sales growth, return on assets, etc.

The subjects in this study did indeed address items related to the above areas. Examination of the PBG's and protocols reveals that every subject reviewed either or both of sales and income growth, debt level, and the industry of the subject firm. In fact, an incomplete list of topics addressed by subjects would include the following: sales and income growth, dividends, compensation, margins, costs, backlog orders, competition, customers, sales basis, uniqueness of the firm's product, industry, military ties, debt, legal matters, the auditor's report, the underwriting firm(s), origin of the stock sold and the size of the offering. While it is relatively a straightforward matter to infer most of the previously cited areas in the above lists, the liquidity notion, which is often ignored, was also clearly evident. For example, several subjects commented that the size of the offering was good, since it would not "flood the market." S7, in his analysis, stated that he was "concerned about the safety of the stock's value." S2 worried that such an offering might be an opportunity for a small firm to "make a killing as (his) expense, or... to develop a market for estate purposes..." In sum, subjects did appear to address the appropriate areas.

An interesting aspect of the information selection and use problem was the implicit faith that some of the subjects expressed relative to the data. For example, S7 assumes that the auditor's report "will be unqualified, since the S.E.C. wouldn't allow the prospectus otherwise." And S4, when beginning his analysis, notes that "(he) assumes that the information is accurate, if the CPA's say it is,... I take their word for it...." In essence, it would appear that safeguards such as an outside audit or legal review serves to reassure investors as to the existence of some minimum level of safety associated with the investment vehicle.

The information attended to by subjects in this study was approached broadly. Information was considered to be attended to if, during analysis, the processor in some way transforms the particular knowledge element. In effect, this implies that any situation in the subject's protocols from which an operator application can be inferred also implies information use.

Both cursory and detailed examination of the problem behavior graphs, protocols, and models of the subjects indicates that there were differences between the professional and nonprofessional subjects. For example, S4, in his analysis, examined the following subject areas: origin of stock, industry, product, compensation, sales progression, return on equity, venture capital involvement, the relationship between earnings and sales, legal matters, auditor's report and the makeup of the firm's clientele. S6, in his analysis, examined the offering size, whether the firm was a manufacturer or not, sales basis, the company's ties to the military, sales growth, debt level, likelihood of trading suspension, dividend payment, return ratios, inventory levels, costs, product price range, contracts out, composition of sales, suppliers, competition, the board, management compensation, where the stock will be traded, the auditor's report, inflation effects on the firm, the assets, the underwriters, firm beta, industry, and employee turnover. While S6 was probably most zealous of all subjects in attending to all facets of the firm, the lists do point out the differences in the information attended to.

In the following table, a percentage analysis of the degree of correspondence between information topics covered by each processor relative to the others is shown. The topics are taken directly from the protocol models of each subject (see Appendix I). In the table, each top figure in a cell for each subject gives the percentage agreement between the topic lists of that subject (i^{th}) with other subjects (j^{th}), using subject "i's" list as a benchmark for measurement. The bottom figure gives the percentage that the topics in agreement between the two subjects list comprised of the j^{th} subjects total list of topics processed. For example, in line 1, under S3, is the comparison for S1 and S3, using S1's list as a comparison benchmark. The figures indicate that S3's list agreed with S1's list only 39% of the time. However, the items in agreement comprised 90% of S3's list. Conversely, if S3's list is taken as a benchmark, S1's list is 90% in agreement with the topics on S3's list, but only 39% of his list is used. In other words, S1 covers many more topics than does S3, but still covers 90% of the topics S3 covers. It should be noted that this analysis does not address the issue of how information was used, or what conclusion was made; only the notion of information use described above is analyzed. The analysis proceeds by successively analyzing the information use similarities and differences for each subject in comparison with all other subjects.

S1 does not offer a clear-cut dichotomy about information use between professionals and nonprofessionals. That is, there is no clear-cut trend in the comparison of his list with the other professionals (S2, S3, S4) when compared to the nonprofessionals (S5, S6, S7). His list is about half in agreement with that of S2 (52%) and of approximately the same length. But this is also true for S5 and S7. In fact, S1's list, in both size <u>and</u> content corresponds most closely with that of S6. S1, who has earned the Certified Financial Analysts designation, is the youngest (33) and least experienced (9 years) of the professionals. His analysis covered more topics than did any other professional.

TABLE 3

PERCENTAGE AGREEMENT AMONG TOPICS ADDRESSED ACROSS SUBJECTS

	S1	S2	S3	S4	S5	S6	S7
S1	--	52	39	35	48	74	52
	--	52	90	53	48	63	44
S2	52	--	35	43	35	35	39
	52	--	80	67	36	29	33
S3	90	80	--	60	30	50	50
	39	35	--	40	13	18	19
S4	53	67	40	--	53	47	47
	35	43	60	--	35	25	26
S5	48	36	13	35	--	48	35
	48	35	30	53	--	39	30
S6	63	29	18	25	39	--	30
	74	35	50	47	48	--	29
S7	44	33	19	26	30	29	--
	52	39	50	47	35	30	--

S2's information use does demonstrate a fairly clear pattern. The topics addressed are, in a general sense, more closely related to those of the other professionals, especially if both agreement and length is considered. While the degree of agreement is not large in a total list sense, if the length of the other processor's list is considered, the agreement is considerable. S3 and S4's items in agreement comprised 80 and 67 percent, respectively of their total lists. The lowest agreement is 52 percent with S1. In contrast, the highest agreement with a nonprofessional is 39 percent, and the length of the list of topics is, in each case, similar. One note here is that S1 and S2 both had lists of approximately the same length, each roughly equivalent in length to the nonprofessionals. However, S2 has 16, rather than 9, years of experience. Also, he is 44 years of age. An implication which may be inferred here is that age and experience may make a difference in how information is used.

S3, while having a short list of topics addressed, nonetheless had a fairly high degree of correspondence between items appearing on his list and also appearing on that of the other professionals. S1 addressed 90 percent; S2, 80 percent; and S4, 60 percent. This was the highest level of agreement for any of the processors. The level of agreement with the nonprofessionals (S5, S6, and S7) was 30, 50, and 50 percent, respectively. More revealing, however, is the fact that the items in agreement comprised less than 20 percent of each nonprofessionals list of topics. This level was approximately double for the professionals. S3 had also earned the Certified Financial Analyst designation.

S4's results were also ambiguous when one considers the degree of agreement only. No clear-cut trend develops since the professional's degree of agreement (53, 67, 40) is not notably different than that of the nonprofessional's (53, 47, 47). When one considers the length of the list as well, a degree of consistency does develop in favor of the professionals. The share of their lists used in "agreeing" with S4 ranges from 35 to 60 percent. For the nonprofessionals, the highest level of items is 35 percent with S5.

S5's list of topics fit best with that of S1. However, in no case did S5's list comprise 50 percent or more of someone else's list. He was 48 percent in agreement with items on S6's list, but the items comprised only 39 percent of S6's list of topics. All other (except for S1) agreement levels ranged from 13 to 36 percent for both the professionals and nonprofessionals. And even though the nonprofessionals all had lists of similar length, when this aspect is added in, S5 still has a maximum agreement share (of the other processor's list) of 40 percent. S5 was the least experienced (in terms of length of time) of the nonprofessionals. He was, however, most experienced in dealing with new offerings and had investigated several on his own earlier in the year.

S6 covered more topics than any other subject. Except for S1, his degree of agreement was not high. Among the professionals, the level was 36, 13, 35, not including S1. When items in agreement as a function of the other processor's topic list's length is considered, the levels are 35, 50, and 47 percent. These levels for both raw agreement and with length considered is roughly equivalent to those with the nonprofessionals -- 39 and 30 percent for agreement, and 48 and 29 percent for length, respectively. No clear pattern emerges with the professionals or the nonprofessionals. S6 made numerous factual and computational errors. In fact, one is left wondering whether the degree of correspondence is a function of the total items covered by S6 or of chance. The latter becomes much more plausible when the protocol evidence between S1 and S6 is considered. In almost every case, the conclusion drawn relative to an information item is quite different.

S7 was the most experienced of the nonprofessional investors. He belonged to an investment club which regularly performed analyses similar to those performed in this study. As can be seen from the data, S7's level of agreement was not large with any particular processor, in no case exceeding 45 percent. Again, no clear-cut trend emerges. The levels of agreement with the professionals (44, 33, 19, and 26 percent respectively) roughly corresponds with those with the nonprofessionals (30 and 29). When the length of the list of topics is considered, the picture is slightly clearer. The length adjusted agreement levels are 52, 39, 50, and 47 percent, respectively, with the professionals and 35 and 30 percent with the nonprofessionals. S7 appears to be slightly more in agreement with the professionals than the nonprofessionals.

There are some rough trends apparent in the data. If an agreement level of 50 percent is used as a benchmark, then several conclusions can be drawn. First, the professionals as a group did tend to use the same information more than did the nonprofessionals. In fact, if any trend was evident about the nonprofessionals, it was that they were more like the professionals than they were like each other! However, one point is clear. When given the same data, both the professionals and the nonprofessionals tended to look at a wide variety of information. While this study did not assess the degree of correlation among items in the data set (which might indicate a higher degree of agreement), the lack of correspondence between items addressed across subjects was pervasive enough to suggest that all of the processors were picking different elements out as important.

One point which became clear in the protocols was the fact that the differential instructions as to the objective of the exercise (analysis for clients versus analysis for own use) made no difference at all. They were routinely ignored. All of the professional subjects simply did an analysis and then proceeded to talk about the kind of individual the subject firm would be suitable for. This invariably included themselves. In no case did any subject suggest that the analysis would be different based on the prospective use.

Age and experience does appear to be a factor. S3 and S4 achieved the highest levels of agreement from the other processors, both achieving better than 50 percent on average. They were both over 50 years of age and had more than 20 years of experience. And even though their lists were shortest, the above results were still apparent among the professionals.

One tentative inference which can be drawn from the data in Table 3 and the protocols is that perhaps an important variable in analysis is how often one does security analysis in a frequency sense rather than how long (overall) one has been doing it. For example, both S5 and S6 indicated that they did such analyses more often than did S7. While their overall results are not markedly different from S7's, they each did achieve at least one result (63% for S6, 48% for S5) which was better than S7's.

While the context and nature of this research is limiting, the finding of a wide variety of items addressed has some relevance for prior research such as that of Ebert and Kruse [1978]. They found that the R^2 of regression models in an investment context was low.

This result is certainly not in conflict with the tentative findings of this research. It would seem logical to surmise that one explanation of low R^2's in preselected items (independent variables) studies is that the items selected simply do not represent items which are both familiar and useful in a parsimonious fashion by the processors.[17] As a result, the models are not overly explanatory relative to output decisions.

In addition, subject to the above constraints relative to the context and sample size, the findings also bear some relevance to the work done by Hofstedt [1972]. While nonprofessionals in the present research did indeed use more qualitative data than did the professionals, they also simply did more analysis in general. In fact, not only did most of the nonprofessionals do the qualitative analyses, they also performed the same types of quantitative analyses as did the professionals. In general, it appeared that the nonprofessionals simply needed more information to make a decision when compared to the professionals. It is interesting to note that none of the nonprofessionals complained about too much data, while every one of the professionals voiced such a complaint. This last result should be of interest to accounting policy-making bodies. Individuals who, as a result of their professional position, act as proxies for other investors, all felt inundated with information they felt was of questionable value. This position is most clearly stated by S4: "Everything that I'm interested in could be put in about four pages,

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[17]Another, perhaps more interesting supposition is that there is no well-developed theory or possibility of estimating future performance of stock prices. In this context, where no past prices exists, the increased uncertainty perhaps leads to more diverse actions than usual.

and the rest of it you can throw in the wastebasket... and if you care to relate that to the S.E.C., why, I'd be glad to have you... (laughter)...."

Finally, one factor which is important both to the information items addressed and to the experiment in general is history -- specifically, the state of the economy. All of the subjects stated some concern about the condition of the stock market in particular and the economy in general. Most wondered if anyone would or should be involved in the stock market during such an uncertain time period. This concern centered on the fact that high quality notes and other interest bearing securities were paying rates of interest well in excess of the traditional returns from stock investments in their view.

5.3 Hypothesis Three: Operator Mix Analysis

H3: Subject classes will differ in operators employed during the analysis.

The operator mix of each subject and the time spent in analysis appears below in Table 4. Like the data regarding strategies and information use, the results are not unambiguous. For example, tag 1, the qualitative impression expression operator, is most popular for all processors. Beyond this operator, however, the results are mixed, but trends are certainly evident.

Operators employed are a reflection of the level of processing engaged in by a subject. In almost every case, the professionals used fewer operators than did the nonprofessionals. This result appears to be related more to the items selected for analysis than total time employed in processing. Note that S2 used more time than two of the nonprofessionals, but still used far fewer operators.

TABLE 4

TIME AND OPERATORS EMPLOYED BY SUBJECTS DURING PROCESSING

	S1	S2	S3	S4	S5	S6	S7
Tag 1	45	28	18	32	49	30	20
CI	5	3	0	2	9	13	14
Increase	15	1	1	2	8	15	9
Compute	3	8	3	1	9	6	8
Formulate Relation	9	0	0	0	5	11	2
Trend	2	2	1	0	0	3	4
CA	0	0	0	0	2	0	0
Formulate Problem	2	1	1	1	0	1	1
Total Operators Used	81	43	24	38	87	79	58
Time	35+"	88+"	15"	13"	72"	49+"	97"

" denotes minutes; + denotes more than

The data continues to indicate that S1, in his analysis, was most similar to the nonprofessionals. Like his information use, this was true whether one considered single operators or the overall mix. For example, S1 is the only professional who utilized the formulate relation operator. While his utilization of the CI operator is not as high as that of the nonprofessionals, it nonetheless is the highest of the professionals. For all other operators, S1 is clearly most similar to the nonprofessionals.

S2 is in line with the dominant trend for the professional subjects -- for less processing. The only operator employed by S2 to any significant degree (other than tag 1) is the compute operator. The use level of this operator was most similar to that of the nonprofessionals. For most of the other operators, S2's use level was less than fifty percent of that of the nonprofessionals. In addition, he did not employ the formulate relation operator, which was used by every nonprofessional subject.

S3's operator utilization pattern is quite similar to S2's, but S3 uses even fewer operators than does S2. S3's second most popular operator was the compute, which was used to assess growth rates for sales and net income. Other than tag 1 and compute, no operator was used more than once and three -- formulate relation, Ci and CA were never used. S3 did very little processing that was not qualitative in nature, a result consistent with the professional view, related in the last section, that detailed analysis was not necessary. S3's mix of operators was even less related to the nonprofessionals than S2's.

S4, like S2 and S3, did far less processing than the nonprofessionals. Almost all of S4's analysis was qualitative. In fact, as evidenced by the following quote, he did not often use quantitative techniques in contexts similar to that in his study: "I look at the figures and I just... I really don't do a whole lot of work with a calculator or anything... I just look at the progression of numbers through here... I don't put numbers on paper, or anything..." S4 used the computer operator once -- to determine the return on equity. The formulate relation, trend, and CA operators were never used. S4's second most popular operator (after tag 1) was the CI and increase, both used twice.

All of the nonprofessionals did more analysis, on average, than the professionals. All used the CI, increase, compute, and formulate relation operators fairly heavily. In fact, the mix clearly indicates that the nonprofessionals tended to do quantitative analysis more often than the professionals. It should be noted that this point addresses quantitative techniques employed as a percentage of total analysis, not the percentage of quantitative data reviewed relative to all data.

In general, the nonprofessionals tended to use the CI (S5 and S7) or the increase (S6) operators most often (excepting, of course, tag 1). This is in contrast with S2 and S3, who used the compute. All of the nonprofessionals used formulate relation to develop linked relationships in the data. As pointed out earlier, only S1 among the professionals used this operator.

In summary, the nonprofessionals clearly seemed to use both more and a different mix of operators than the professionals, with the exception of S1. Again, this finding seems to present tentative evidence that processing behavior is related to age and experience. For accounting researchers, the results appear to imply that experienced subjects engage in somewhat different behaviors than do less experienced subjects. As in the general case, this result is limited in generalizability to contexts similar to that found in this study.

Finally, an additional caution is also necessary related to the operator analysis above. The analysis implicitly relies on Newell and Simon's assumption of invariance of processing speed (on average). It is only in this context that operator use across subjects can be compared.

5.4 Hypothesis Four: Time Use Assessment

H4: Subject classes will differ in amount of time spent in analysis (both on specific items of information and overall time).

As can be seen in Table 4, there were substantial differences in the amount of time spent in analysis by the different processors. The professional subjects, when viewed individually or as a group, clearly tended to use less time with the task than did the nonprofessionals. Only S2 spent an amount of time similar to that used by the nonprofessionals, and much of his time was used to read the prospectus (rather than in analysis). When time spent in analysis (here time spent is viewed as the application of operators, not actually time episodes) is considered, even S2's time is much closer to that of the other professionals, rather than to that of the nonprofessionals. Most of the professional subjects spent their time looking only at specific items in the information provided. And S2, in his analysis generally tended to examine the items as the other professionals, a point which is verified by reviewing the topic areas in his protocol model, as well as the results of section 5.2.

The nonprofessional subjects used their time to engage in a much more thorough analysis of the provided information. This included explicit examination of most aspects of the financial condition, asset base, and results of operations of the subject firm. Not only were sales, earnings, and debt reviewed, but also costs, inventory including cost flow procedure, as well as certain aspects of the statement of changes in financial position. In fact, it became difficult in many cases to discern which aspects of the analysis were more important since no real distinctions were drawn by the nonprofessional processors.

Little evidence on the importance of time spent in analysis appears in the literature since most structured lab studies tend to have fixed time analysis sessions. In his earlier cited study, Hofstedt [1972] did find preliminary evidence indicating that professionals tend to use less time and more quantitative data than do students in financial statement analysis. Hofstedt's finding appears to be substantially supported by the results of this research.[18]

Time, like any input in analysis, can be viewed as a costly item. Given any number of alternative investments, it is readily apparent that one's ability to assess them is a function of time available. Excessive use of time on any particular analysis is clearly going to result in fewer assessments being made or less time being spent on other analyses. Since Lewellyn, Lease and Schlarbaum [1976] found that most nonprofessionals in their study spent less than three hours monthly on such analysis, time per alternative analyzed would seem to be a clear limiting factor on total assessments made.

Another perspective may be used to view the time use aspect of the analysis by the nonprofessionals. As stated above, the time was spent in detailed probing of the firm. One potential inference is that the nonprofessionals felt that by spending more time and delving

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[18]None of the subjects appeared worried about time spent, per se. In fact, all wanted to talk after the experimental session itself was over.

more deeply into the firm they obtained a "surer" knowledge of its potential worth. Further, it may be the case that such detailed knowledge leads the nonprofessionals to feel that distinctions among items is unnecessary. The detail itself is a sufficient basis to assert knowledgeability about the firm, and hence an ability to make a decision. While there is no protocol evidence to support these suppositions, the processing behavior of the nonprofessionals does. Instances in which the nonprofessionals ranked or otherwise exhibited an ability to discriminate in terms of importance were few; only S5 did so with any regularity.

It is possible that the time element is an indicator of a lack of a clear-cut analysis process which entails data screening and/or ranking. This premise is similar to results reported by Ashton and Kramer [1980] that students have a lesser degree of self-insight and more ambiguous weighting schemes when compared to professional accountants. While the nonprofessional subjects in this study are experienced and reported that they regularly engaged in investment analysis, the above inference may still be valid. It seems reasonable to assume that the nonprofessionals may, at each analysis, go through an elongated, refamiliarization process since they don't do such analysis on a daily basis as do the professionals.

Finally, the above findings also support conclusions drawn in earlier sections of this chapter. Nonprofessionals seem to be doing something different than do professionals. The point that policymakers should probably be cognizant of placement vis-a-vis importance again seems appropriate. From an accounting research perspective, it would appear that care should be taken in using nonprofessionals to make statements or inferences about professionals.

5.5 Processing Behavior

Like most of the data generated in this study, the processing behavior could not be categorized in an unambiguous fashion for all subjects. However, there were some strong trends discernable in the data, especially for the professional subjects. For example, consider the following excerpts from the protocols of S4: "And... if I'm satisfied with the numbers and I like the company and I like the industry it's in and I think the product of their making has a future, then I'll probably make a decision to buy. And if all of these things don't come together, then I don't do anything with it...." S4 is clearly describing, in this review of his processing, what can be viewed as a large production system. This finding was also evident in the protocols of S2 and S3.

The above quote can also be used to illustrate, at least in part, the evidence which emerged from the protocols in support of a linear compensatory model for the professional subjects. In fact, the evidence was almost overwhelming in indicating that such a process was being used. For example, consider the excerpts below from the protocols of S1, S2, S3, and S4:

> S1: "... sales originate from contracts awarded on a competitive bid basis... sounds somewhat to be as of a negative feature... 58% of (ACP's)... sales were to defense-related agencies. Another possible negative ... having one large customer; however, given that we seem to be going to a more defense-oriented posture... possibly that could be a plus...."

S2: "Number one, it's a new issue... built-in bias right away against new issues.... Number two..., it is a company who's had a very rapid rate of growth... which is a positive.... However, 58... percent of the growth is with one customer... the government... which I would count to be a negative...."

S3: "... Competitive bid basis -- well, that's bad... O.K., ... 58 percent went to defense... that's bad.... So far we have two bad marks and not one good... not a bad record... seventeen point six annual growth rate... pretty good.

S4: "The stocks all being sold by the company -- that's one point in their favor.... Company's in an industry that's of interest... fact that it's plug compatible with IBM is of even more interest... one potential negative would be the fact that 58 percent of their... sales... were to defense related agencies...."

As these quotes demonstrate, the protocol evidence pointed strongly toward the use of a compensatory model. While this finding was not totally unexpected due to findings such as Payne's [1976] research which indicated that processors tended to use compensatory models for analyzing particular choice items, the strength of the finding was somewhat unexpected. In fact, this protocol evidence was the basis for the construction of models for the professionals which are essentially versions of Dawes and Corrigan's [1974] description of linear models: "The trick is to decide what variables to look at and then to know how to add."

The compensatory nature of the models is also compatible with Newell and Simon's [1972] characterization of the human information processor as a production system. As related earlier in the present study, a production consists of a series of premises, conditional in nature, which lead to certain actions if the prescribed conditions are met. In the usual case, the actions are triggered by the cascading effect of the summarization of likelihoods related to each additional condition or fact. Thus, for example, the situation might begin with some perceived probability that a certain action will take place. As each additional fact (or condition) becomes realized, the probability changes (either increases or remains the same). When some prescribed level of certainty is reached, the action occurs. If the level is not reached, nothing happens.

Now consider the scenario in a compensatory model. In the usual case, there is a criterion variable (action) and one or more independent or predictor variables (conditions). What makes a model compensatory is the fact that a minimum contribution from any given predictor is not required to reach some prescribed criterion level. Low values on one variable can be offset by (compensated for) larger contributions from other variables. There is no requirement of a relationship with the other predictors (the model assumes statistical independence). Each variable's beta weight can be viewed as analogous to the contribution to the unconditional probability of the production model. That is, summing the weighted prediction values leads to the criterion level. This summing activity is precisely what occurs in the production system case. The choice of the action level is relatively unimportant since it depends on the use of the system. Therefore, the claim is made that the activities in each case are similar. More precisely, the claim is made that compensatory models can be interpreted as a subclass of the set of production systems. That is, any compensatory model can be restructured as a production system.

For example, consider the case of a graduate admission process. Generally, some combination of undergraduate grade point, graduate record exam score and "recommendation" is used to assess probable success of the candidate if admitted. The weights assigned to each predictor factor can be interpreted as probabilistic assessment of their unconditional value in predicting the criterion variable. The change in R^2 or the criterion score can be viewed as the conditional value of each variable (the relationships are best surveyed from a standardized perspective since units are equal). A possible production rule model would be:

If (GPA) x ("weight") > "value"

or If (GRE) x ("weight") > "value"

or If (Evaluation) x ("weight") > "value"

or If [(GRE) x ("weight") + (Evaluation) x ("weight")]>"value"

or If [(Evaluation) x ("weight") + (GPA) x ("weight")]>"value"

or If [(GRE) x ("weight") + (GPA) x ("weight")]> "value"

or If [(Evaluation) x ("weight") + (GRE) x ("weight") + (GPA) x ("weight")] > "value"

then admit student.

Note that even though the above model may seem naive and "trivial" (for example, why not use the following rule: if [(GPA) x (weight) + (GRE) x (weight) + (Evaluation) x (weight)] "values" then, admit student), the underlying behavior is not. In essence, a line says "If parameter is "value" then conclude success or failure with probability "value". That is, the admit action implicitly carries with it a prediction of future success at some probabilistic level. The production model merely presents a greater level of detail for assessing possible combinations of the underlying decisions being made.

An additional feature of subject processing was the evidence of a ranking scheme. For example, S4, in starting to talk about processing states: "If the majority of the stock is coming from selling stockholders, I don't read beyond the first page... I throw (the prospectus) in the wastebasket." S2 has virtually the same sentiments about the same point: "(These are) not shares sold by current officers... sometimes it's the kiss of death... getting a public market for their stock for estate purposes...." In fact, all of the professional subjects commented on the fact that the stock originated from the company rather than from selling stockholders.

One element of the ranking seemed to be that negative features appeared to outweigh positive ones, especially if the negative features were encountered early in the processing. S3, in his analysis, came across two negatives early on. He then saw a positive (high growth) which he disbelieved due to the nature of one of the negatives (competitive bids). S3's response to this perceived discrepancy was to search for corroborating evidence to his belief that the situation as depicted was "not realistic." For example, the subject firm had less than one percent debt in its capital structure. While this was a positive to all other subjects, it became a negative for S3. The product's tie-in to IBM, a strong feature for almost all other subjects, likewise became a negative. In short, one perceived negative feature resulted in a ripple-effect which overshadowed subsequent positive ones. This negative feature impact also shows up, in less dramatic fashion, in the protocols of S2 when addressing the issue of having one large customer:

> S2: "... Companies with single products... or with single markets... as soon as their market was cut off they, uh...down went the price of stock.... One that comes to mind is (   ). They were in computer systems... a very difficult market, a lot of competitors..."

Even though he found many positive features in the firm, S2 continued explaining, for several minutes, the effects of single customers or markets. This behavior never occurred relative to positive features. Additionally, even though positive aspects outnumbered negative ones for almost every processor (all except S3) the decision relative to the firm was generally quite narrow and in every case, hedged. The subjects generally thought the firm had good prospects if -- costs were kept down, the market turned up, etc.

It should be noted that protocol evidence clearly existed for other types of processing. This is particularly evident if one breaks the processing down in terms of particular decision points. For example, one could dichotomize a processor's decision in terms of a decision to either stop or continue processing. In this context, the decision by S4 to either "dump the prospectus into the waste-basket" or continue depending on the origin of the securities offered can be interpreted as an indicator of an elimination by aspects process,[19] rather than the mere assignment of a larger weight to this variable. Once the decision was made to continue processing, the evidence clearly pointed toward a compensatory process.

Most of the behavior described above in this section was found only in the protocols of the professional subjects. The behavior of

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[19] This model, described by Tversky, appears in the 1976 article by Payne. The choice behavior consists of ranking each choice on the i^{th} attribute, and eliminating all but the highest ranking choice. Here, the "i" denotes importance of the attribute. In case of ties, the same procedure is repeated for the $i + 1^{th}$ attribute. [Tversky,1972].

the nonprofessionals was much more ambiguous. For example, S6 often described information or elements addressed in the data as "good", but the meaning was not clear. Not once did S6 describe anything in a directly negative way. Instead, when describing something perceived as being good, he would say, "it would not be good if--," where the "if" explained the opposite scenario to that described as "good." S6 basically moved through the data without revealing his perceptions of particular elements. The only hint of such perceptions came in his summarization of his view of the firm at the end of processing. There, he stated that the company "ought to be a good company if they kept costs down and kept turnover (personnel) low."

S7 was clearer than S6, but only slightly. He often stated that the firm had a problem with "x", without giving much information relative to the importance of "x". However, in his summarization at the end of processing, it was evident that he was much more conscious of the negative features of the firm, even though he had not explicitly designated them as such during processing. For reasons such as these, it was much more difficult to categorize the behavior of S6 and S7.[20]

S5 exhibited behaviors similar to the professionals in that he expressed fairly clearly what items were important to him. For example, negative features of high importance were "red flags". Positive aspects of the firm were "goods". In short, S5 tended to exhibit compensatory behavior. However, even S5 did not offer as clean protocol evidence as did the professionals relative to his overall behavior.

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[20]These differences are exemplified in the derived models for the nonprofessionals. In an attempt to be as accurate as possible, the models are not explicitly compensatory in overall structure. For example, the mere existence of a positive assignment device was not taken to be direct evidence of the existence of a negative one.

While the results of this study are exploratory in nature, they do point to some implications for research. In this task context, one might suspect that a linear model ought to fit subject judgments since, indeed, that appears to have been the predominant model used. In a similar context, Ebert and Kruse [1978] found that linear models could be fit to the decisions of security analysts, although the R^2 values were less than .30 in general. One tentative explanation for that finding may be the criterion variable used -- expected return. While this study is clearly not scientifically conducted in the usual experimental sense, it is interesting that only one subject attempted to estimate return -- the academic participant. It is further enlightening to note that he engaged in at least three iterations before coming up with what he perceived as an acceptable estimation procedure. At worst, it is tentative evidence that probably none of the participants willfully engage in such activity.

Another implication which may be drawn concerns Ungson, Braunstein, and Hall's [1981] earlier cited contention that the findings of structured problems may be inappropriate for ill-structured settings. While noting the limitations and nongeneralizability of results beyond the context of this experimental situation, some interesting conclusions may be drawn. First, the processing behavior often ascribed to structured settings (compensatory) was also found in the relatively unstructured settings of this research. Second, in the absence of compelling theoretical guides, the choice of predictor variables presents a substantial problem. The construction of realistic, non-artificial predictors would appear to be extremely difficult. For example, in this study, as many as twenty-eight topic areas were addressed. Only three of these appeared on all of the processors' lists, representing at most thirty percent of items attended to by any particular subject. From this perspective, it seems that the problem is not so much one of having the wrong setting, but understanding what is important and familiar across different settings. For example, while price/earnings (P/E) ratios may supposedly be important in a particular setting, they may not be to subject "i", who may not understand completely what they're supposed to do. Or, the subject may use an entirely different set of variables to do his own predicting. When presented with P/E ratios in the experimental setting, he may simply be trying to apply inappropriate rules. These difficulties simply would not surface in most compensatory models, except as lowered R^2 or regression weight values. Each subject, in the normal ill-structured setting, has the ability to review all available data with no real constraints as to how it should be condensed or summarized. Better understanding of the variables and their relationships to users and each other in particular settings would probably go far in alleviating some of these problems currently found in modeling "judges" and problems.

5.6 Model Reliability

As related earlier, the primary purpose of this research was the analysis of the processing behavior of the participants. The models derived were developed as vehicles for this assessment. It was not possible nor intended that the models be proposed as explicit subject models beyond the context of this experiment. Such a proposition would have required many arbitrary and indefensible assumptions about

the subjects' behavior since no tests were conducted relative to contexts different than that of this experiment. In spite of these limitations, some limited cross-validation and reliability procedures were conducted during the course of the research. These procedures are described below.

In the general case, models are cross-validated by testing in a new population (one other than that from which the model was developed). This usually entails predicting some criterion variable based on inputs from the new population. In this study, validation consisted of constructing a new case prospectus and allowing one subject and his derived model to assess the new case firm. The results of this analysis is described below.

Validation procedures were limited by time, and subject constraints. Many of the subjects simply did not have time (given the research time constraints) to participate in validation procedures. S4, who did participate, did yield interesting results

Application of the derived model (see Appendix I - Figure 14) of S4 to the new data set yields a prediction of a negative view of the firm. This prediction is apparent from either of the two decision boxes of S4's model -- the growth potential of the industry or the origin of the stock being sold. Also note that this prediction is independent of the case firm's operating results.

Obtained actual results matched those predicted by the model. While S4 talked of the origin of the stock as a "negative in his mind" in the second case, he clearly was not enamored with the firm and was ready to stop processing. This is evident in the following quote, in which he also mentions operating results: "I don't see anything that makes me excited about this company... there are many others doing the same thing.... They have a nice earning progression, but... I don't think much of anything is going to happen to this stock...." After several additional explanatory comments, S4 said he really had nothing more to add (see the Appendix II, Figures 24-26). It can be inferred that the negative features outweigh any positive attributes.

The retest reliability of the model must be assessed relative to the structure of the second data set. The subject firm of the second data set had a different line of business (computer related, but not minicomputers) as well as a different composition of stock being sold. Much of the stock in the second data set came from a selling stockholder. These revised features sufficiently altered the data set such that a complete test of S4's derived model was not obtained. S4 stopped processing before examination of all elements in his derived model, just as that model would predict.

In spite of these limitations, the model derived from the second case analysis is quite similar to the original model developed for S4. In fact, when S4 was probed after processing, he stated that he would normally review information on the auditors, legal matters, and whether venture capital firms were involved when interested in a particular firm. When these features are added to the derived model from the second case analysis, the obtained model has seventy percent of the cues in S4's original model. Those cues left out, customer type, return on equity, and the product's relation to existing products are relatively minor in impact. Customer type is an assessment of the expected margin (military customers have restricted margins), return on equity is related to sales growth, and the product's relation to other products is related to the uniqueness aspect of the product. That is, each of the cues are partially correlated to at least one other cue already in the model.

One final aspect of the validation of the derived models involves the processing order. As constructed, the derived models contain elements in the order processed by the subjects. In a process tracing framework, order is of importance, but not in an absolute sense. As Clarkson [1962] pointed out, a particular processor may change the order in which information items are assessed, either by chance or many other potential factors. The primary issue is whether the important components of the decision process are present in the model. For example, it may not be critical that a processor such as S4 address the industry item before addressing the origin of stock sold item. The critical issue is whether the behaviors and decisions predicted by the model relative to those items corresponds to those of the processor. In general, production model systems will enact first that action for which the preconditions for action have been met [Newell, 1973].

This aspect of processing models and the linear compensatory nature of the derived models are not strictly compatible. If one considers a statistical linear compensatory model, processing order is of importance unless the cues are uncorrelated; an unlikely situation for most ill-structured problems. This result, while problem-

atical, does not alter the nature of the findings of the study. The objective is to point out that care must be taken when building models that unwarranted statements about the importance of information not be made in the absence of tests or other data which supports the conclusions drawn. The indication that processing behavior is compensatory does not correspond to a statement about processing order and importance.

5.7 Inter-rater Reliability

Two raters were used in this study -- the researcher and one student. The student rater was a senior accounting major with no previous research experience or psychological training. He was given a description of the operators, Bouwman's [1980] description of his operators, and two training sessions. The training sessions involved coding the protocols of subjects from the pilot study. These sessions lasted about one hour. In short, the student coder was relatively naive. Obtained inter-rater reliability is shown below and discussed in the following paragraphs. The reliabilities are calculated as explained in section 4.6 of the dissertation.

	Unadjusted	Adjusted
Inter-rater reliability	.90	.66

The unadjusted figure is simply the proportion of agreement between raters. The adjusted figure is the Kappa coefficient developed by Cohen [1960]. The obtained results are comparable to those reported in section 3.1 in this study. Analysis of the errors made indicated that in general errors were made within behavior types, rather than across behaviors. For example, the rater would have difficulty distinguishing between an increase operator versus a trend operator. The distinction is a rather fine one which is difficult to detect. One has to discern if a change involves a period greater than two years. Without extremely careful analysis of the protocols, the implication could be missed.

The adjusted inter-rater reliability corrects for chance agreement between the raters. It is, therefore, a conservative assessment of agreement between raters.

CHAPTER VI

SUMMARY AND FUTURE DIRECTIONS

This study has addressed the problem of information use in the investment domain. Using the technique of verbal protocol analysis, an examination was made of the processing behavior exhibited by professionals and nonprofessionals in the assessment of an initial offering in the computer industry. The objective of the research was to ascertain the nature of processing behavior in a setting which emphasized external validity.

The issue of information use has been addressed in the literature of psychology as well as accounting. The results of research to date indicates that though we can construct models which will predict well the output decisions of decision-makers, we cannot really translate prediction success into knowledge of how decision-makers make their decisions. Attempts to increase the consistency of decision made or to otherwise change the behavior of decision-makers has met with limited success [Slovic, Fischoff, and Lichtenstein, 1977]. This has led to a search for new methodological techniques which allow for more realistic data inputs. Attempts have also been made to revamp commonly used techniques and experimental settings in order to increase the degree of correspondence to real world settings [Ebbesen and Konecni, 1980; Olshavsky, 1979]. By increasing the external validity of their research efforts, researchers hope that they will then be able to address directly problems that decision-makers face in their work. Another potential benefit is the development of decision aids which increase the consistency and quality of decisions.

Much of the motivation for the study stemmed from the considerable body of evidence that decision-makers often did not make decisions in ways posited by models used to describe the decision-making process [Einhorn and Hogarth, 1980; Ungson, Braunstein, and Hall, 1981]. The evidence indicates that in many situations man is not bayesian in nature; nor does he make his decisions in a linear fashion. The objective of this study was to allow decision-makers to process a problem which had not been decomposed in order to see what kind of behavior would be used.

The task was processed by two groups -- professionals and non-professionals. The objective here was to see if professional subjects would process the information in ways substantially different from the nonprofessionals.

Obtained results of the study support the premise that professionals do indeed process information differently than nonprofessionals. In this study, professionals used less time and examined different kinds of data than the nonprofessionals. Professionals tended to use only the sales, earnings, and debt items of the quantitative data provided. They expressed some interest in the audit report and legal matters, but were far more interested in the firm's product(s) vis-a-vis the marketplace as a whole. This appeared to be the primary decision point in this task and context. Little interest was shown in probing the firm in detail.

In contrast, the nonprofessionals closely examined most facets of the firm. As a result, they tended to spend greater amounts of time and address different items of information. The nonprofessionals did not clearly discriminate among items processed on the basis of importance. Little evidence existed to support any scheme for ranking or otherwise making distinctions among information items.

The difference in processing also extended to the behaviors exhibited by the subjects. Professional subjects processed information in a linear compensatory fashion. Protocol evidence supporting this conclusion were prevalent in the transcripts of all professional subjects. This result was in marked contrast to the behaviors exhibited by the nonprofessionals. No clear-cut pattern emerged. Some of the behaviors were linear in nature; for other situations, the implications were uncertain.

The results of the research would imply several tentative conclusions. The use of students and other nonprofessionals to draw inferences about the behaviors of professionals is not supported by the results of this study. The subjects in this study, all of whom were educated and held responsible business positions, performed differently than did the professionals. The placement of information appeared to matter to the nonprofessionals more so than for the professionals. Nonprofessionals tended to move sequentially through the data. It would seem appropriate to place information in ranked order in required disclosures for processors such as the nonprofessionals. This position was also supported by several of the professional subjects in unsolicited comments during analysis.

As pointed out earlier, some of the tentative findings of this study do indicate that more research is needed in certain areas. For example, the finding that all of the subjects tended to process widely disparate topic areas from the data set clearly demonstrates, at least for the experimental subjects, a lack of precise knowledge about what is important. A previous solution to this problem has been the application of factor analytic techniques to develop composite factors which represent all of the underlying variables [Libby, 1975]. While clearly useful if the general areas (and factors) are interpretable and understood by subjects, the aggregation may serve to confuse, rather than clarify, the situation. It may be possible that the research objective may be better served by presenting nonaggregated data and allowing the subjects to select from the menu. As long as the menu is theoretically derived, the models should be capable of both individual and aggregate interpretation. That is, since most variables are correlated for a particular topic area (this is in fact the underlying premise of factor analytic techniques), it would be possible to develop general models which are theoretically related to the individual models. The individual models would be used to better examine individual differences in processing strategies.[21] And, as a minimum, one should expect such studies to indicate possible directions or emphasis for educational programs.

The strong indications of compensatory processing lends support to the findings of the extensive body of research which indicates

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[21]This is essentially the technique demonstrated by Abdel-khalik [1973]. He found that subjects using nonaggregate data were able to make better decisions in particular tasks.

that such models are good predictors of human decisions. In addition, there were some tentative indications as to when linear processing would perhaps likely occur (in this context), a question advanced for examination by Payne [1976]. In this study, linear processing occurred when characteristics of the single study firm were addressed. However, when other firms or situations were introduced, screening processes or other ranking schemes were mentioned. More research is needed to fully address this issue.

Another potentially interesting research question involves the examination of variables assessed in this study in a more structured multiple choice setting. Such a study would enhance the possibility of ascertaining the importance of particular data items to subjects. If done in a process tracing setting, such a study could potentially offer information about how weights are derived in a multiple choice setting. To date, this process has not been closely investigated. Additionally, if the choices offered are large enough, multiple data analysis techniques could be applied to the data, a procedure advocated by Payne, Carroll, and Braunstein [1978].

The results of this research study are clearly limited by the research design and the experimental context. Most investment decisions are not made in terms of initial offerings. However, the analysis of the firm and its position relative to other investment opportunities is relatively representative of many such decisions in the real world. To the extent that decisions are made in environments which conform to the setting and context of this research, the results offer tentative evidence relative to expected behaviors.

This conclusion is in conformity with Newell and Simon's contention that the task is the major determinant of processing behavior [1972].

By its very nature, exploratory research is probably best viewed as a vehicle for establishing fruitful avenues for future research. Such studies usually entail the abrogation of some or even all of the usual tenets of experimental research, or perhaps involve data manipulations without benefit of well-developed theoretical guidelines. This is clearly the case with the present study. The experimental sample was not random or large. The experimental sessions were not simultaneously administered. Internally, no structured tests were included in the data, nor were data manipulation techniques standardized. All such factors work to limit the generalizability of the results of this study beyond the context found in the study itself.

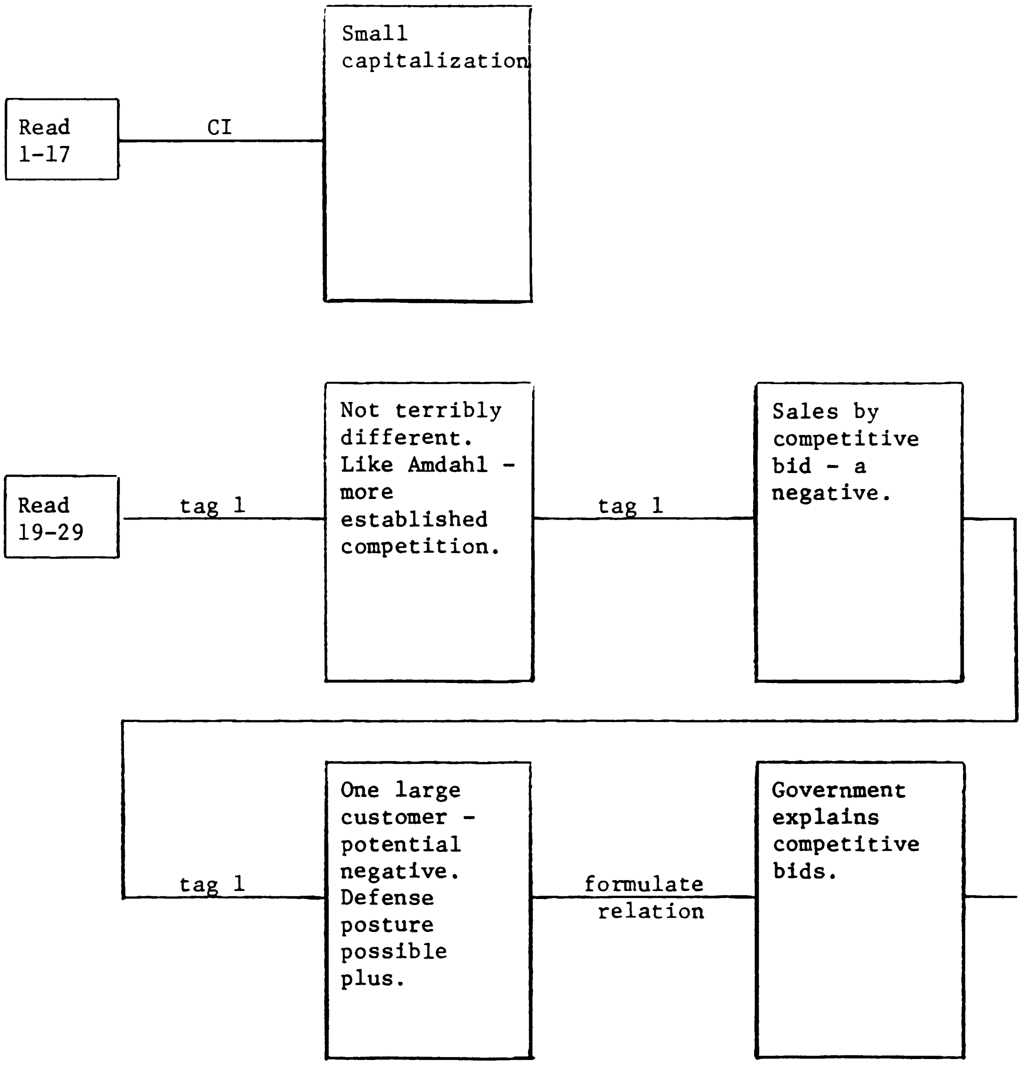
In the usual case, violations of accepted practice are permissable when the objective is to investigate particular aspects of a problem. A researcher may, for example, wish to maintain high internal validity and consistency in a given situation, at the expense of greater external validity, or vice versa. As long as the objective is clearly stated and reasonable practices adopted, such tradeoffs are not only acceptable, but quite common. In this research, the objective was the maximization of realism in the experimental situation. While this objective can never be fully met, to the extent that it is achieved, experimental control is proportionately diminished. However, it is hoped that studies in the same vein as this can be used to develop more precise and theoretically sound experimental studies in the classical sense.

APPENDICES

APPENDIX I

APPENDIX I

Subject Problem Behavior Graphs and Models



Problem Behavior Graph of S1

Figure 3

Figure 3 (cont.)

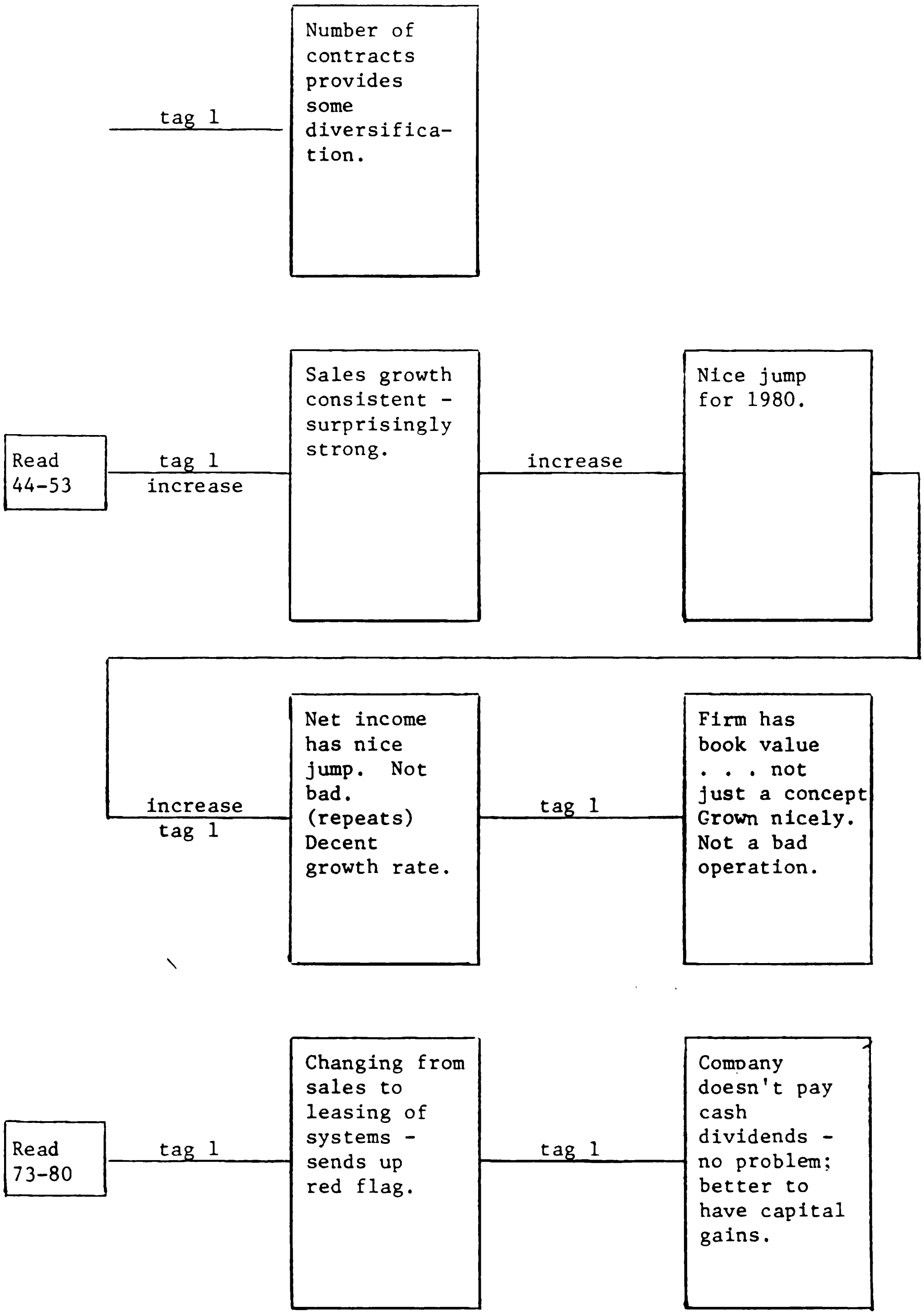


Figure 3 (cont.)

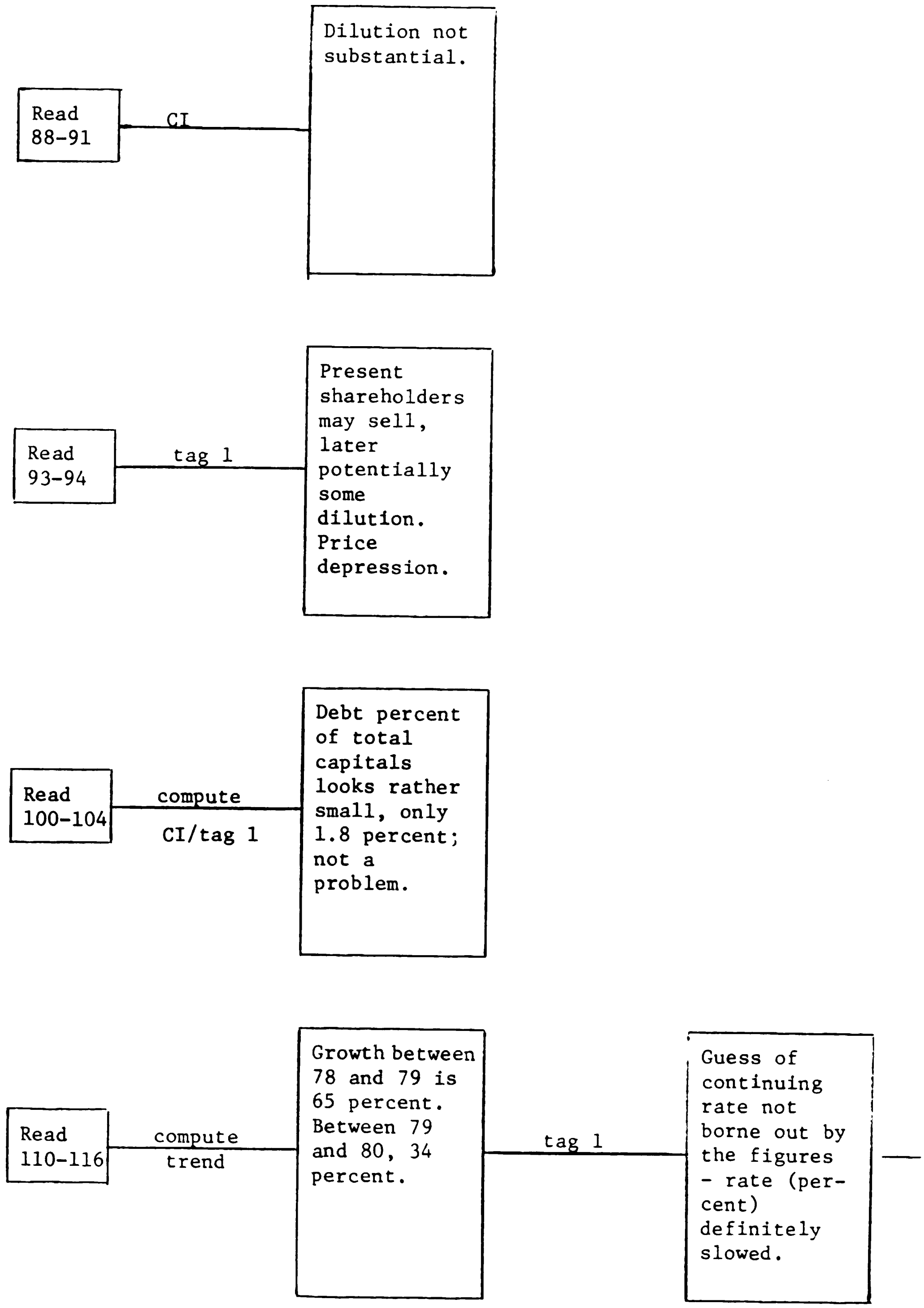
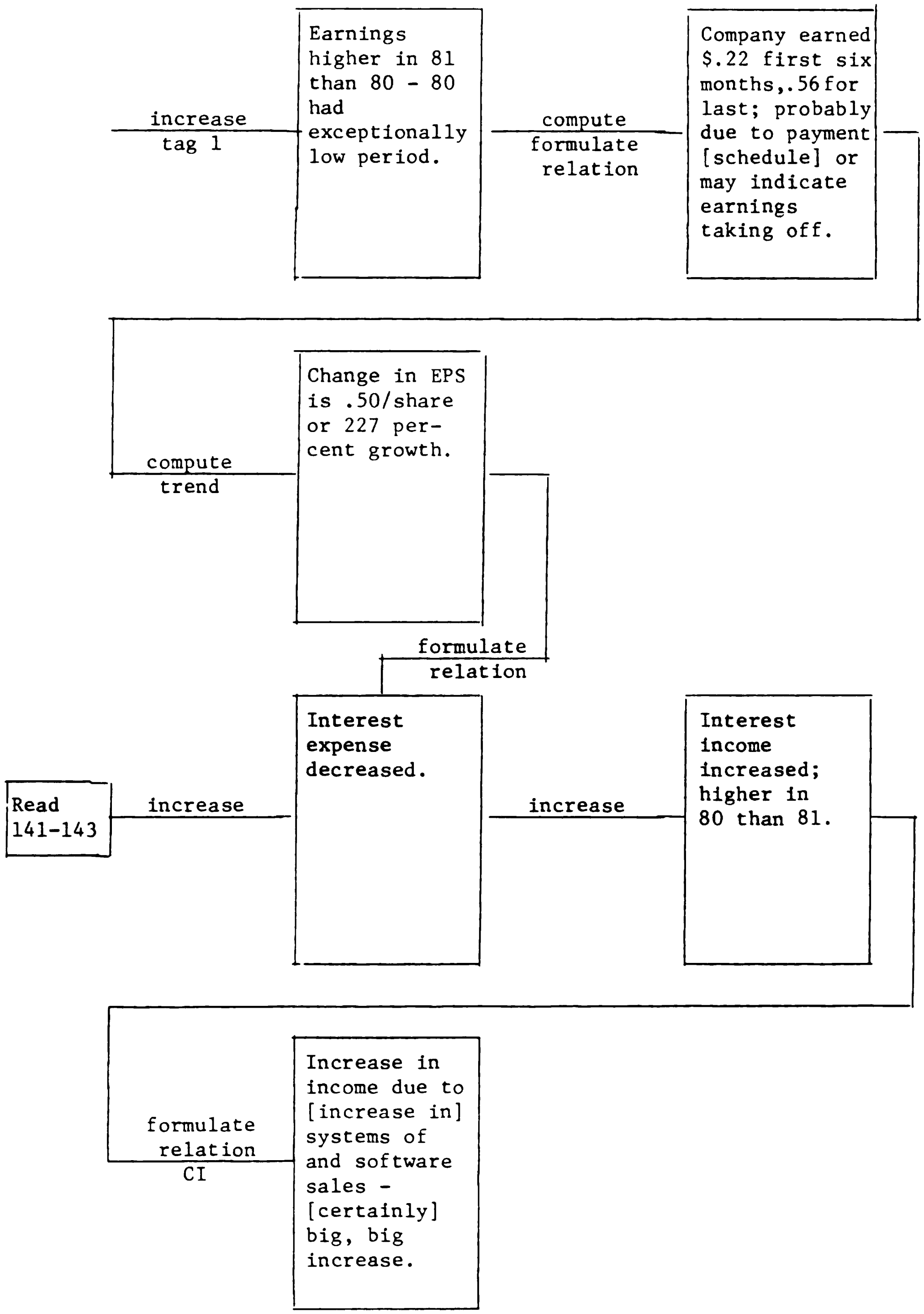


Figure 3 (cont.)



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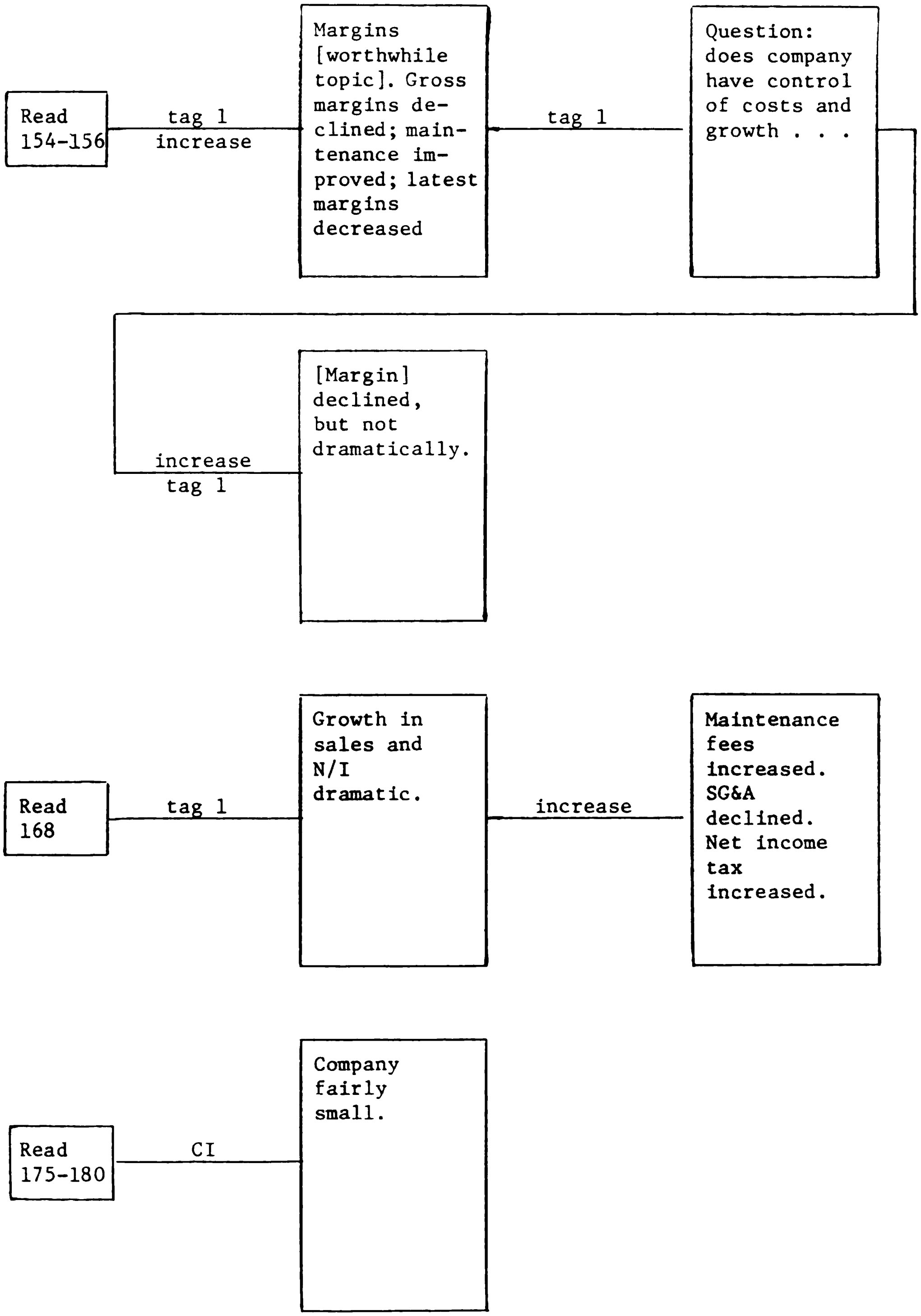

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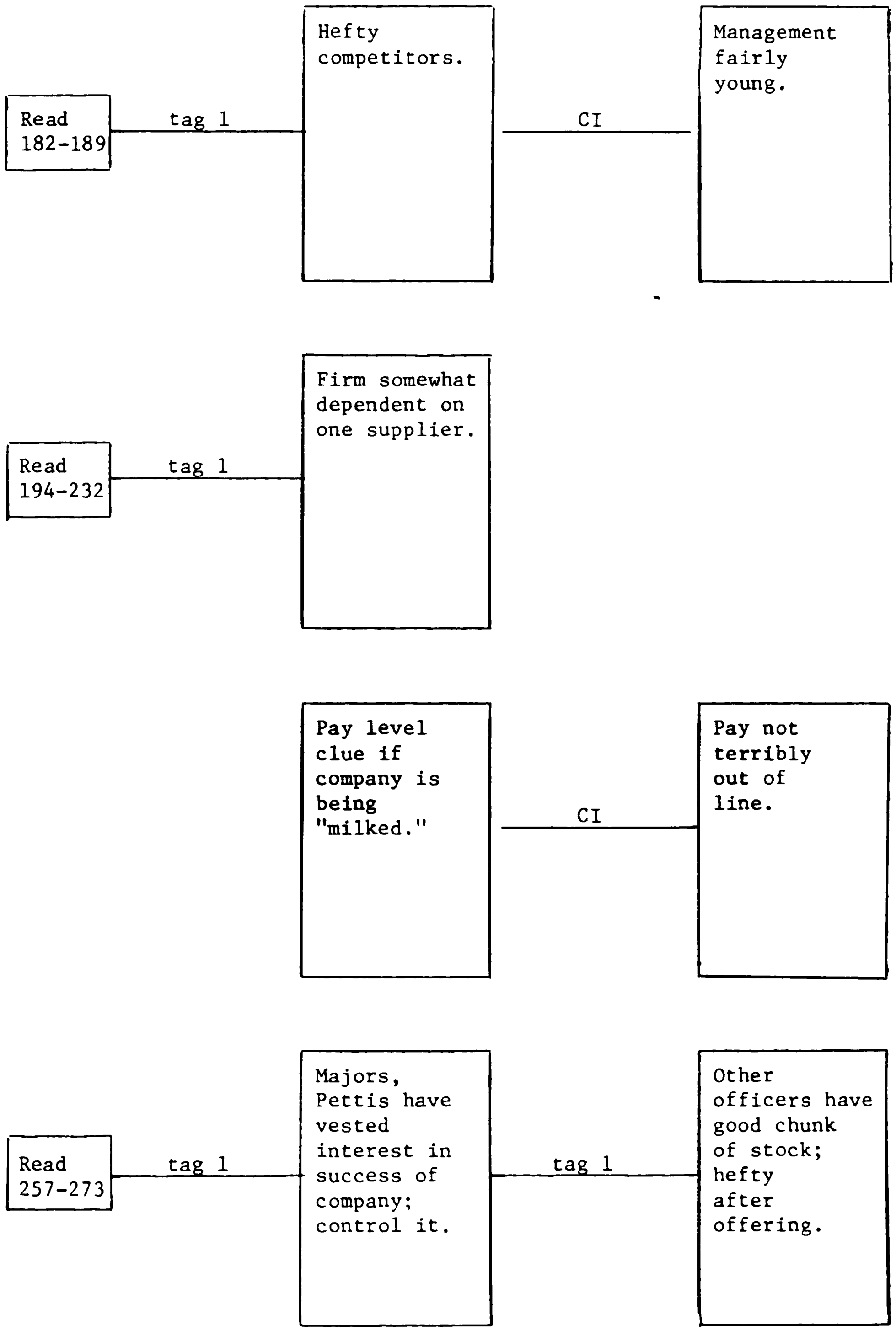

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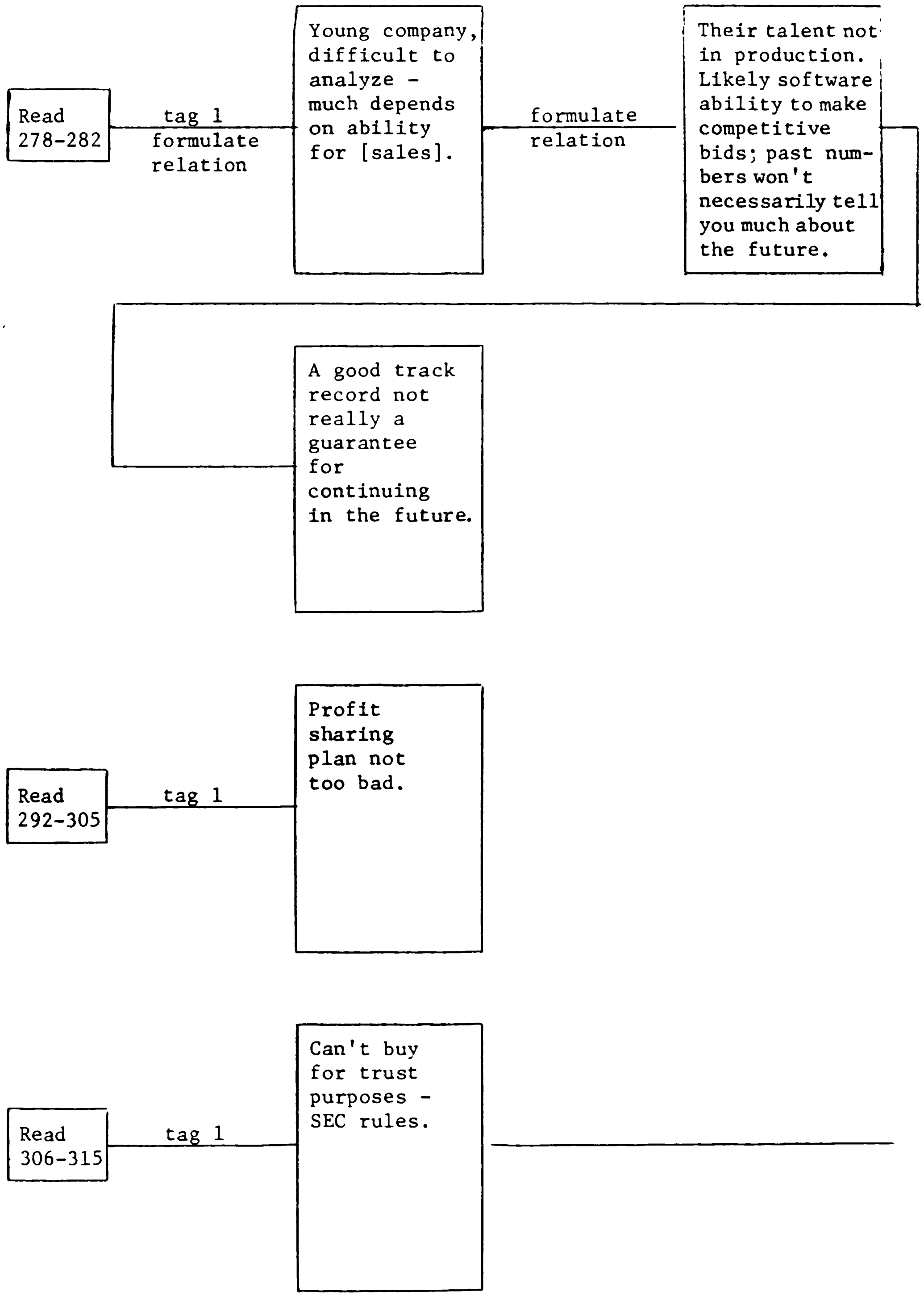


Figure 3 (cont.)

formulate / problem	Hot new issue; tend to have proclivity against; wouldn't put in a safe deposit box. Definitely vulnerable; might have niche in market. Hardware largely bought, develop software - not untypical. Volatility in earnings. No dividends. Aggressive situation. Risk-free assets returning 15-17 percent; opportunity cost is high; much depends on growth.

Start

Not terribly different - like Amdahl
Sales by competitive bid - a negative
One large customer - potential negative
Number of contracts provides some diversification
Sales growth consistent . . . strong
NI - not bad
Decent growth rate
Firm has book value . . . not a bad operation
Changing from sales to leasing - red flag
No cash dividends - no problem
Dilution - not substantial
Debt percent of total capital rather small - not a problem
Growth rate definitely slowed
Earnings taking off?
Interest expense decreased, interest income increased
System sales - big increase
Margins declined - not dramatically
Growth - sales and NI dramatic
Company fairly small
Hefty competitors
Firm somewhat dependent on one supplier
Management young
Pay not terribly out of line
Majors, Pettis have vested interest in success of company
Talent not in production; ability to make competitive bids
Good track record not really a guarantee for continuing in the future
Hot new issue . . . proclivity against . . vulnerable . . .
Might have niche in market
Hardware largely bought - not untypical
Volatility in earnings
No dividends

Firm Specific Decision

Protocol Model of S1
Figure 4

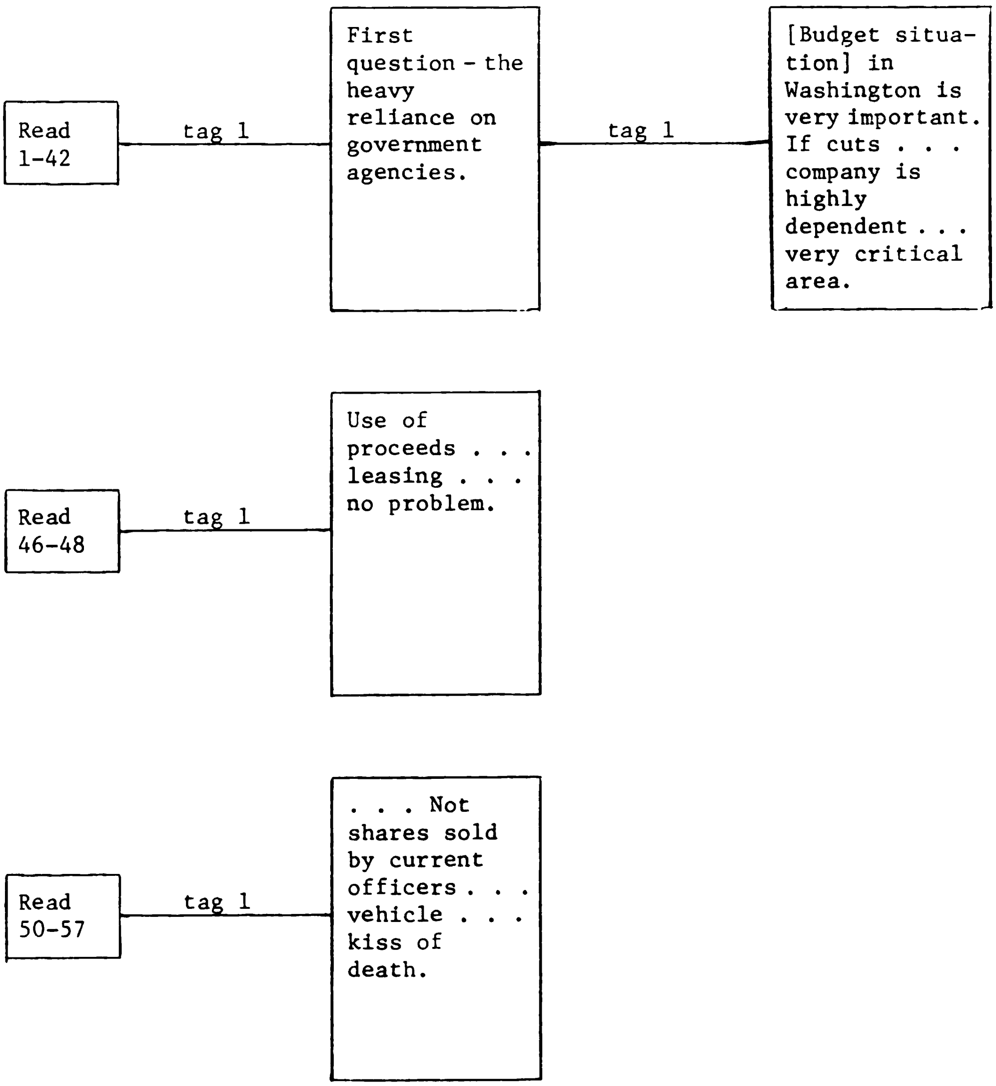
Start

Origin of stock sold:	company	positive
	selling stockholders	negative
Company product:	unique	positive
	not unique	negative
Sales basis:	customer solicited	positive
	competitive bids	negative
Customer type:	more than 50 percent of sales to one customer	negative
	No one customer provides more than 50 percent	postive
NI, sales growth:	Increasing trend	positive
	changing or decreasing	negative
Book value:	more than $3/share	positive
	less than $3/share	negative
Suppliers:	one more than 20 percent	negative
	none more than 20 percent	positive
Cash dividends:	company growing and none	positive
	company not growing and none	negative
Dilution:	less than 43 percent	positive
	more than 43 percent	negative
Debt ratio: (of total capital)	less than 1 percent	positive
	more than 1 percent	negative
Competition:	large companies	negative
	small companies	positive
Management:	average age more than 50	negative
	average age less than 50	positive
Pay rate of management:	top pay less than $200,000/year	positive
	top pay more than $200,000/year	negative
First offering:	yes	negative
	no	positive

Firm specific decision

Derived Model of S1

Figure 5



Problem Behavior Graph of S2

Figure 6

Figure 6 (cont.)

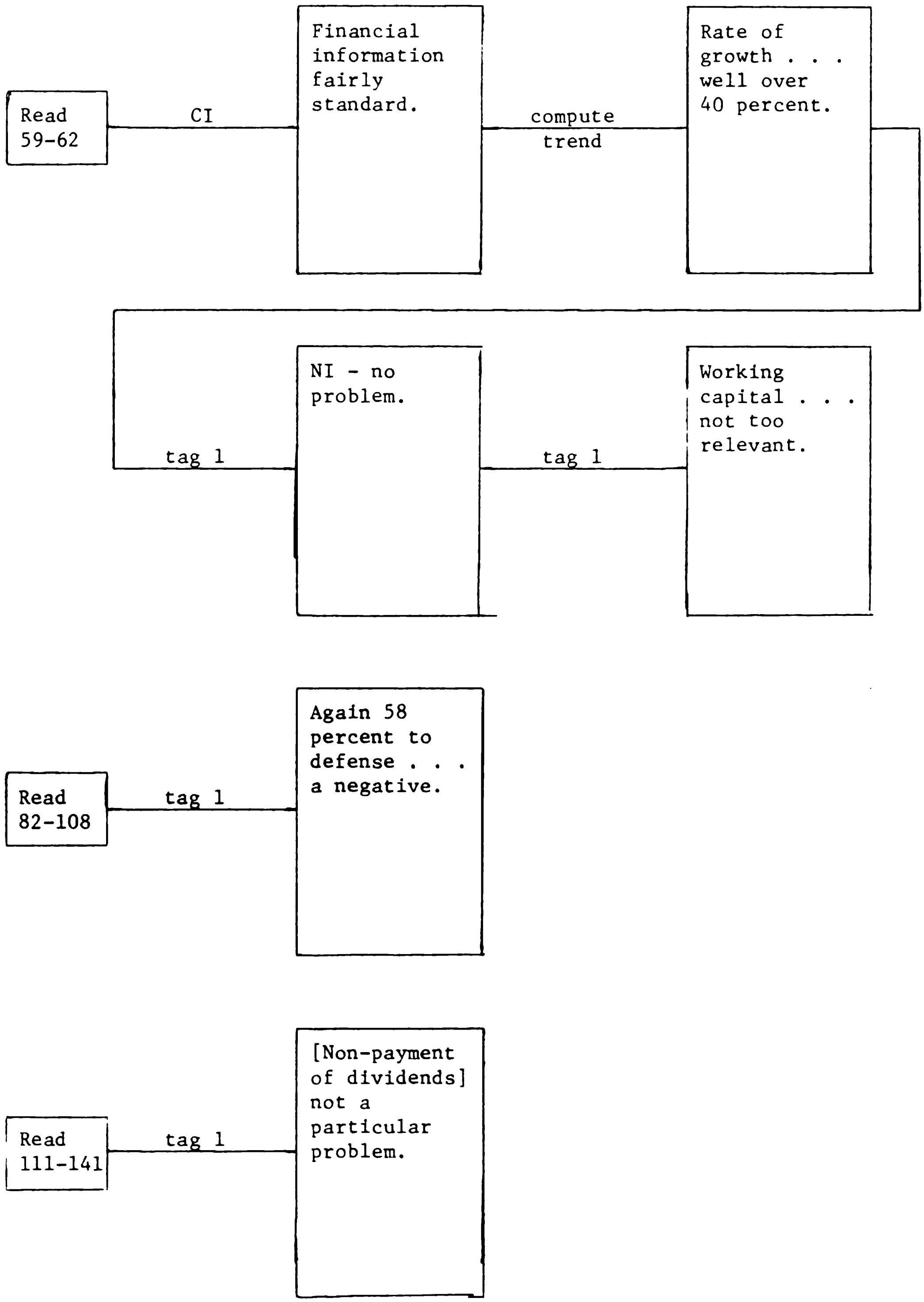
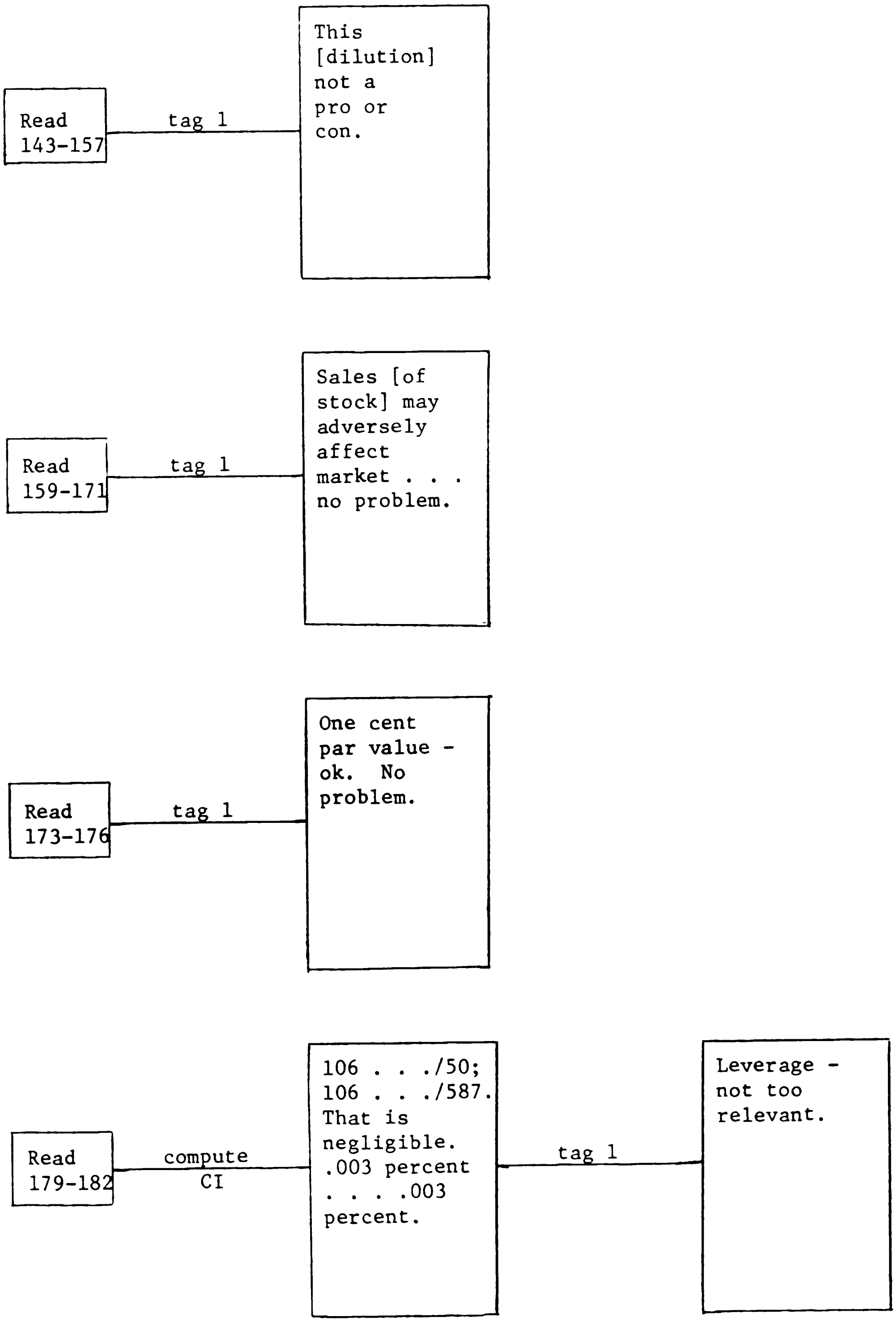


Figure 6 (cont.)



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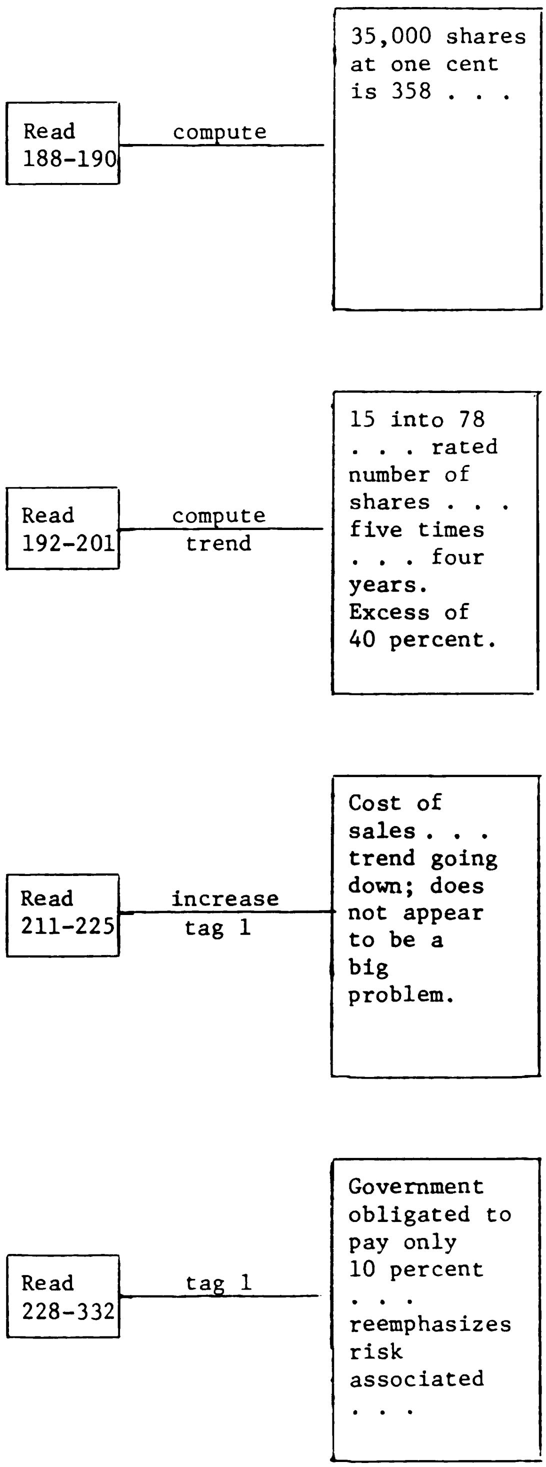

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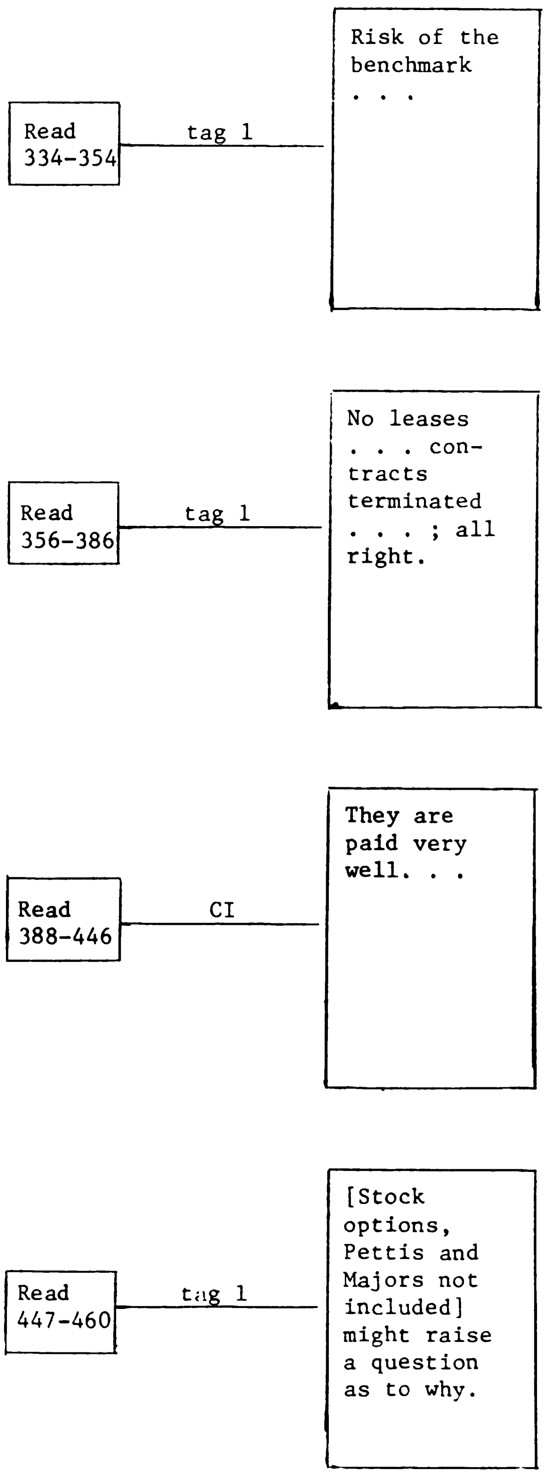

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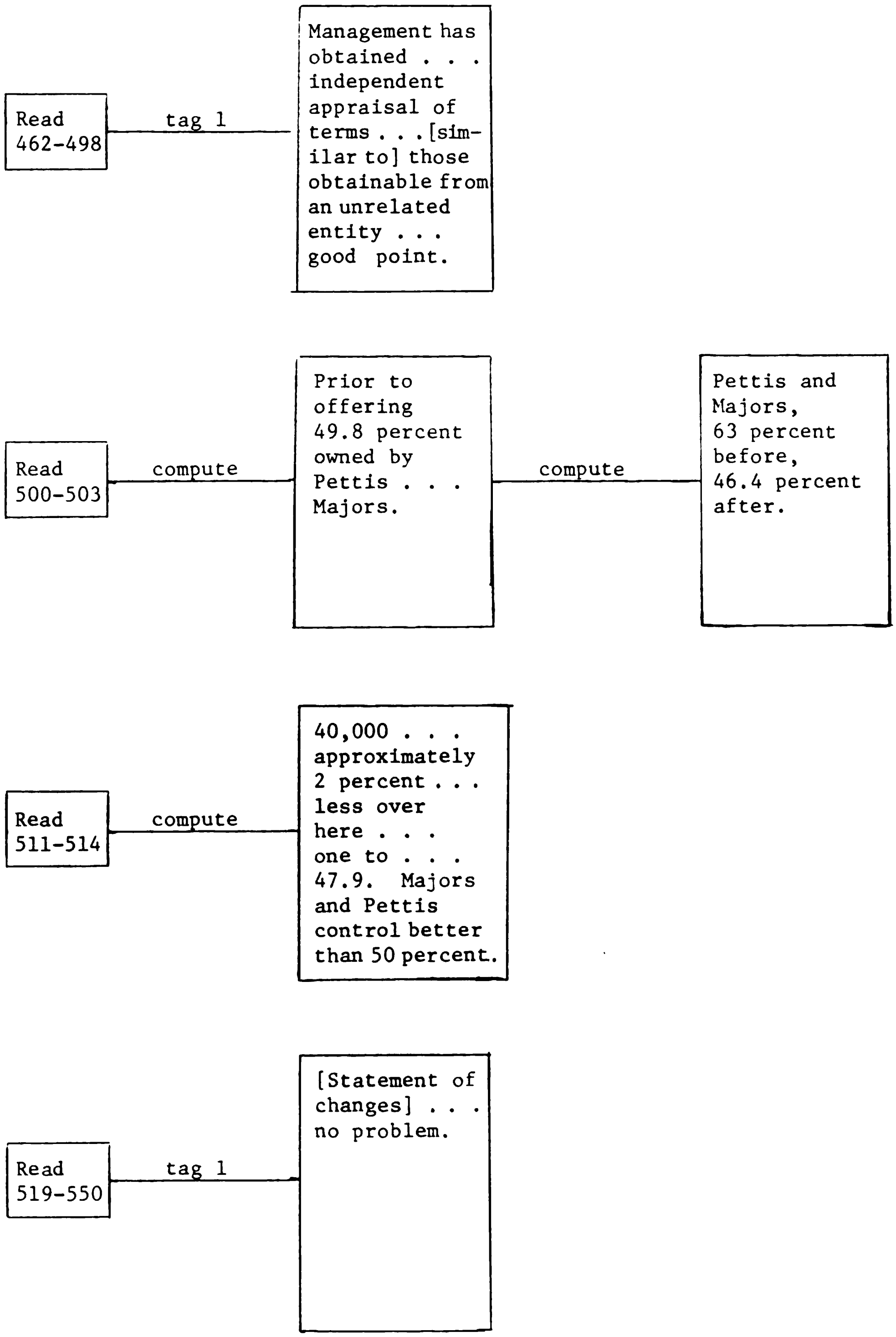


Figure 6 (cont.)

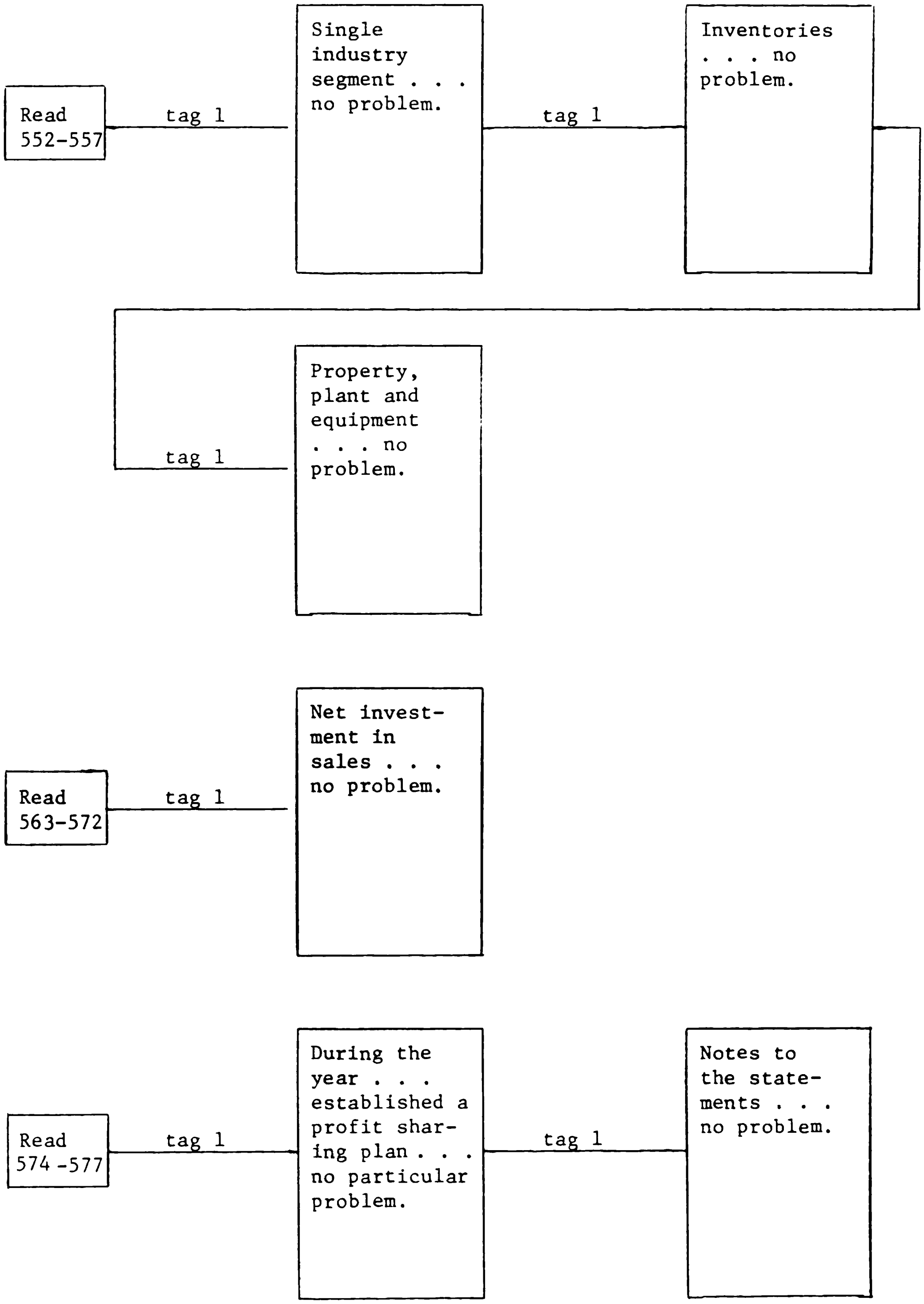


Figure 6 (cont.)

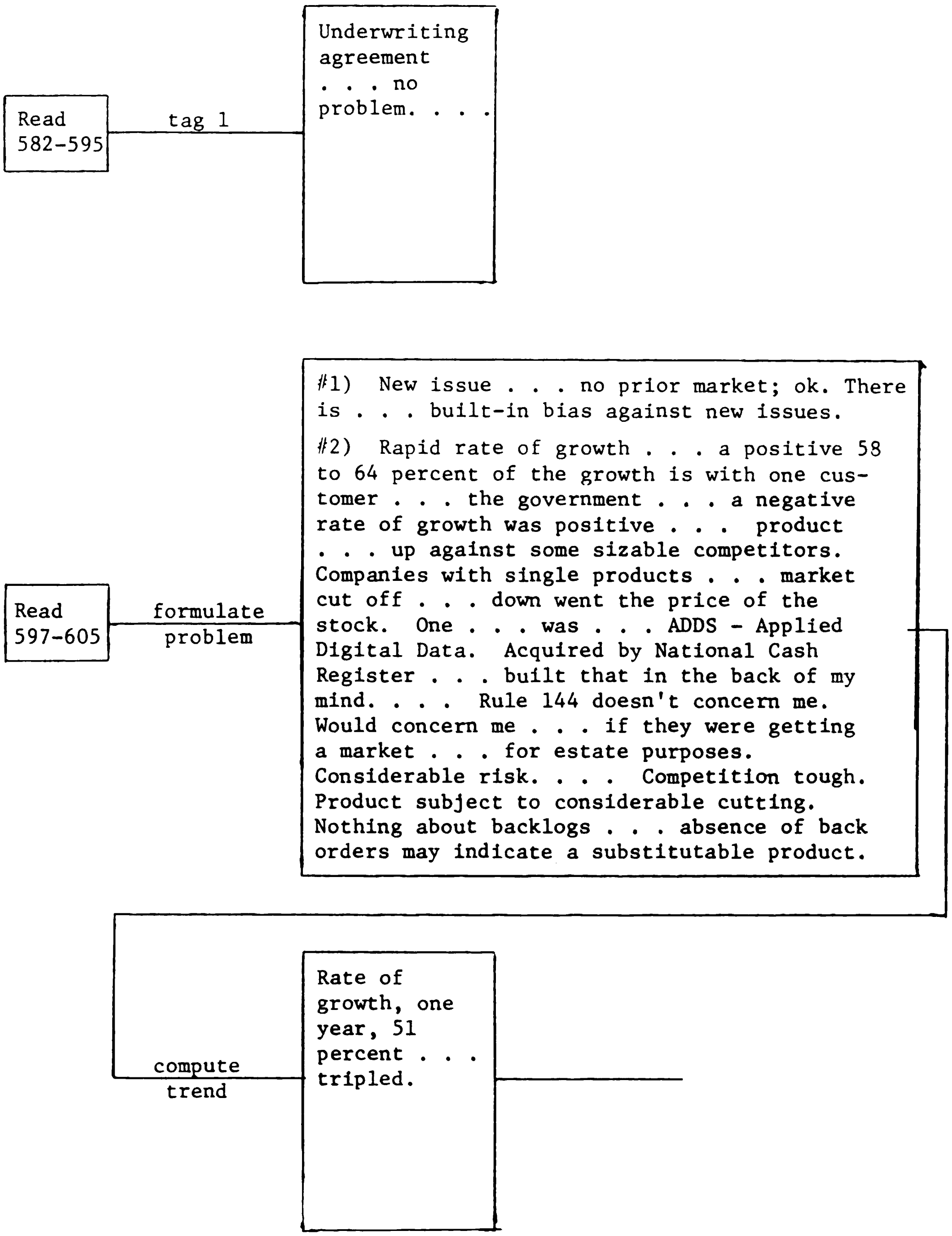
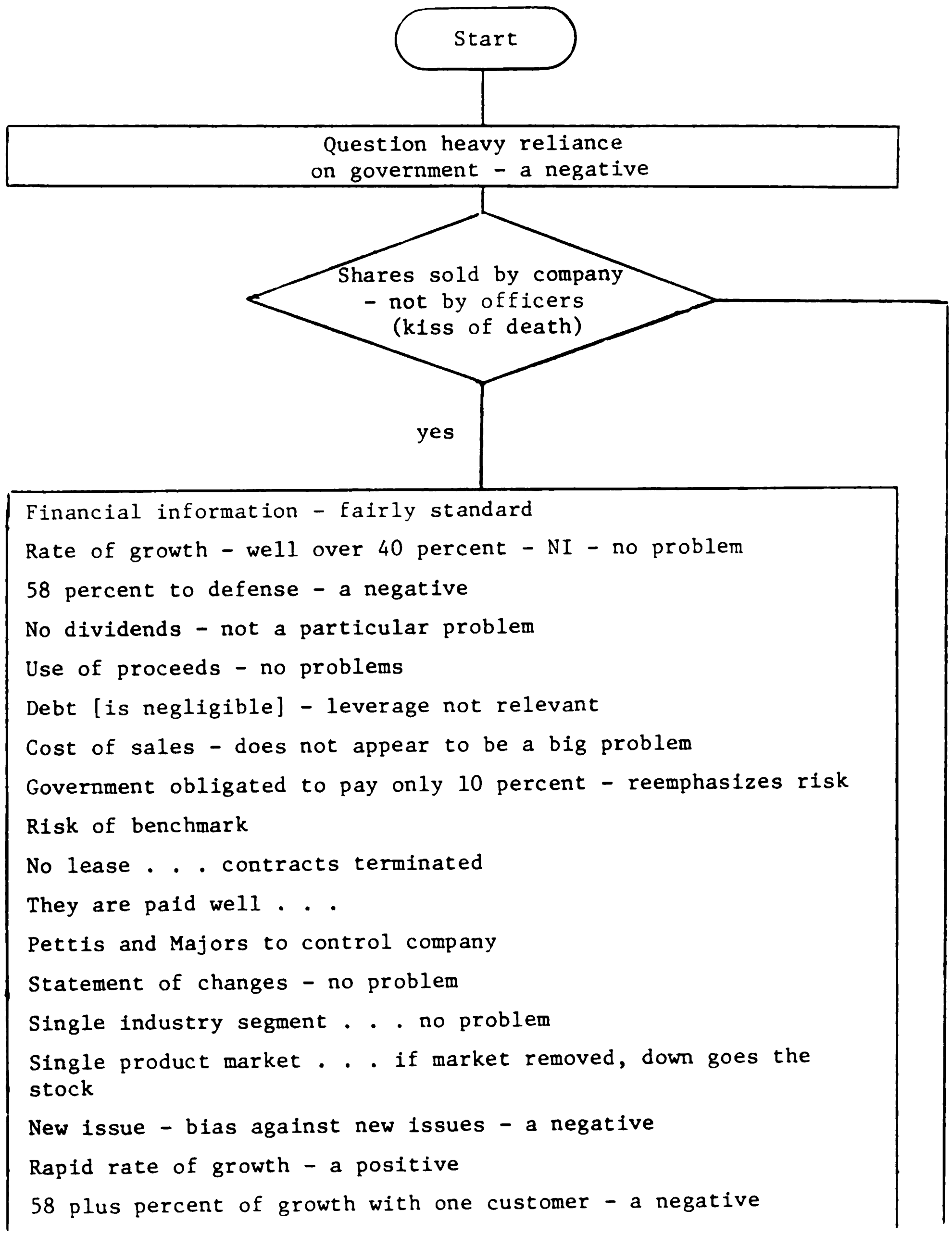


Figure 6 (cont.)

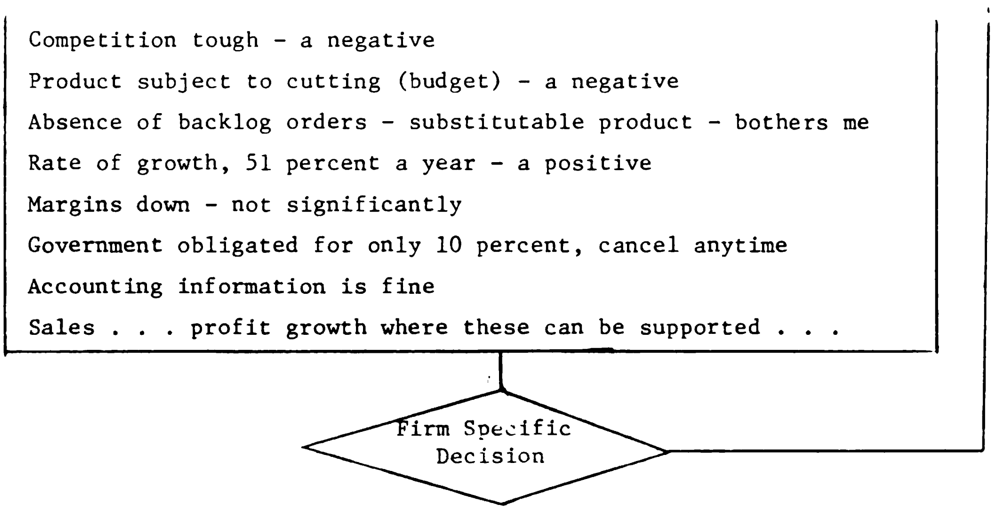
formulate / problem	Background information . . . economy . . . monetary . . . fiscal policy . . . good time to be in stocks . . [?] . . Dow's been hit pretty hard. . . . Good industry to be in. . . . It . . . good company. . . . Margins down. Not significantly bothered by the absence of backlogs. Government obligated to only 10 percent . . . cancel any time. . . . Maybe outlet for a small company to make a killing at my expense. . . . Accounting information is fine. . . . Look at sales . . . profit growth . . . where these can be supported company is growing. . . .

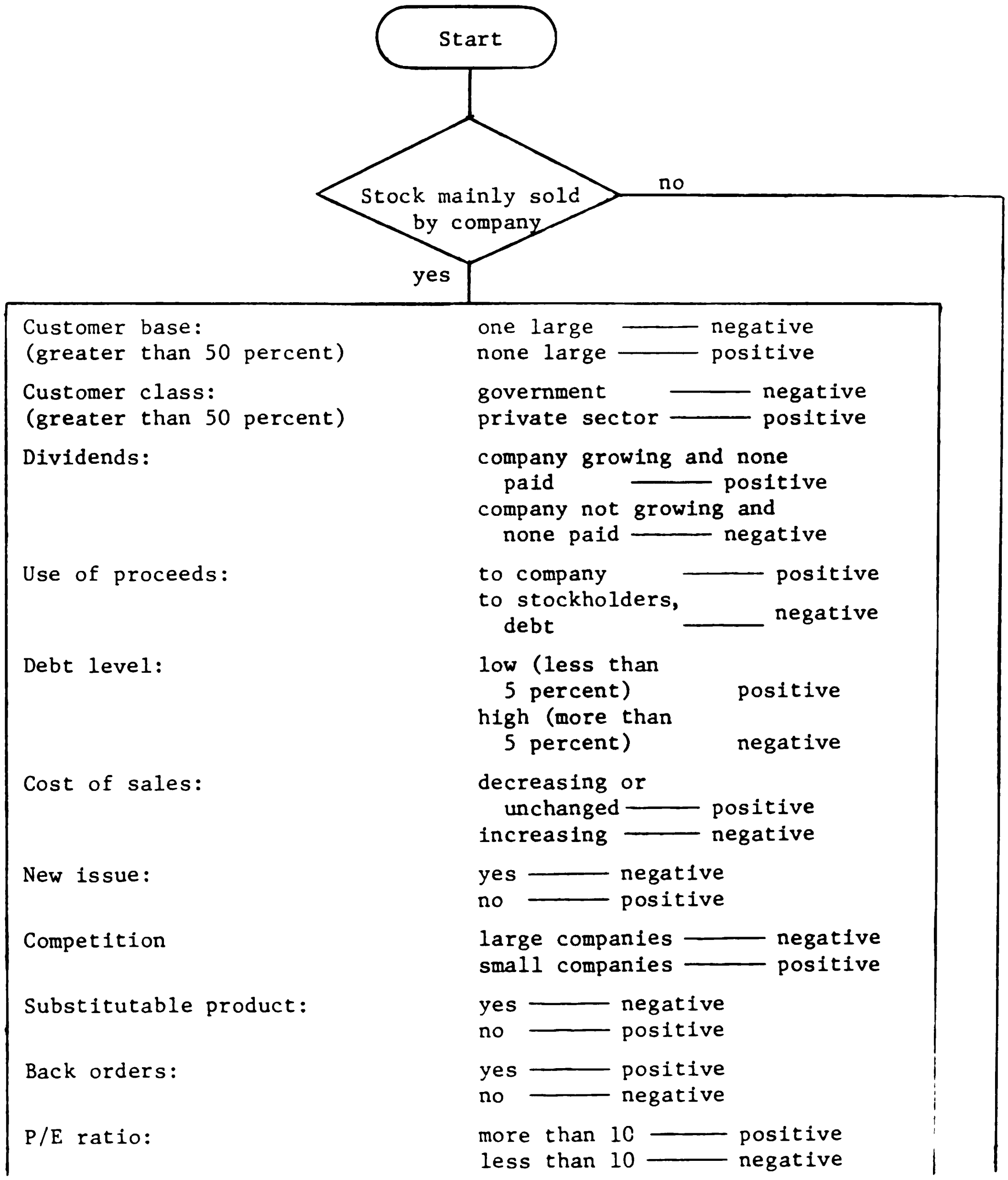


Protocol Model of S2

Figure 7

Figure 7 (cont.)

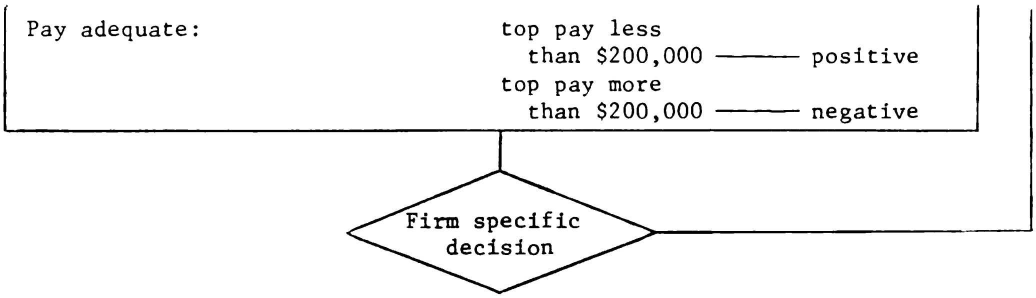


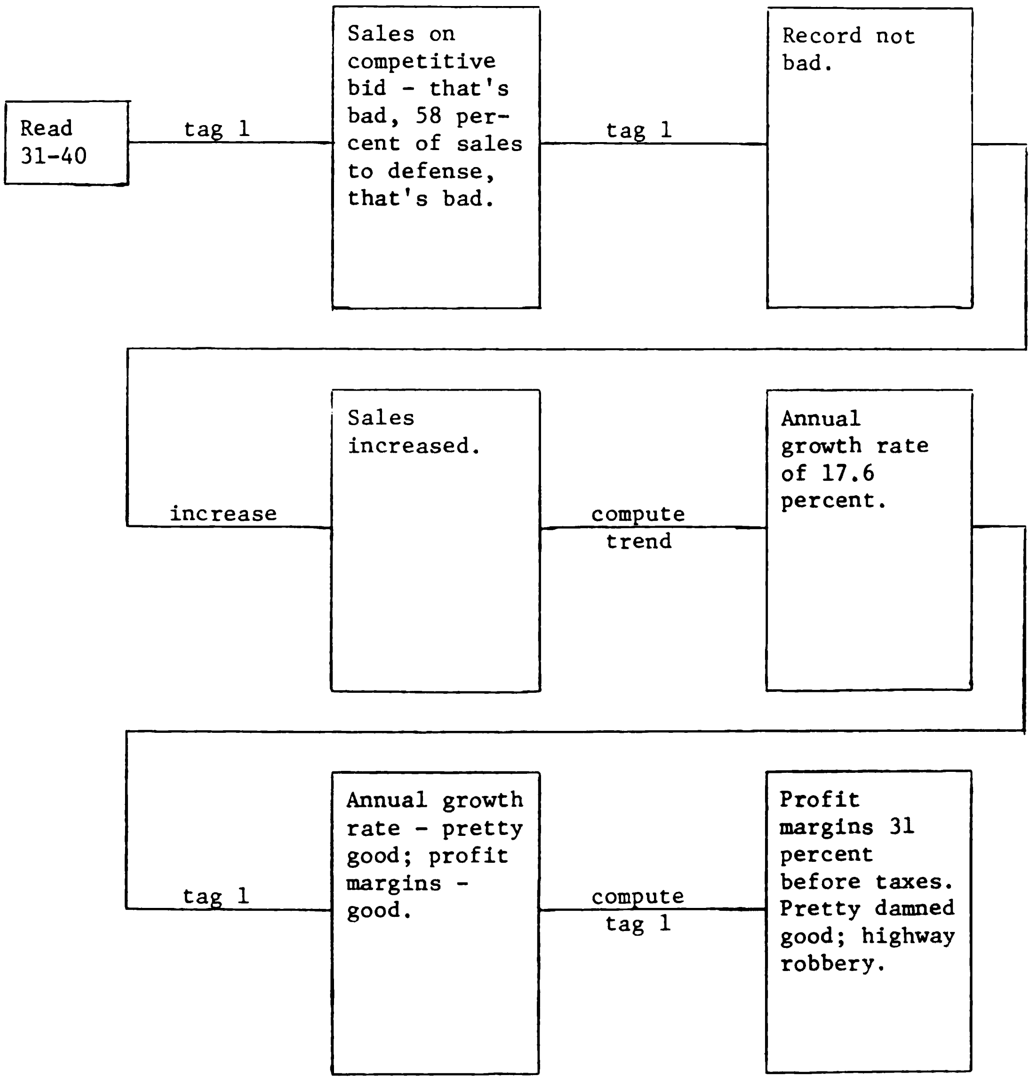


Derived Model of S2

Figure 8

Figure 8 (cont.)





Problem Behavior Graph of S3

Figure 9

Figure 9 (cont.)

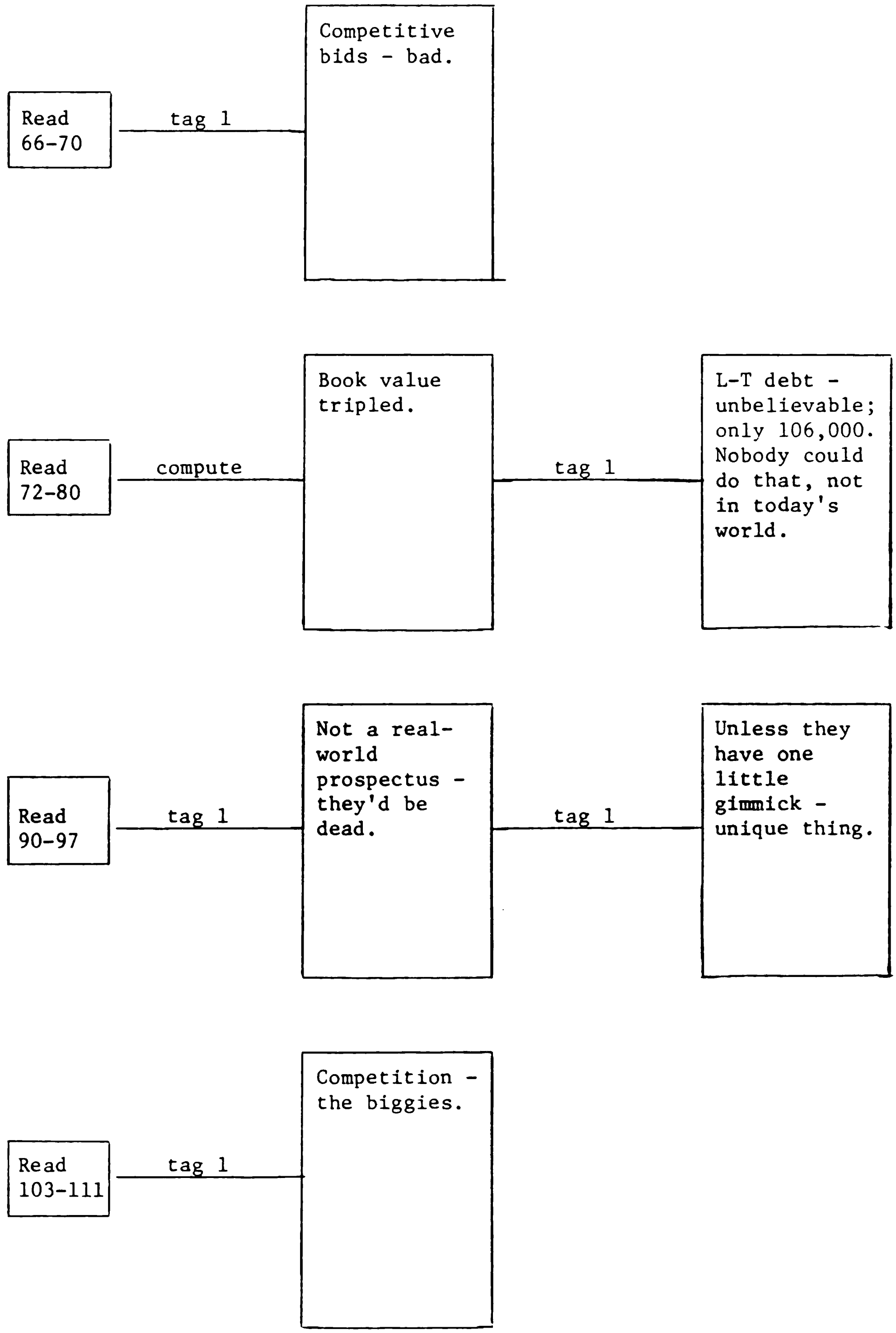
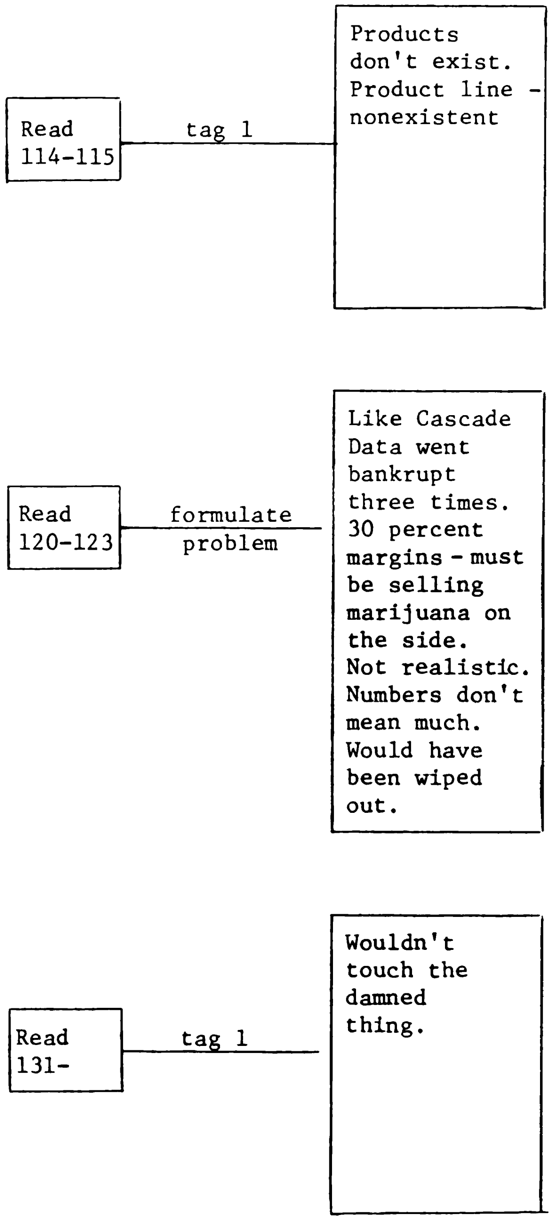
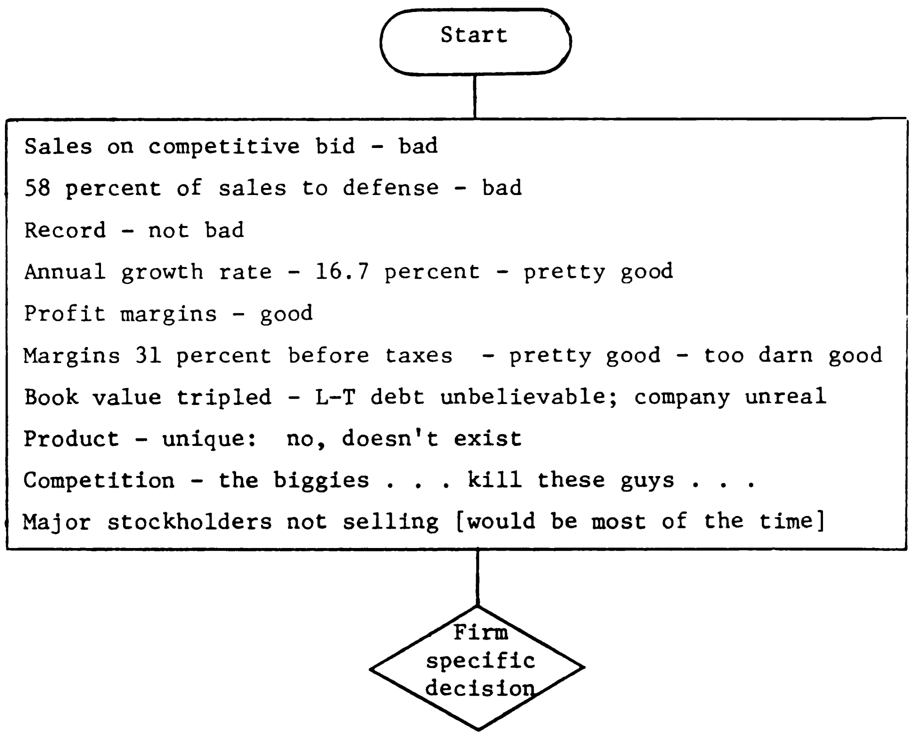


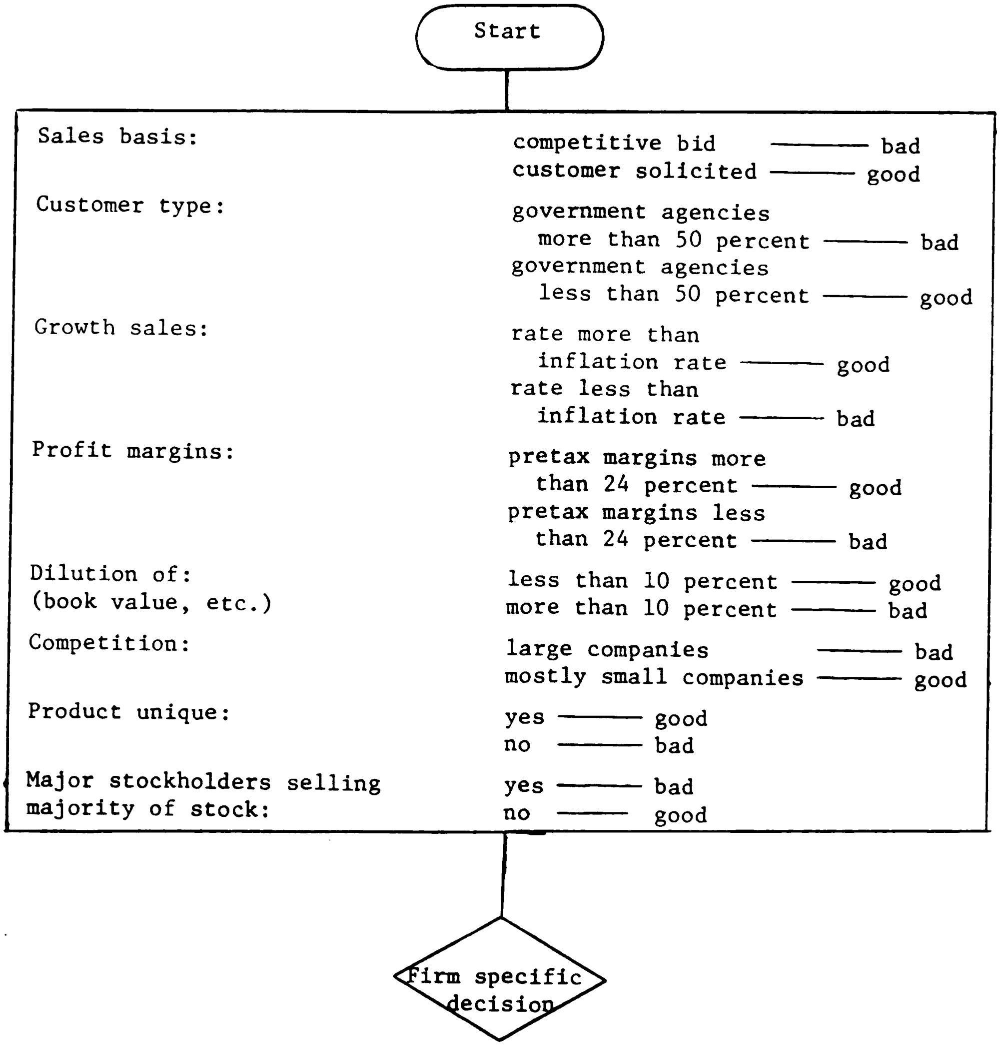
Figure 9 (cont.)





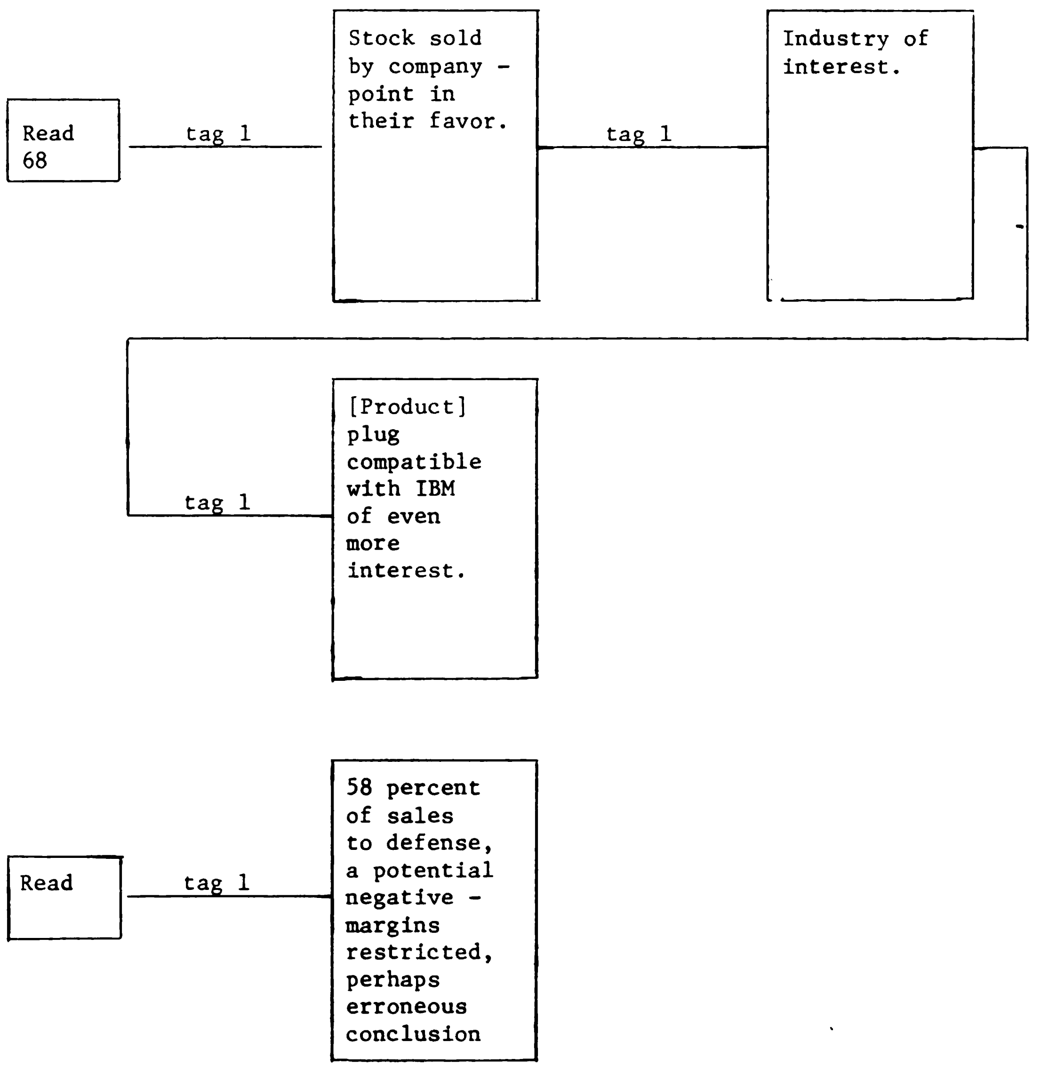
Protocol Model of S3

Figure 10



Derived Model of S3

Figure 11



Problem Behavior Graph of S4

Figure 12

Figure 12 (cont.)

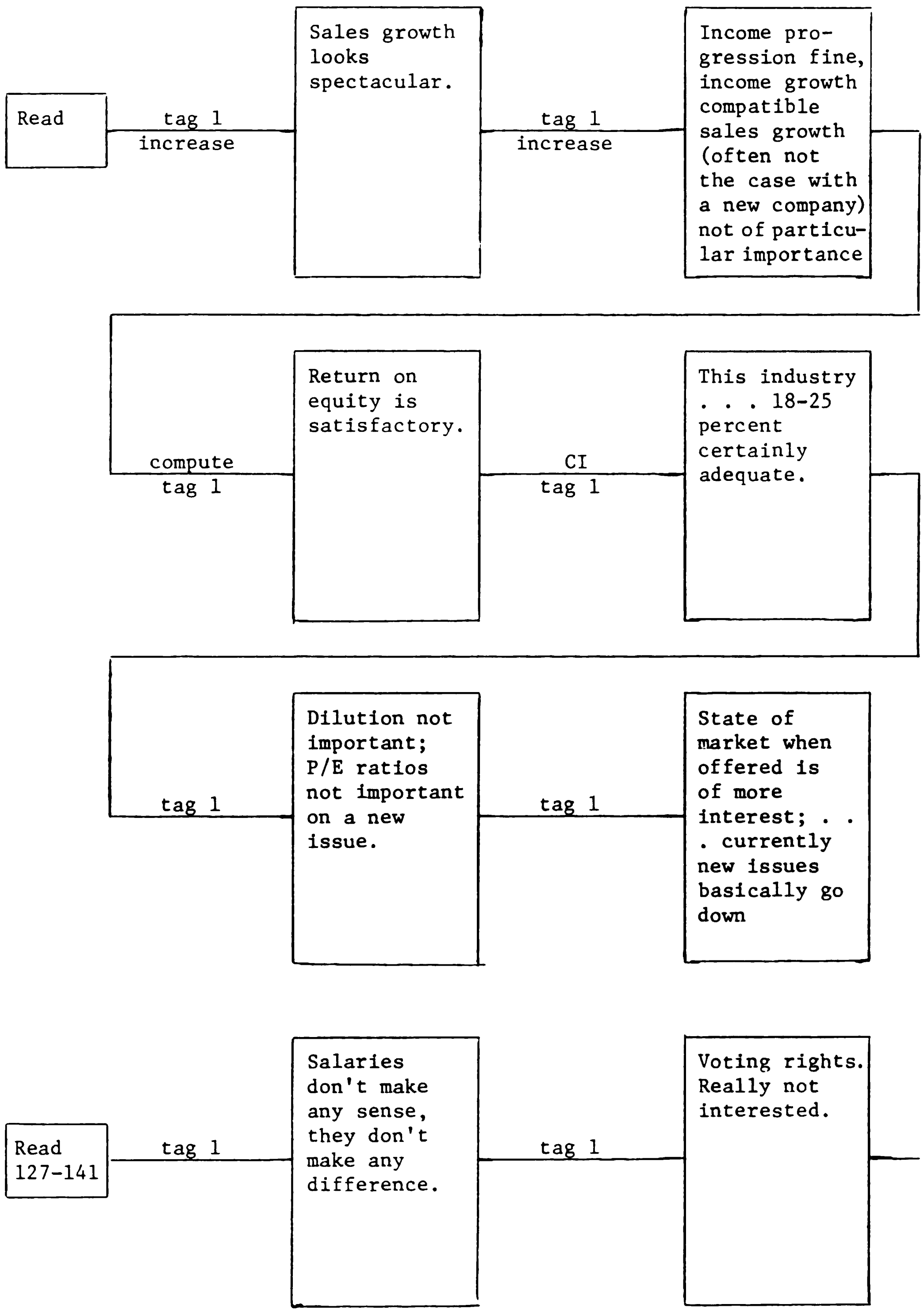
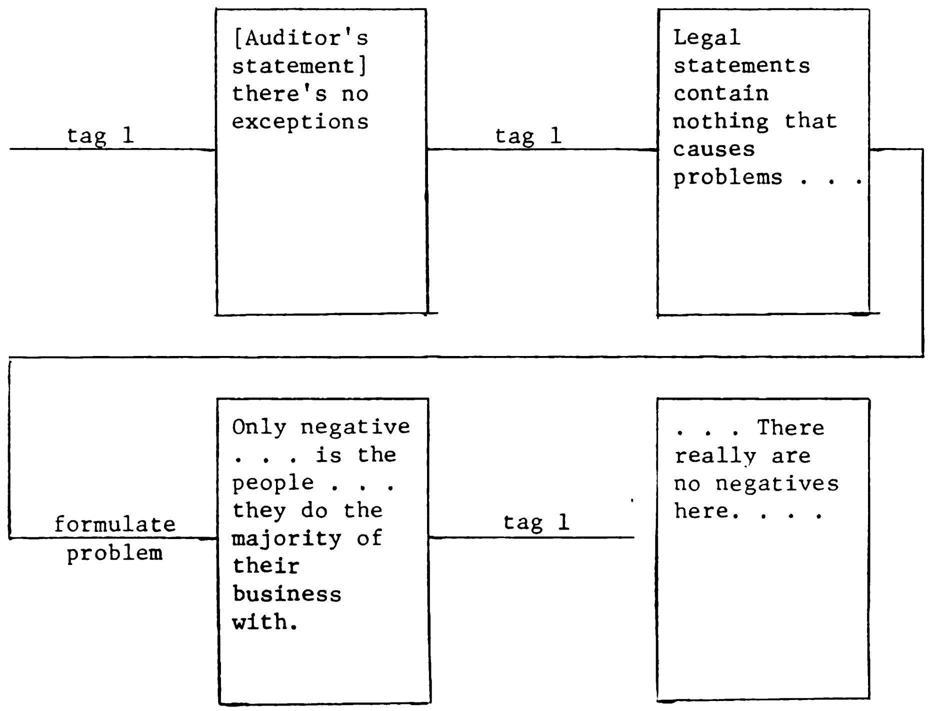
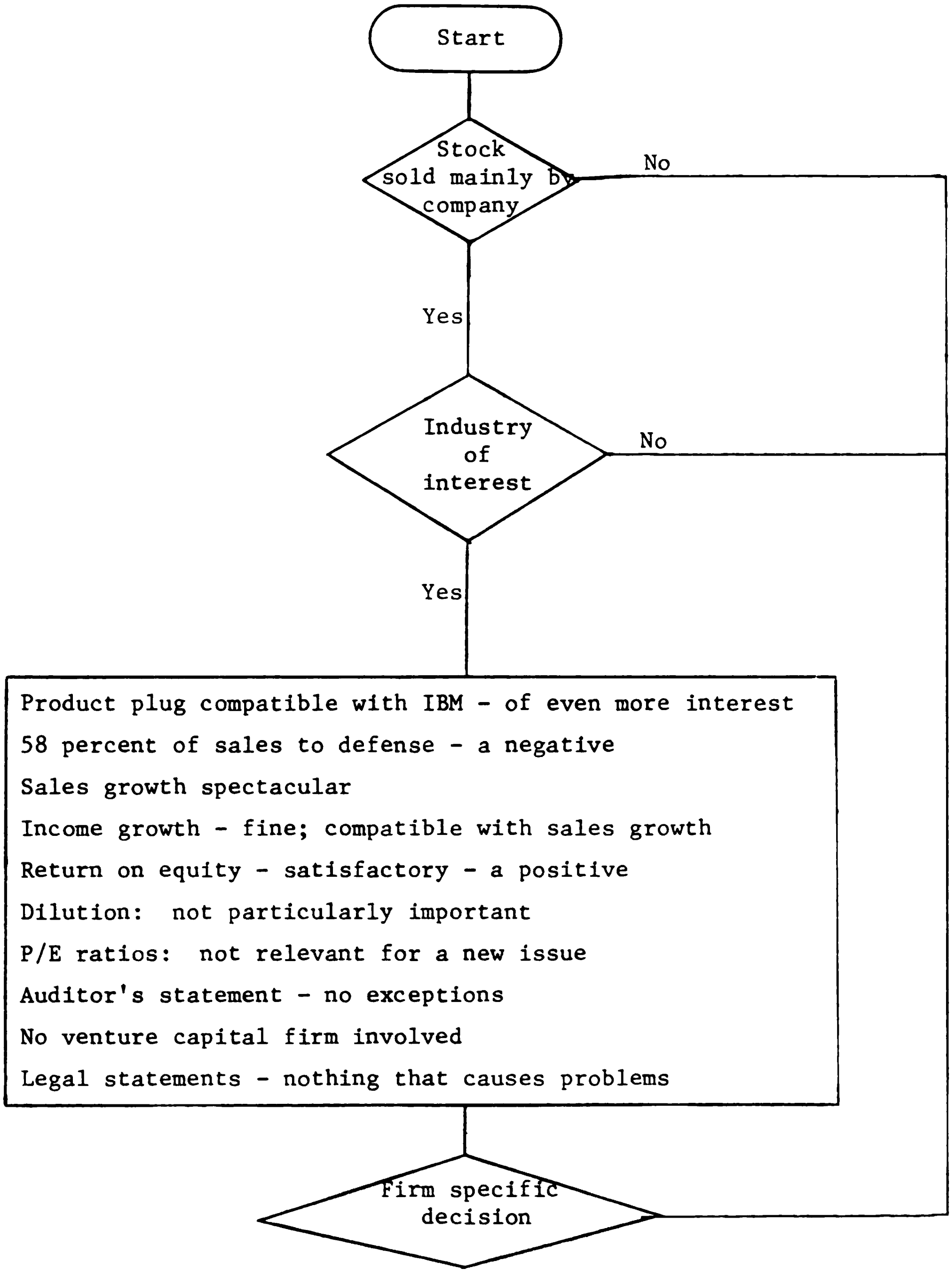


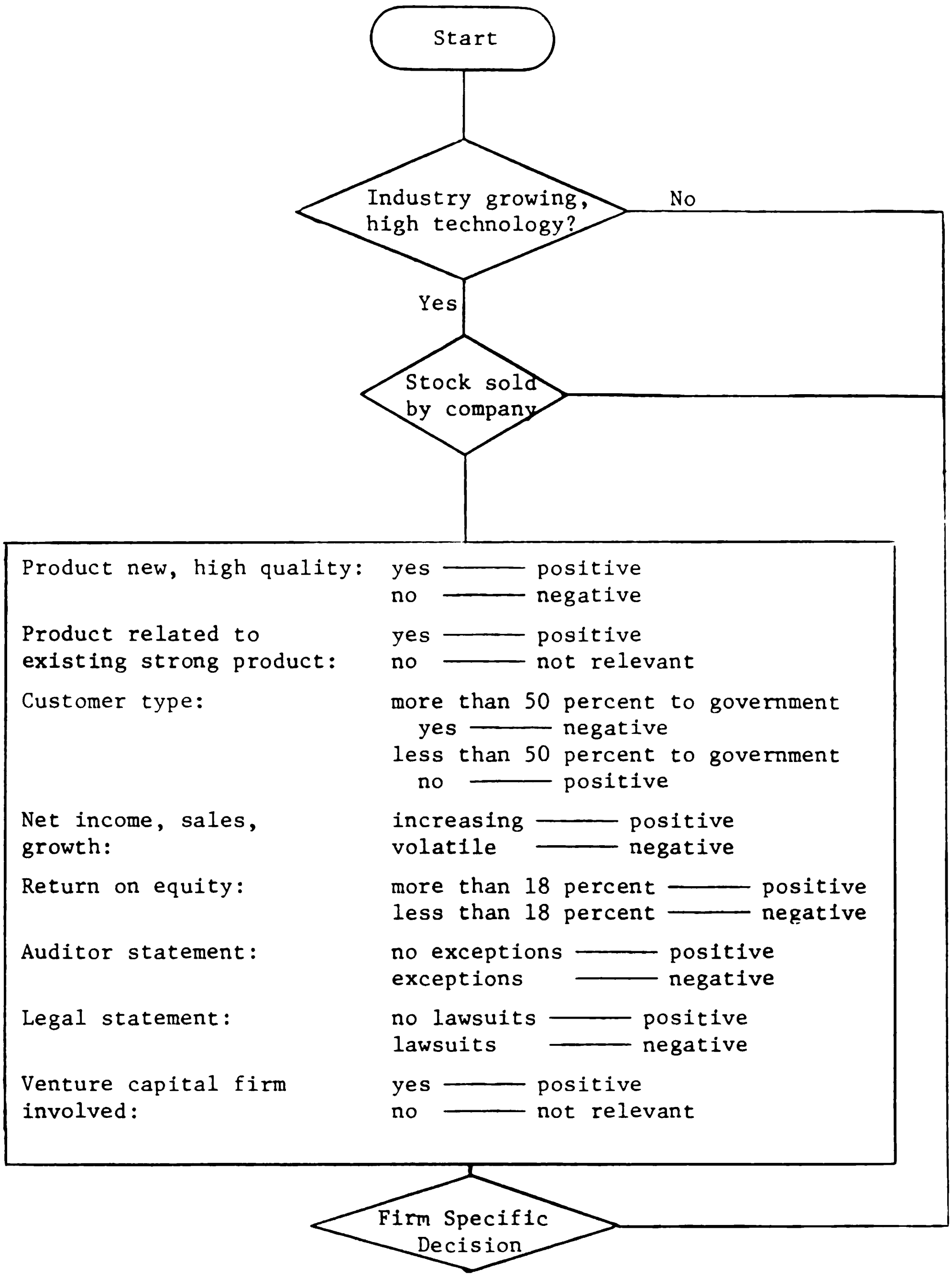
Figure 12 (cont.)





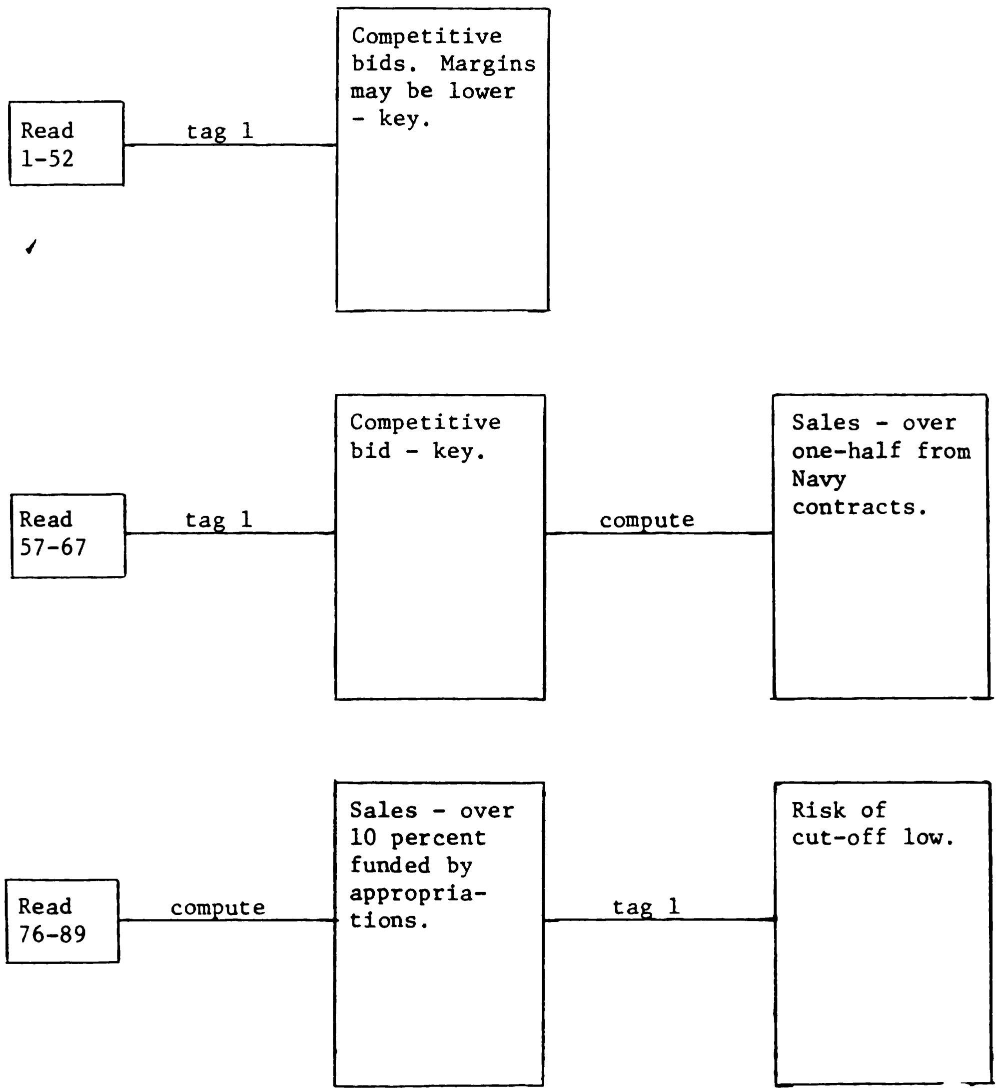
Protocol Model of S4

Figure 13



Derived Model of S4

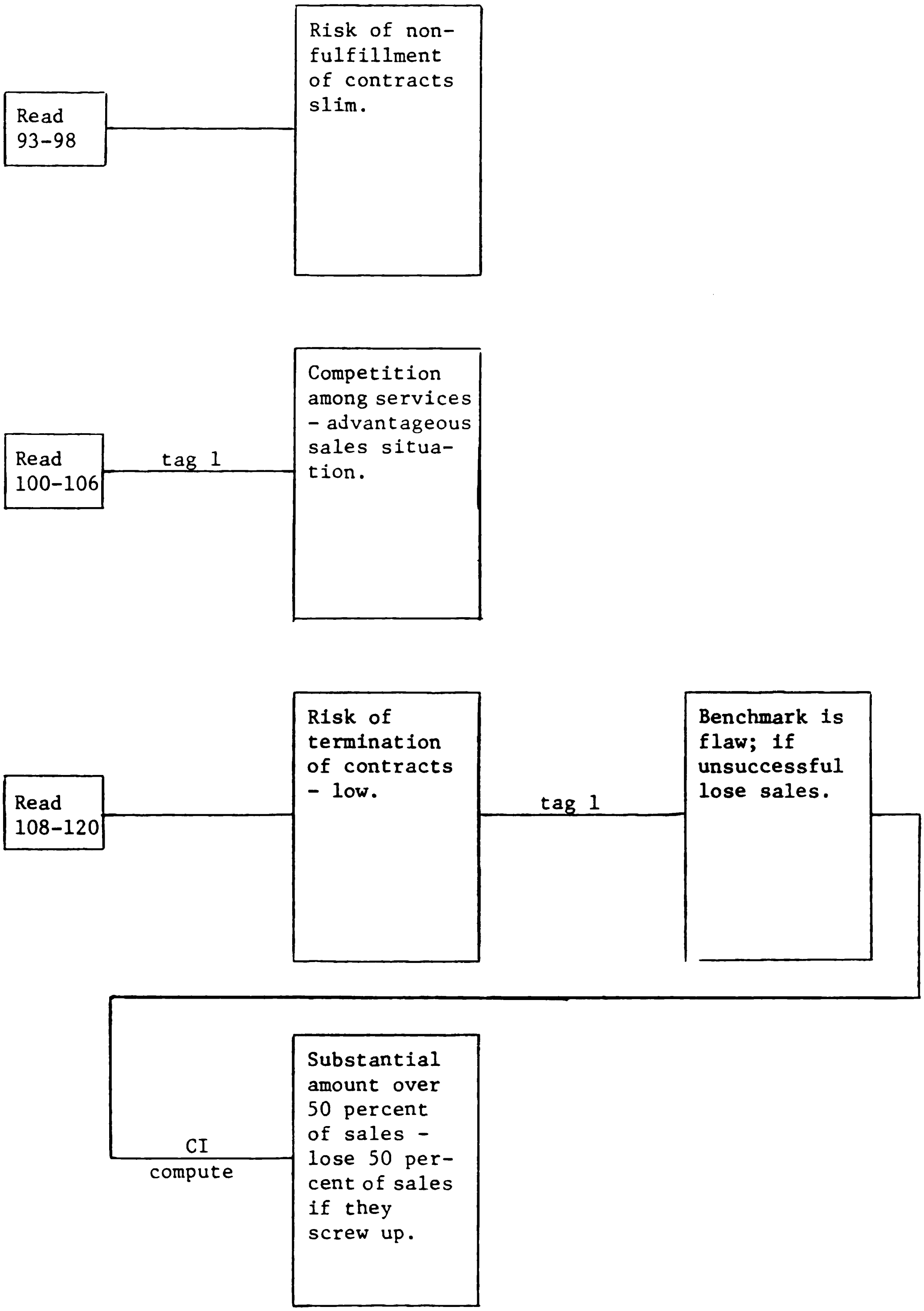
Figure 14



Problem Behavior Graph of S5

Figure 15

Figure 15 (cont.)



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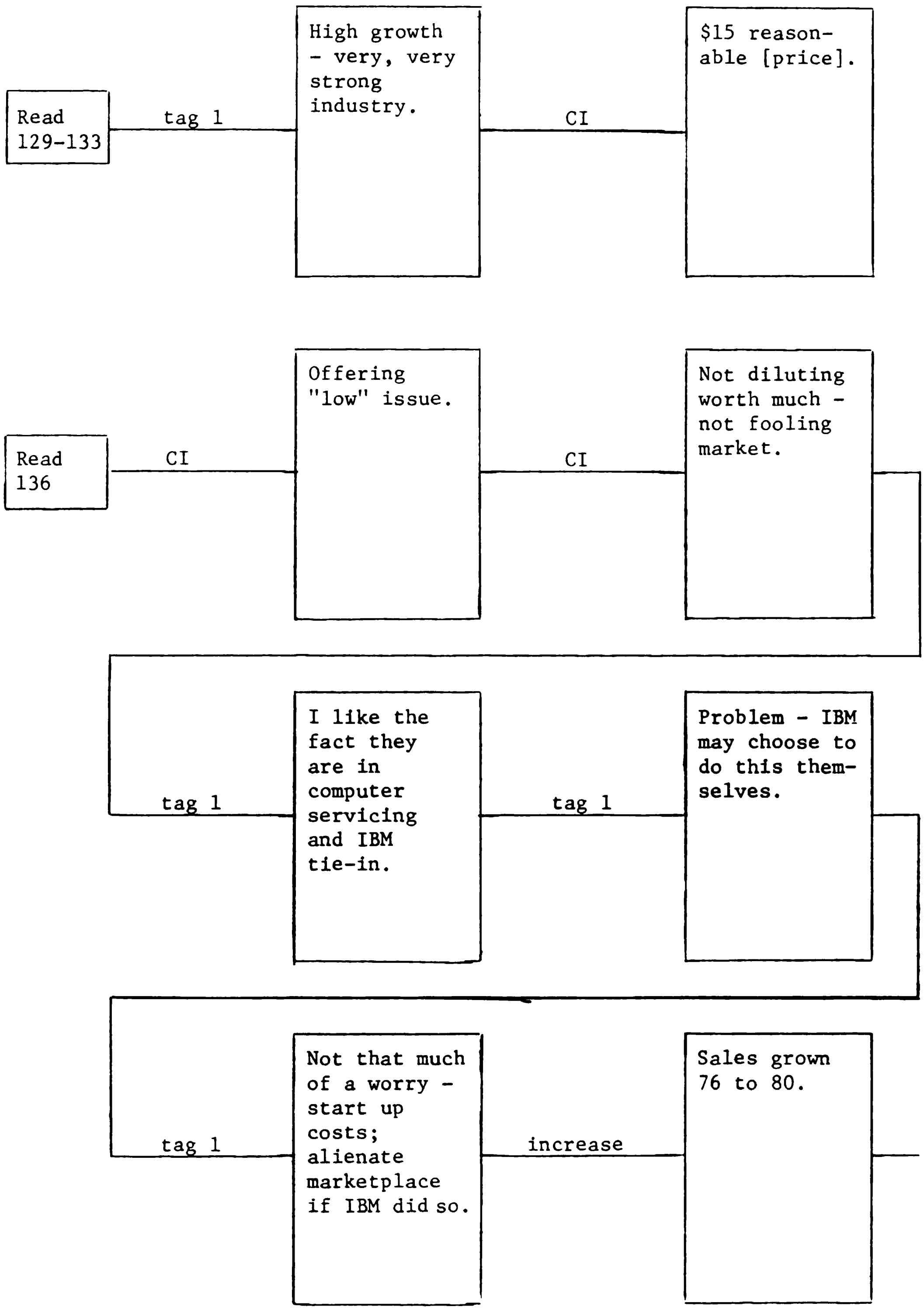

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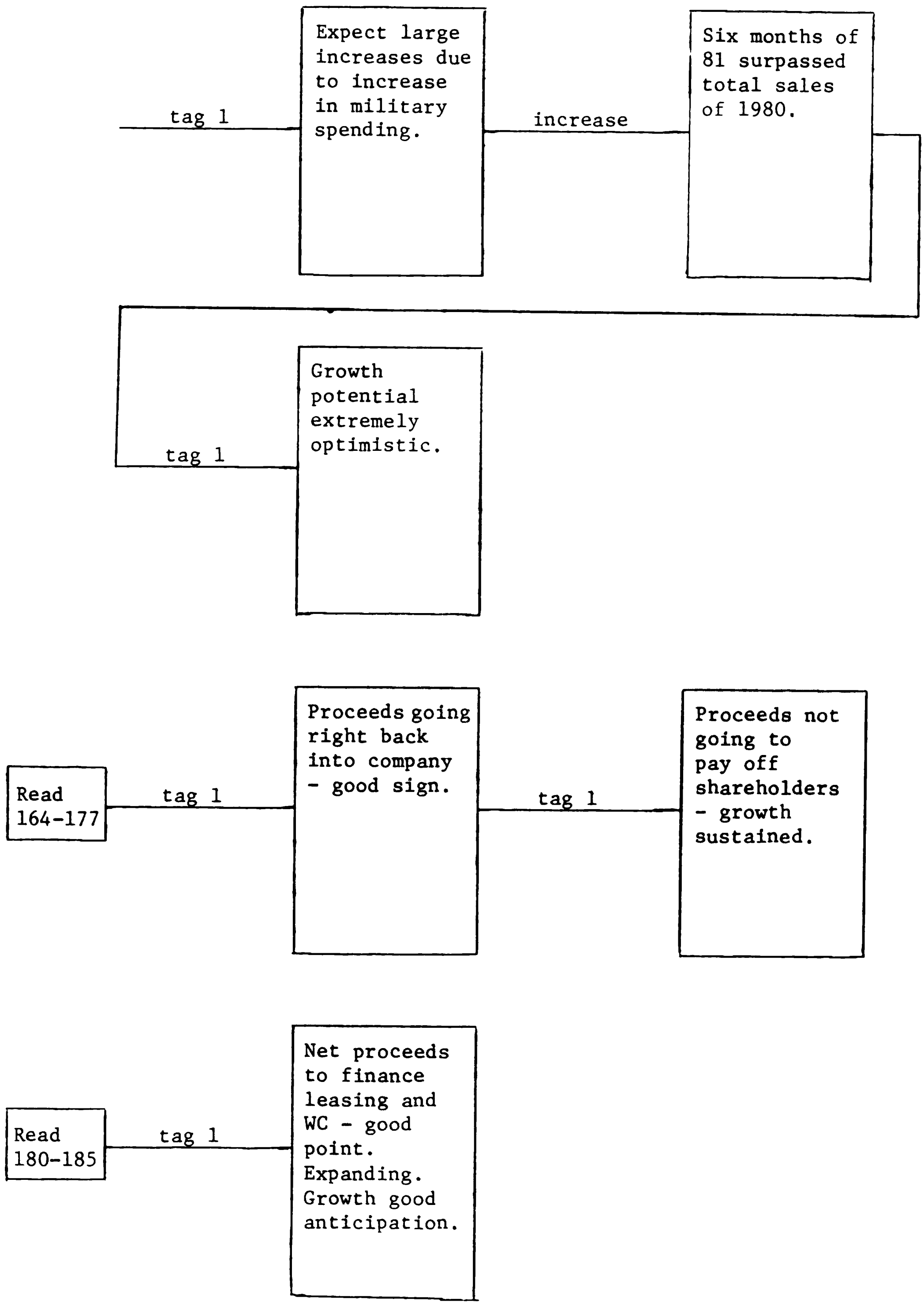

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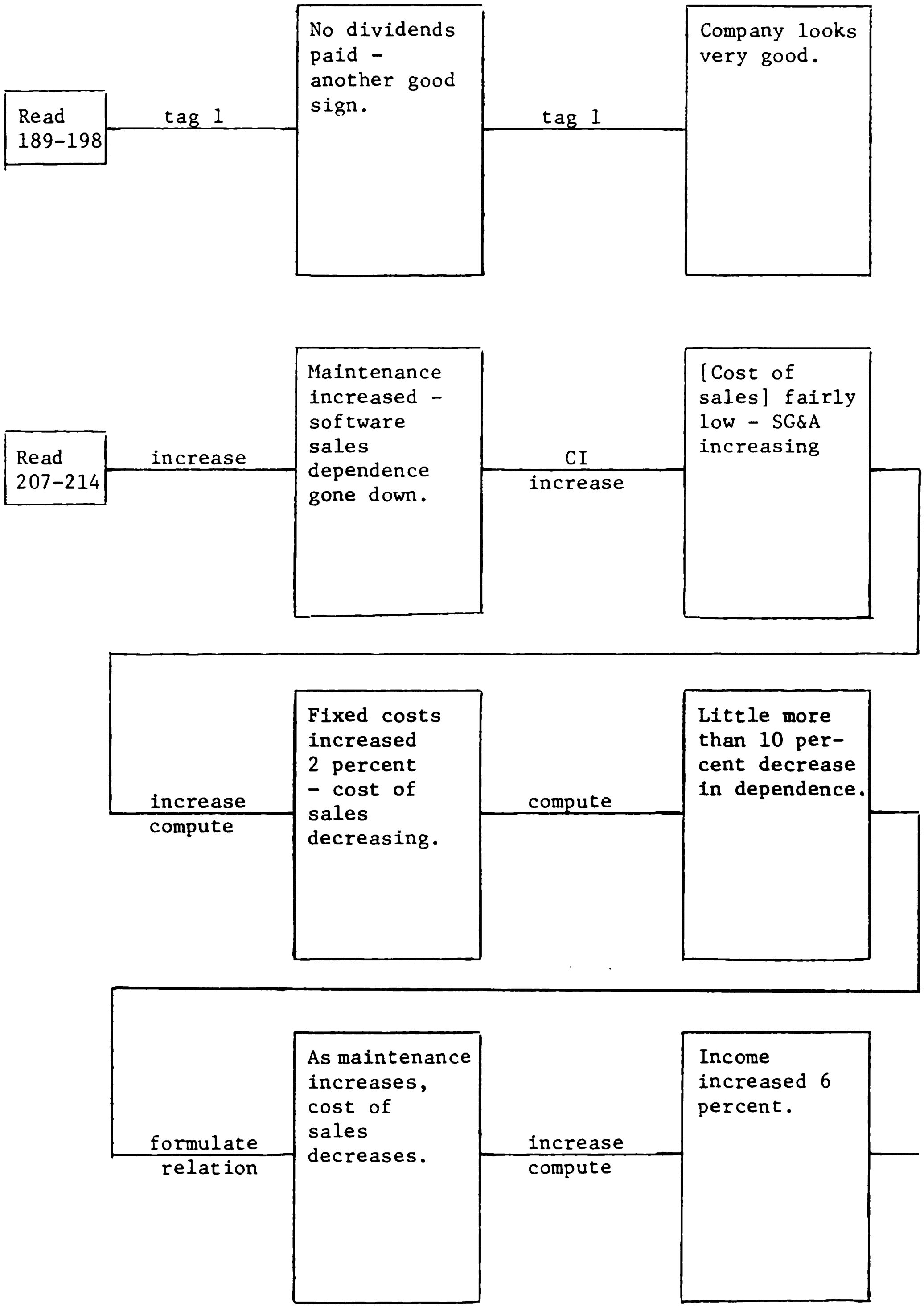

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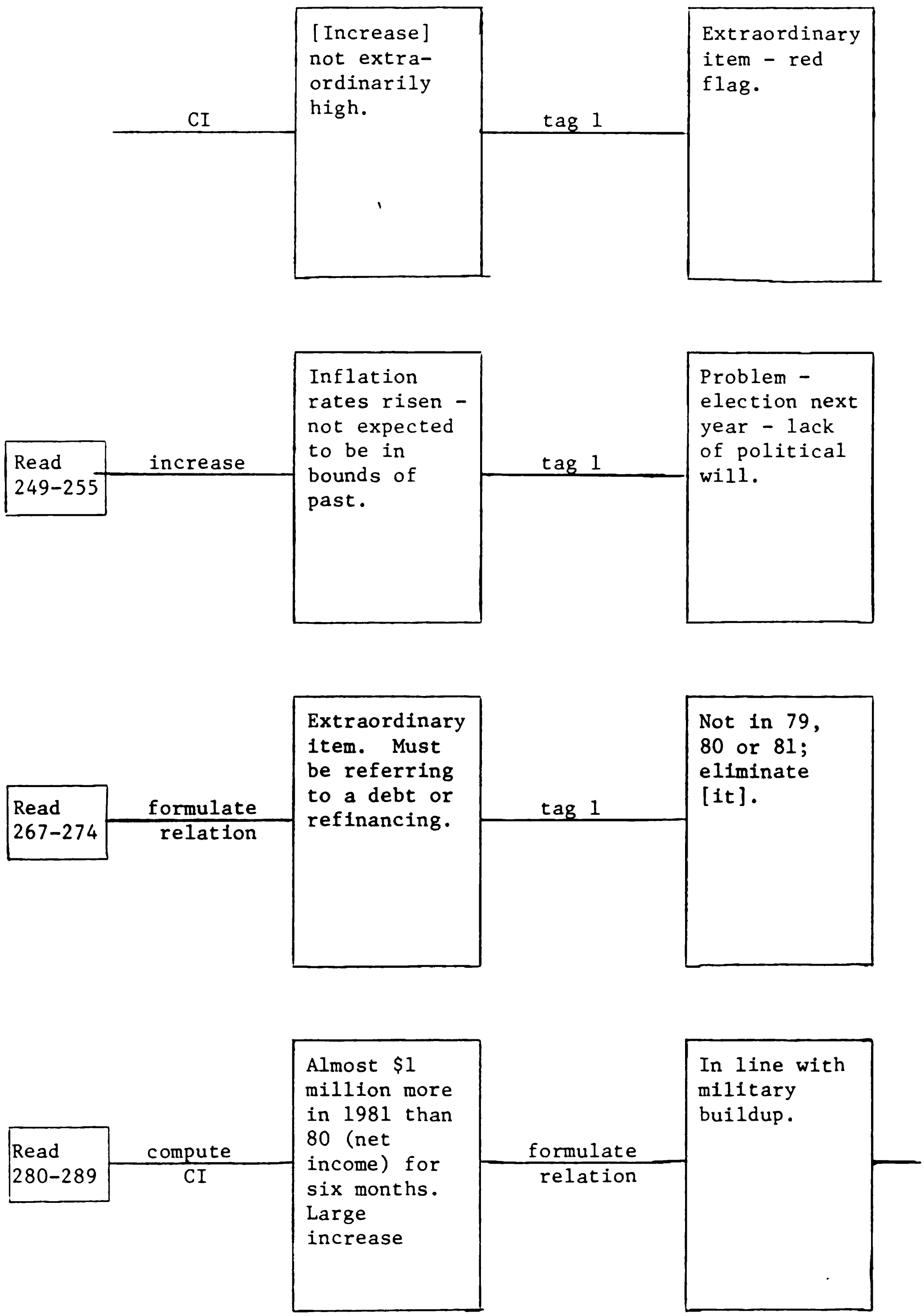

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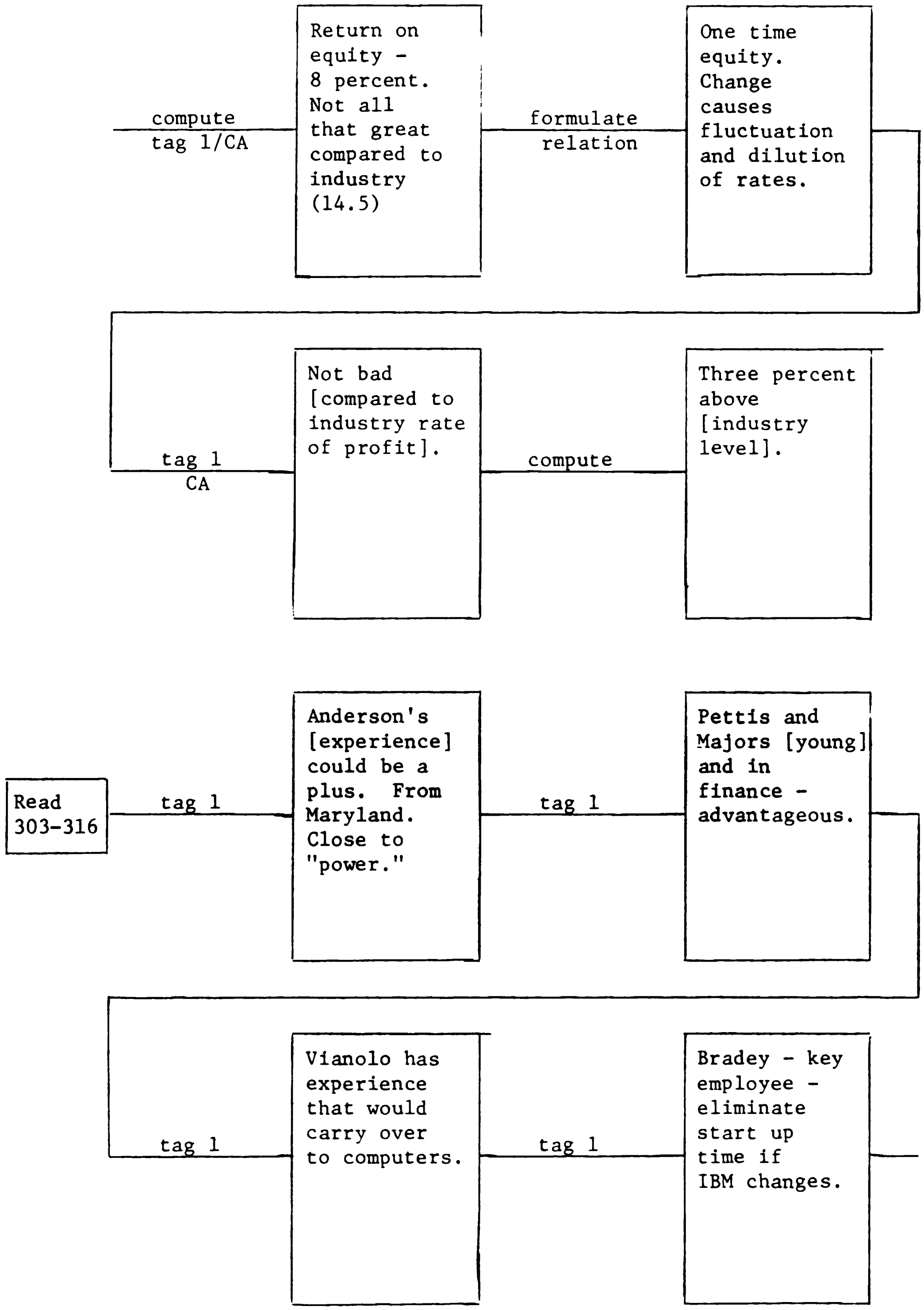

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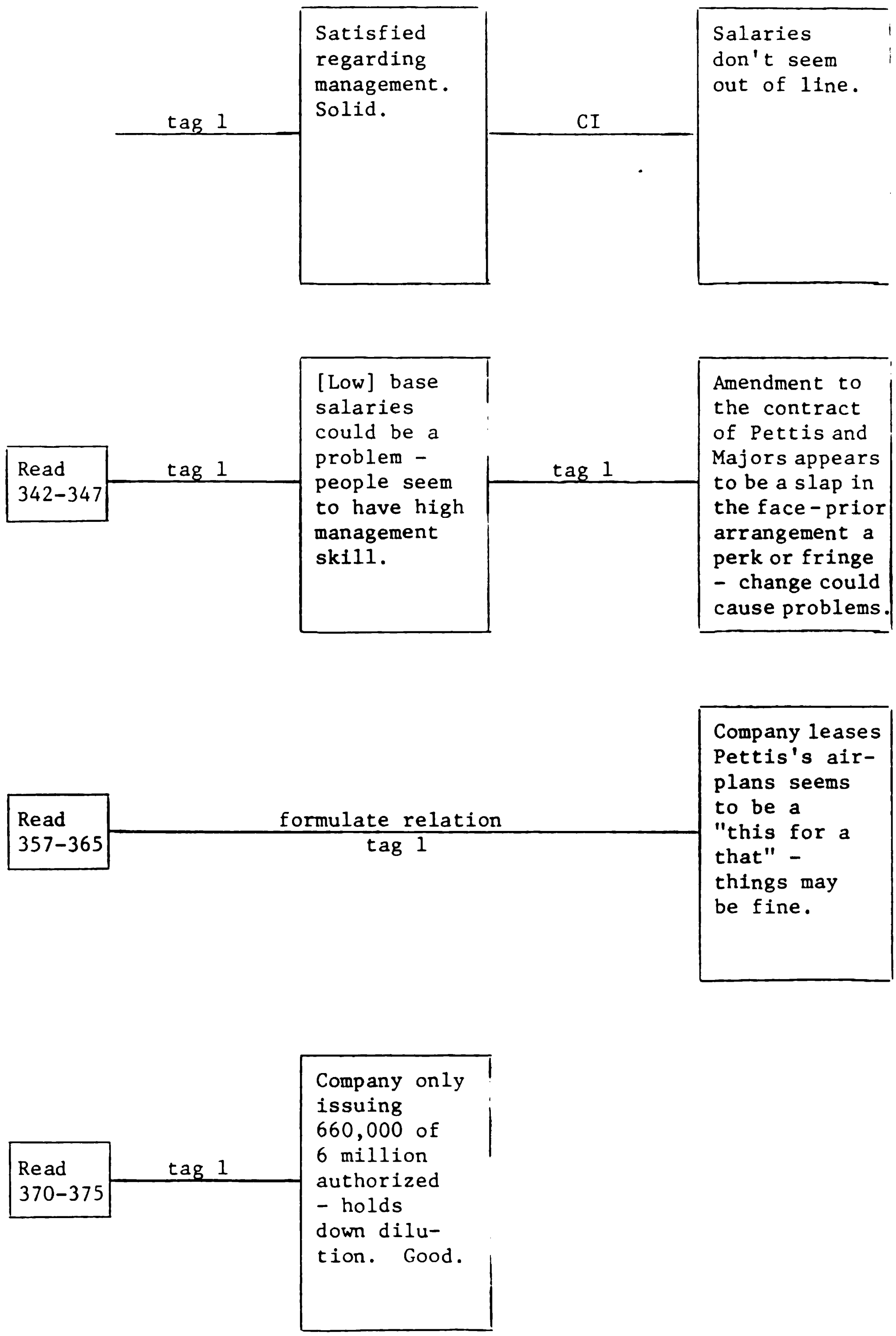

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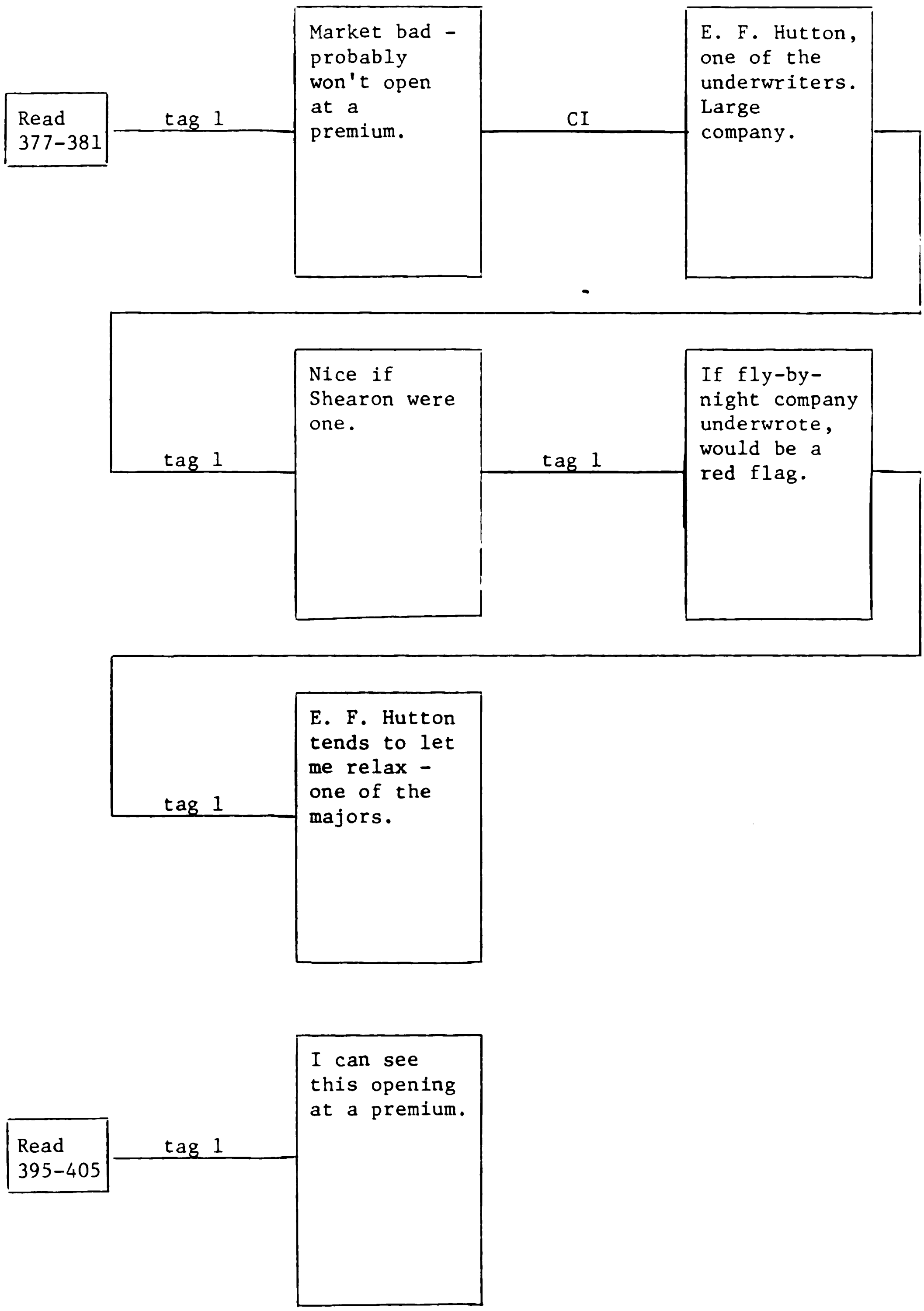


Start

Competitive bids - margins may be lower - key

Sales - over one-half from Navy contracts, over 10 percent funded; Risk of cut-off - low

Contract termination risk - low

Benchmark is flaw - lose over 50 percent of sales if unsuccessful

Industry - high growth; very, very strong

$15 - reasonable price

Issue [total] low; no diluting market place

Computer servicing with IBM tie-in [I like]

Problem: IBM may choose to do this themselves: not much of a worry

Sales - grown; expect large increases due to increase in military spending

Growth potential - extremely optimistic

Proceeds: going back into company: good sign

Proceeds: to finance leasing; provide working capital - good point

Growth a good anticipation

Dividends: none - good sign (another)

Company: looks very good

Maintenance increased; dependence on software down

Cost of sales - fairly low

SG&A increasing

As maintenance increases, cost of sales decreases

Income increase - not extraordinarily high

Extraordinary item - red flag; not in 80 or 81; eliminate

Increase in income for 81 is large - in line with military buildup

ROE (8 percent) not all that great compared to industry; however one-time change (stock sale) causes fluctuation and dilution of the ratio

[Ratio] not bad when compared to industry profit rate

Anderson's experience - could be a plus

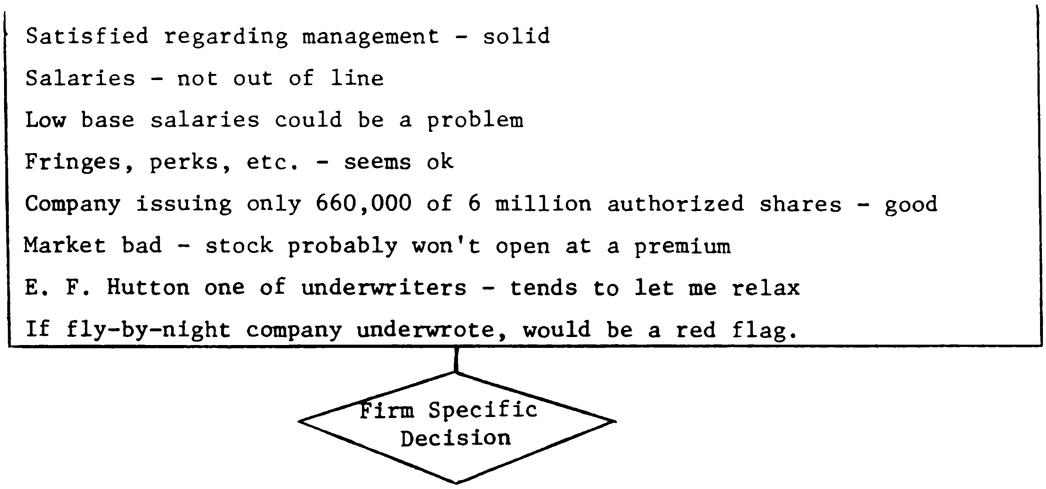
P&M, [young] and in finance - advantageous

Vianolo's experience - could carry over to computers

Bradley - key employee; eliminate start-up time if IBM [changes models]

Protocol Model of S5
Figure 16

Figure 16 (cont.)



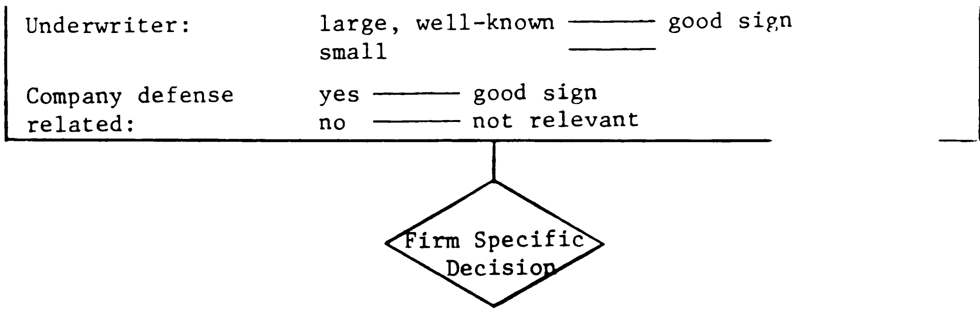
Start

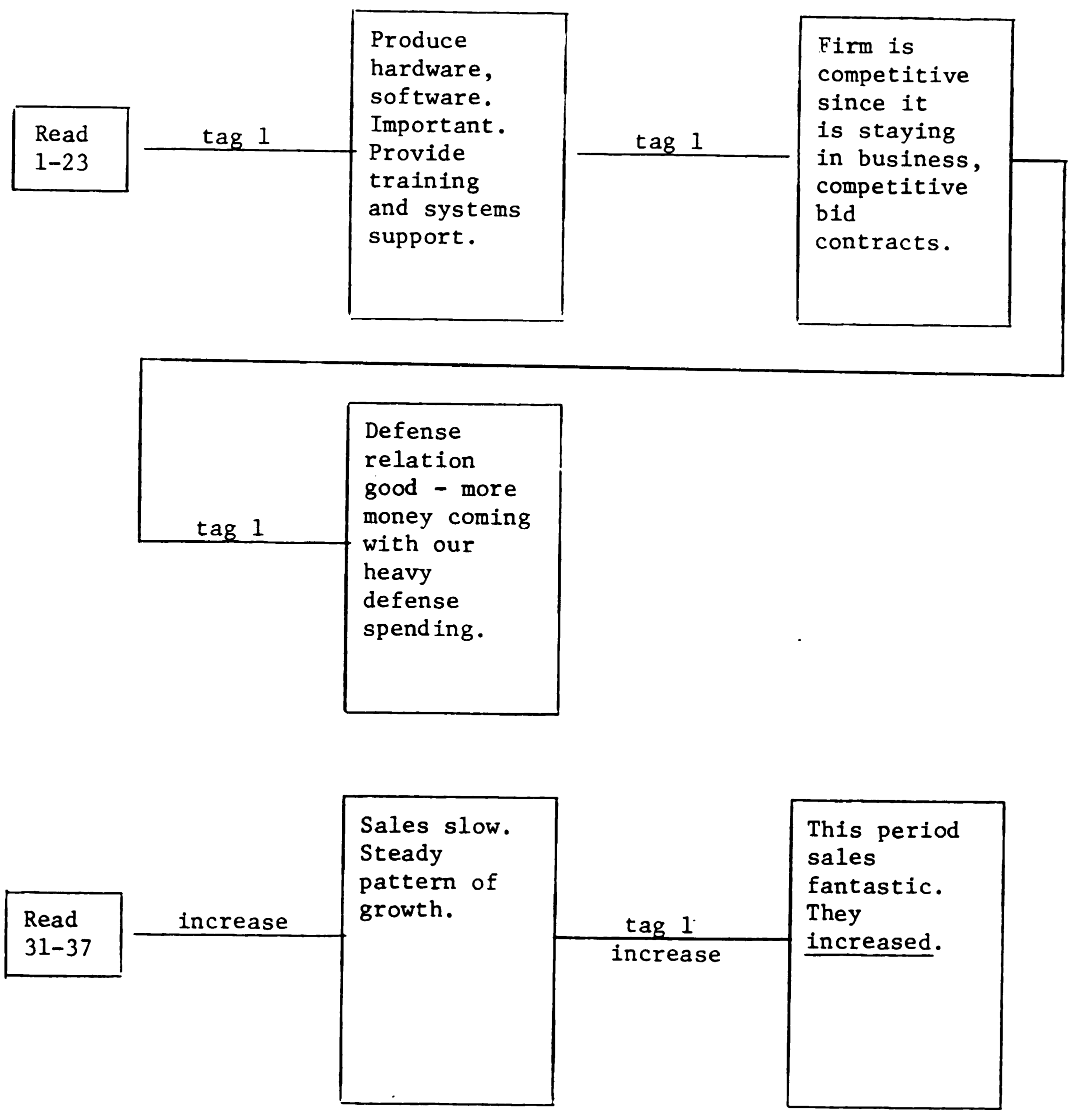
Product:	high technology, new	good sign
	conventional	red flag
Sales basis:	customer solicited	good sign
	competitive bids	red flag
Contracts:	noncancellable	good sign
	cancellable	red flag
Benchmark:	not necessary	good sign
	necessary	red flag
Industry growth:	strong	good sign
	not strong	red flag
Stock price:	less than or equal to $15	reasonable
	more than $15	unreasonable
Number of shares offered:	less than 1 million	good sign
	more than 1 million	red flag
Proceeds of issue:	to company	good sign
	to shareholders, debt	red flag
Dividends:	none	good sign
	paid	red flag
More than one product:	yes	good sign
	no	red flag
Extraordinary item:	none	good sign
	present	red flag
Income level:	increase more than 80 percent	good sign
	increase less than 80 percent	red flag
Return on equity: (after offering)	more than 80 percent	good sign
	less than 8 percent	red flag
Management experienced in industry, finance:	yes	good sign
	no	red flag
Salaries:	top pay less than $200,000	good sign
	top pay greater than $200,000	red flag
Base salaries, top management:	greater than $25,000	good sign
	less than $25,000	red flag
Stock market trend:	up	good sign
	down	red flag

Derived Model of S5

Figure 17

Figure 17 (cont.)

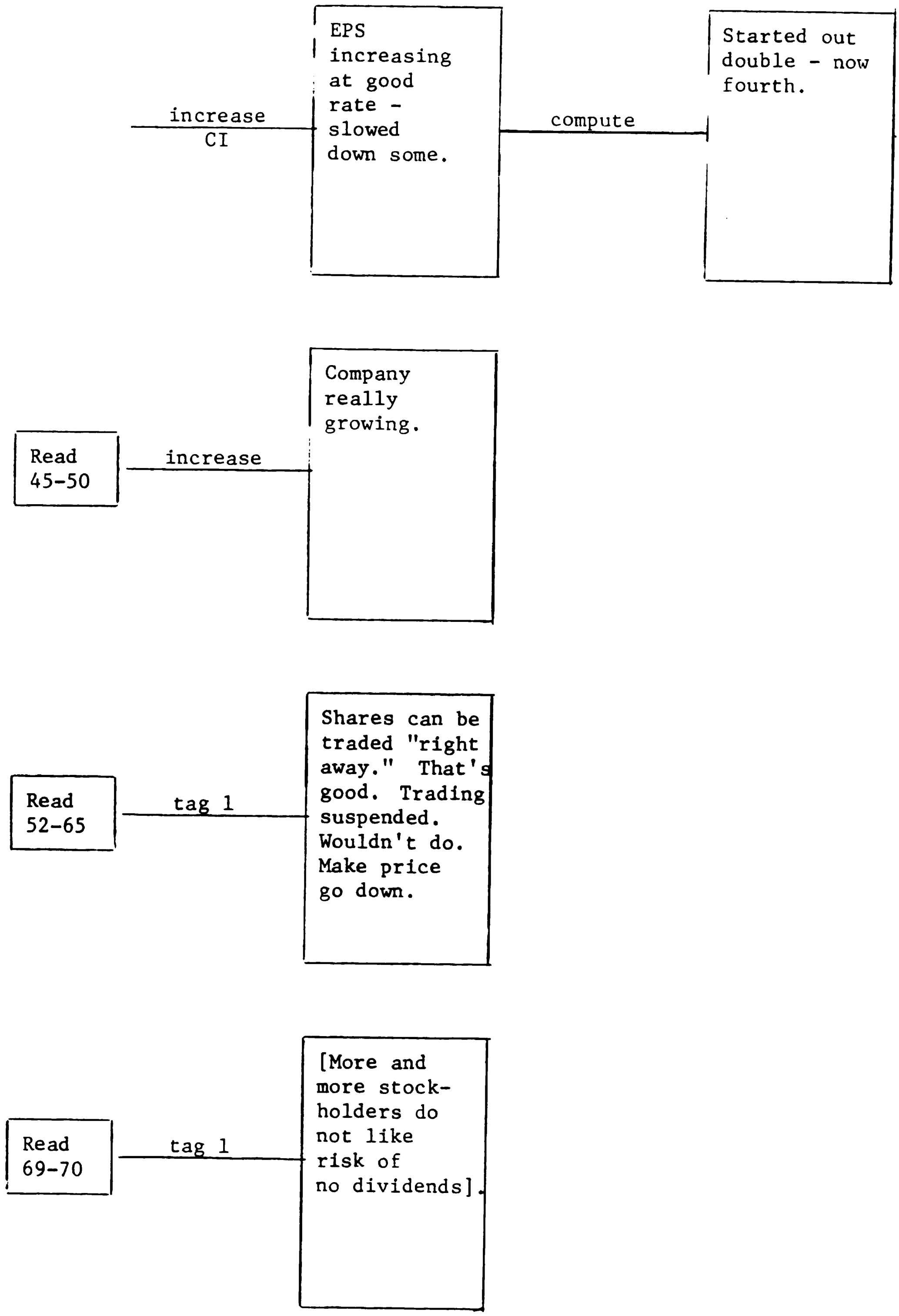




Problem Behavior Graph of S6

Figure 18

Figure 18 (cont.)



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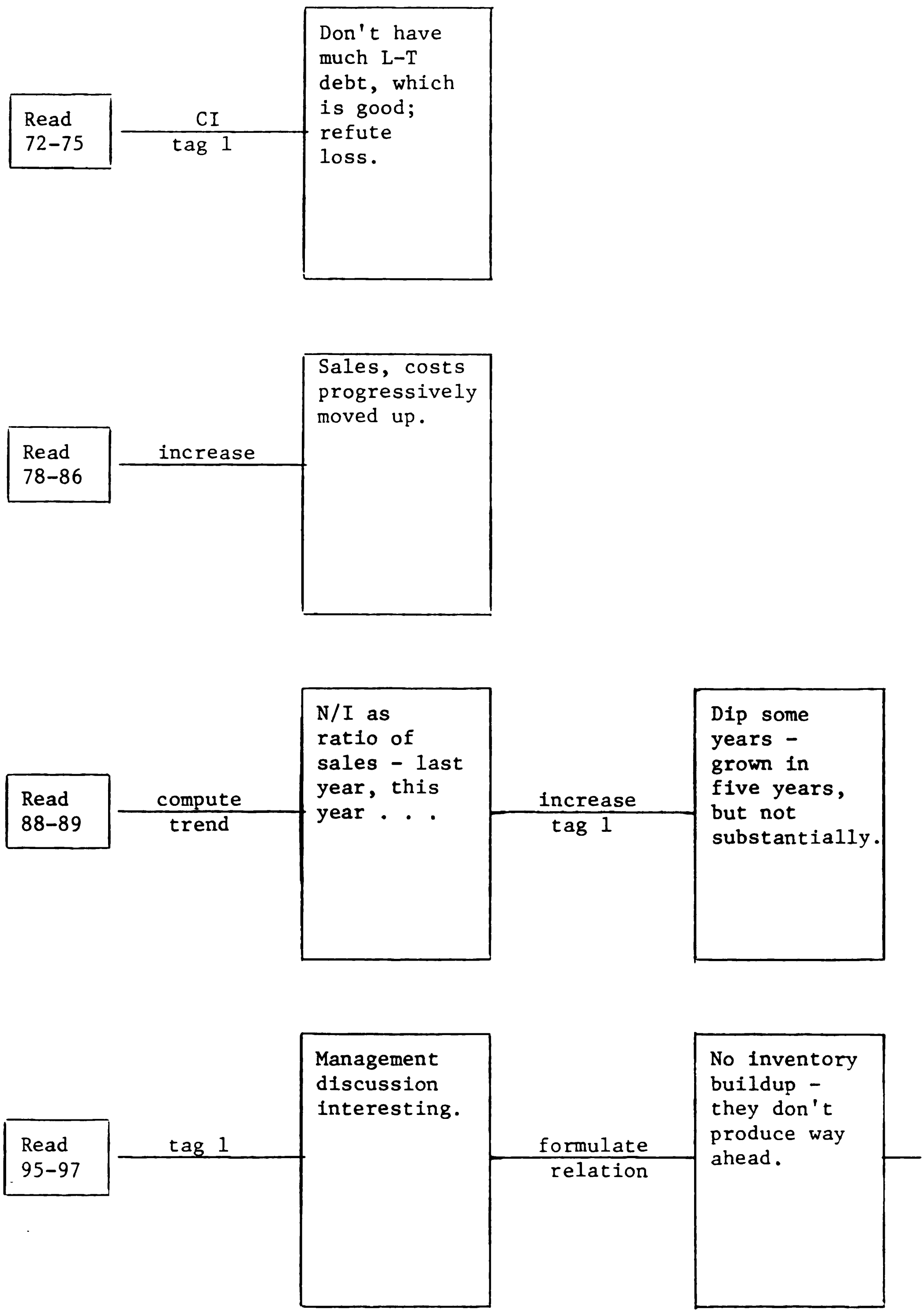

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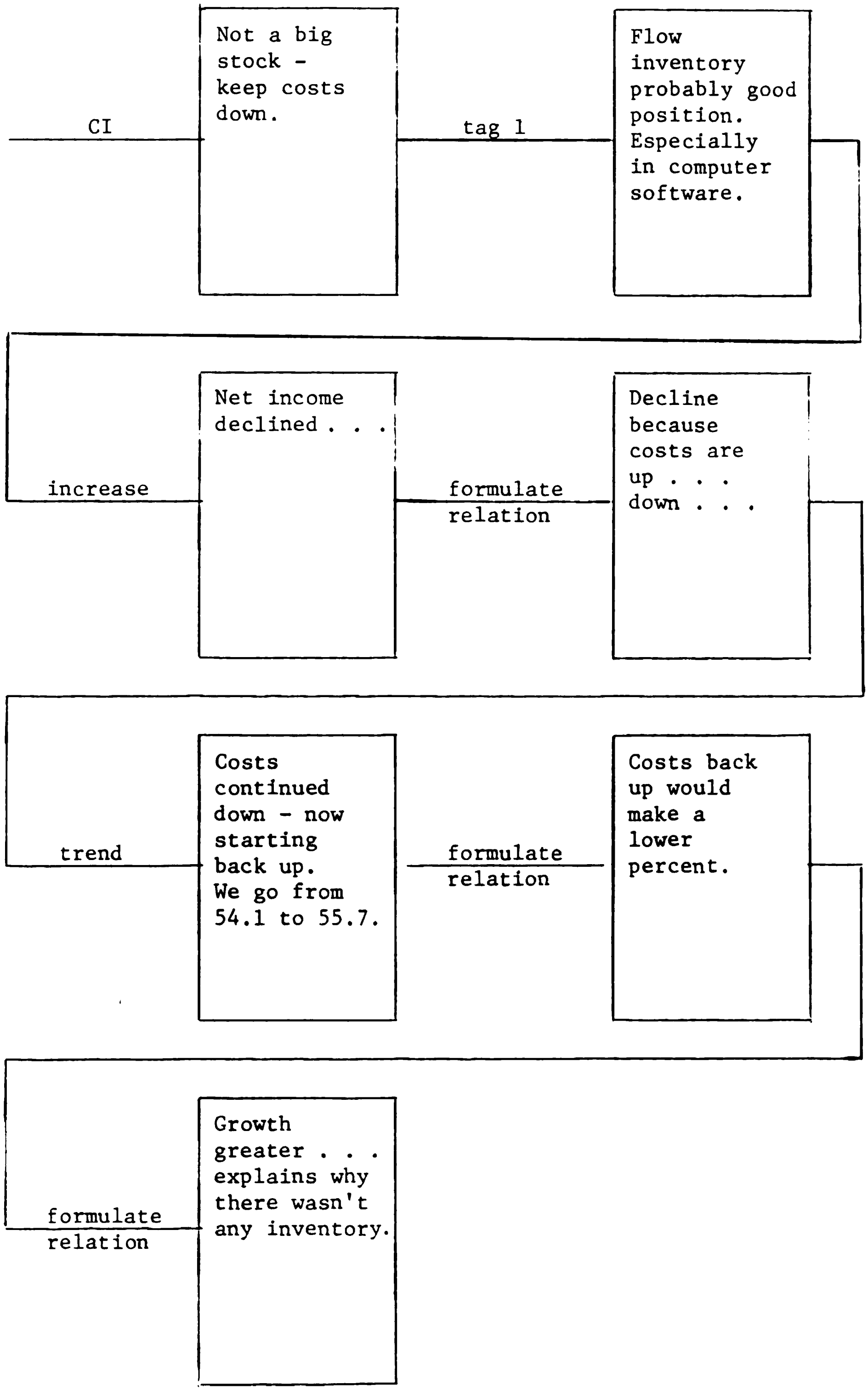

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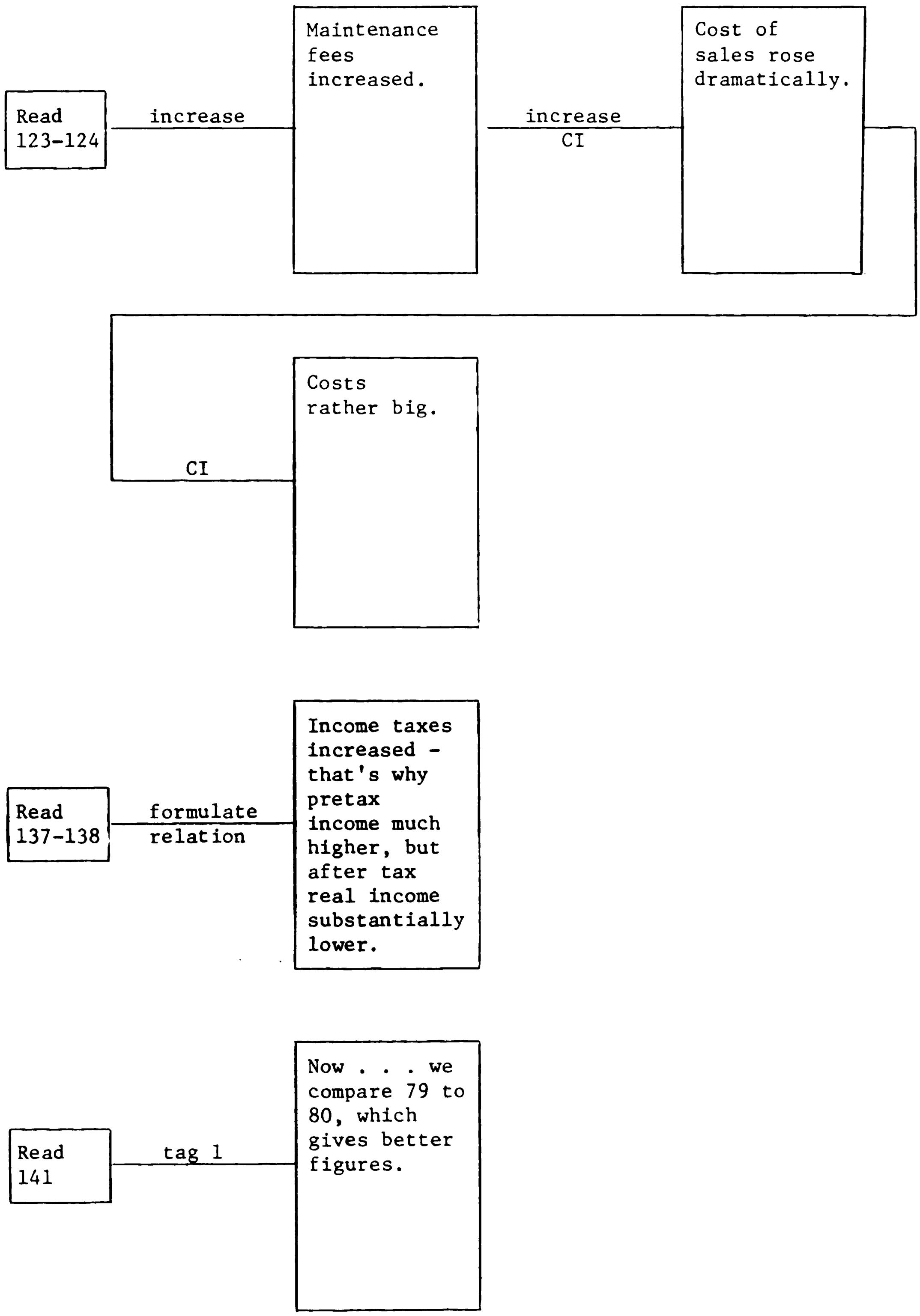

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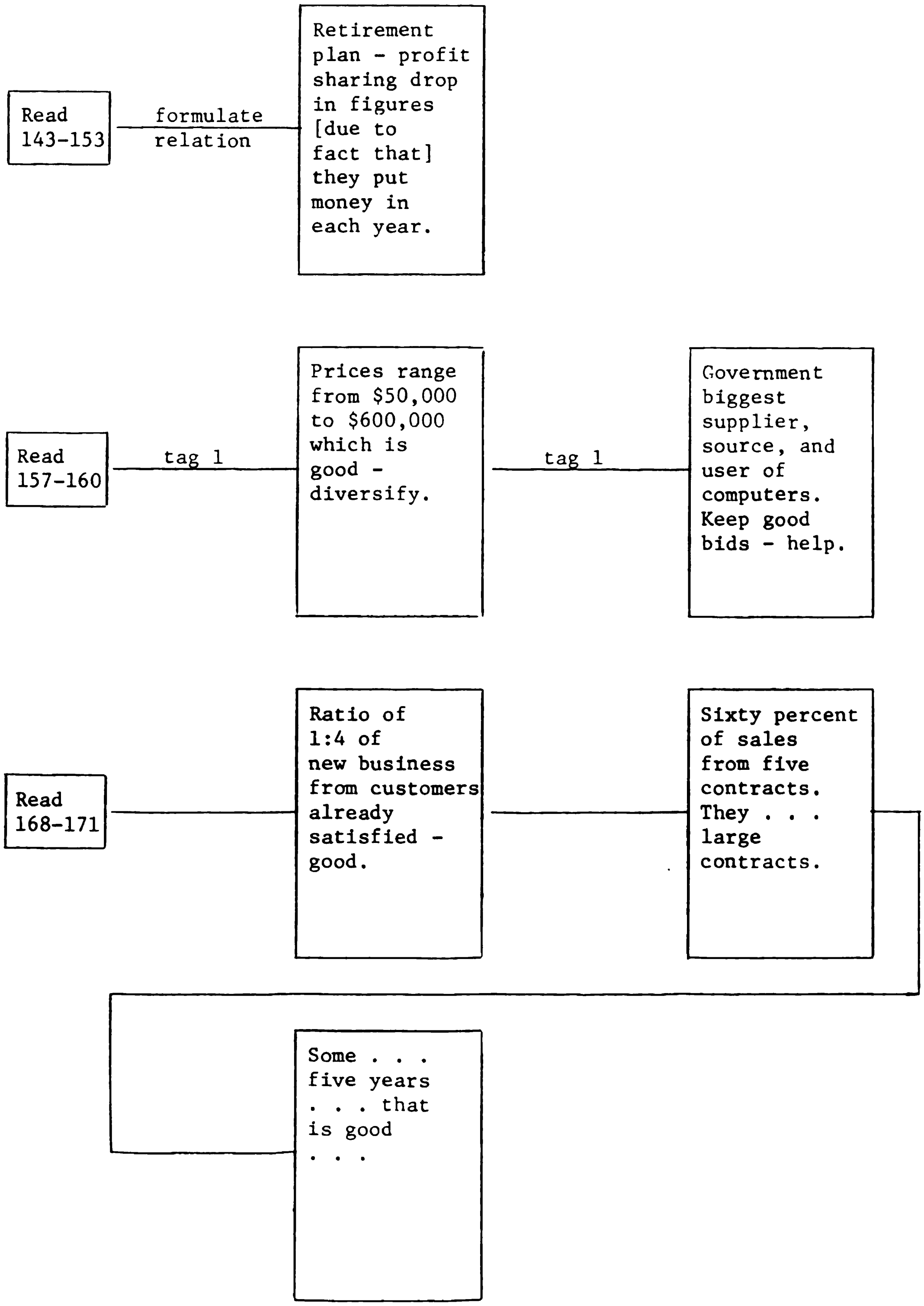

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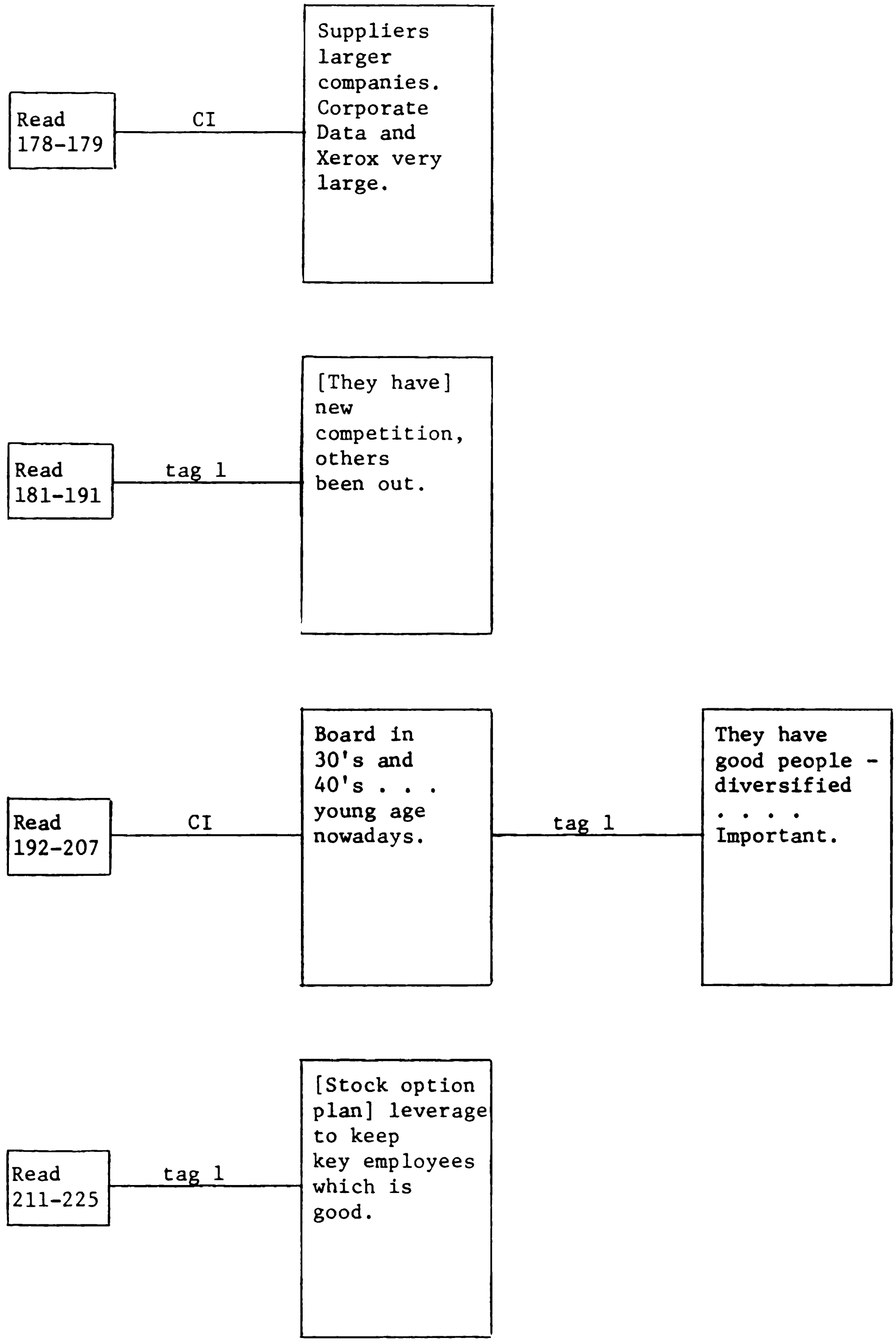

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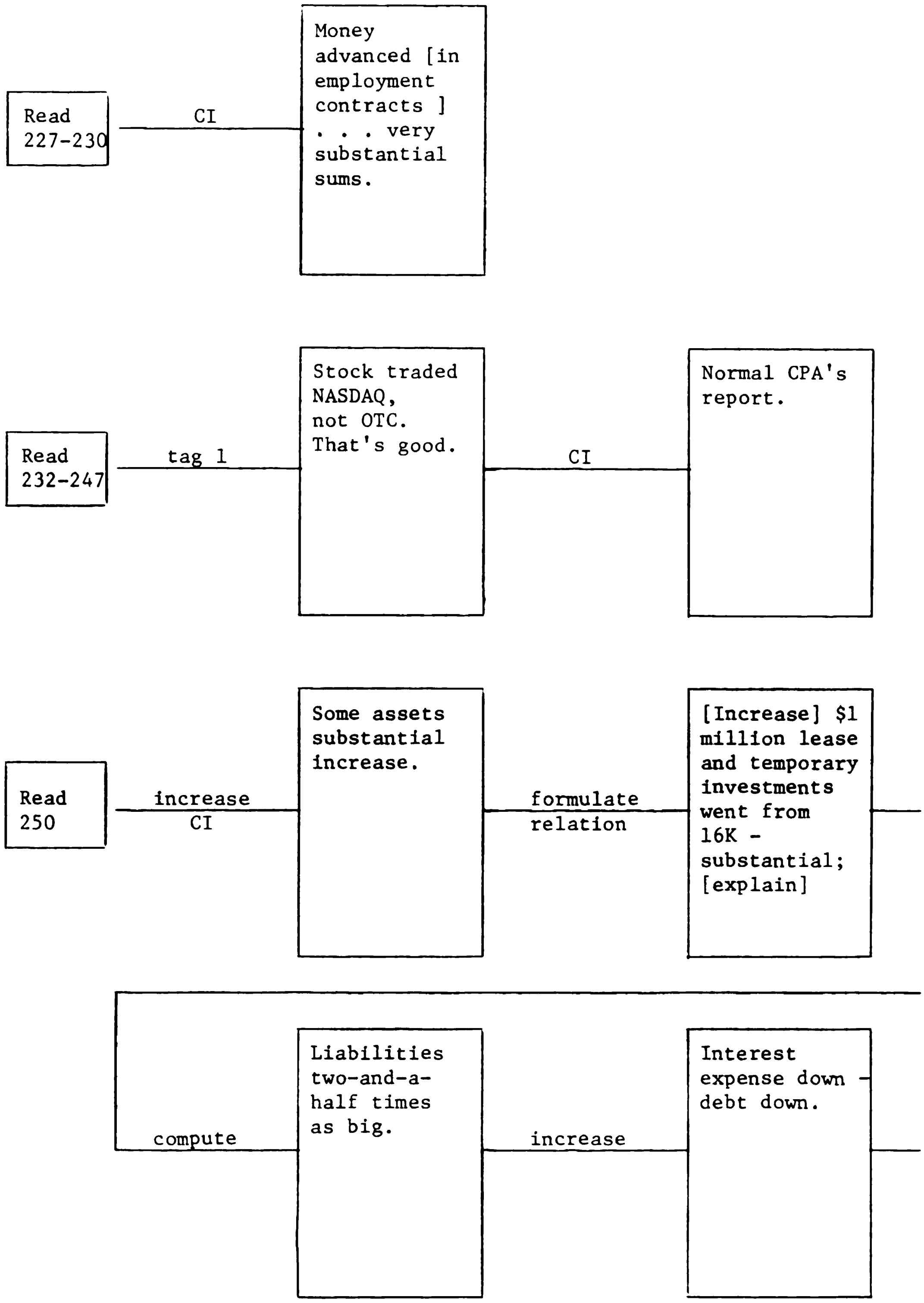

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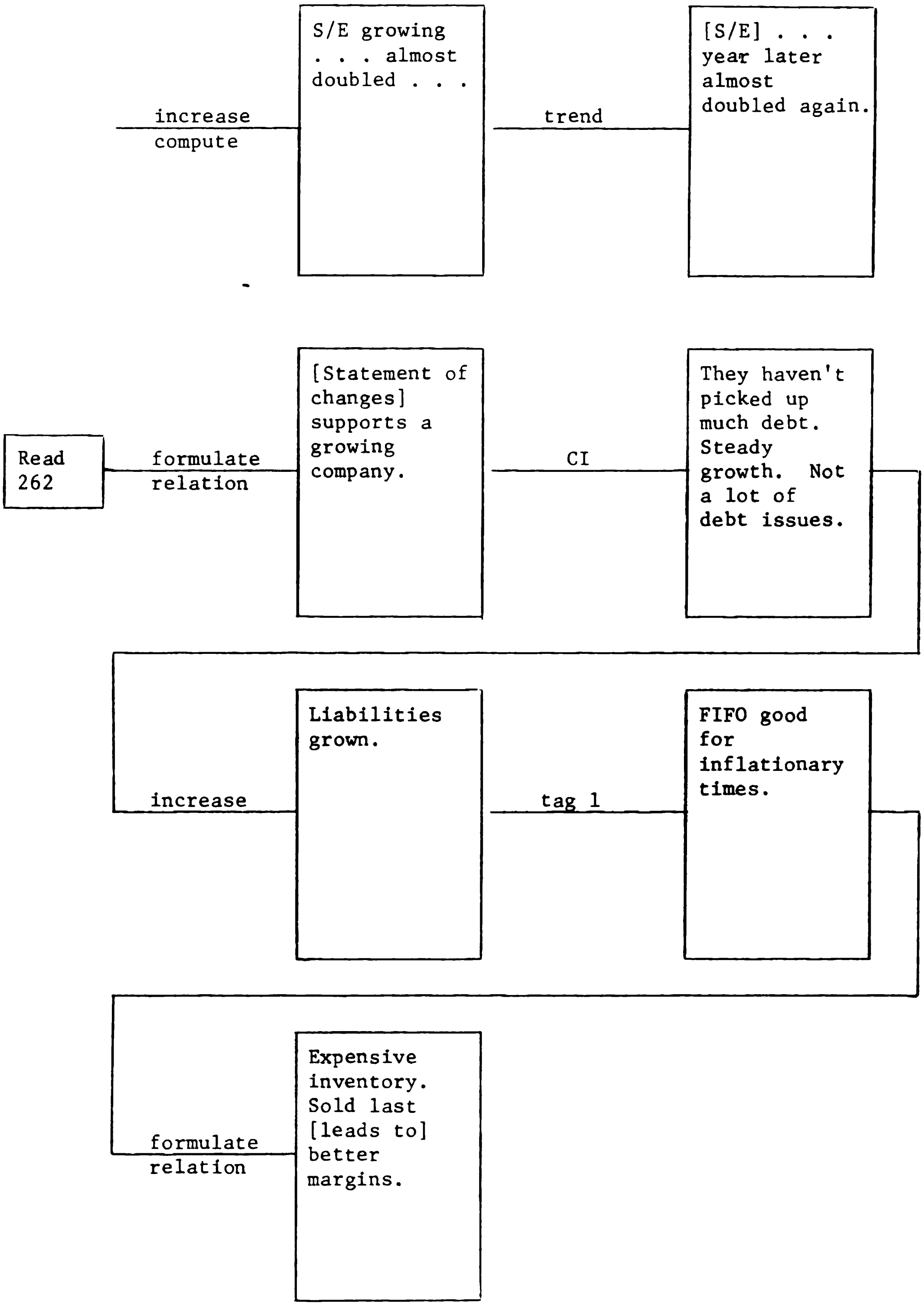

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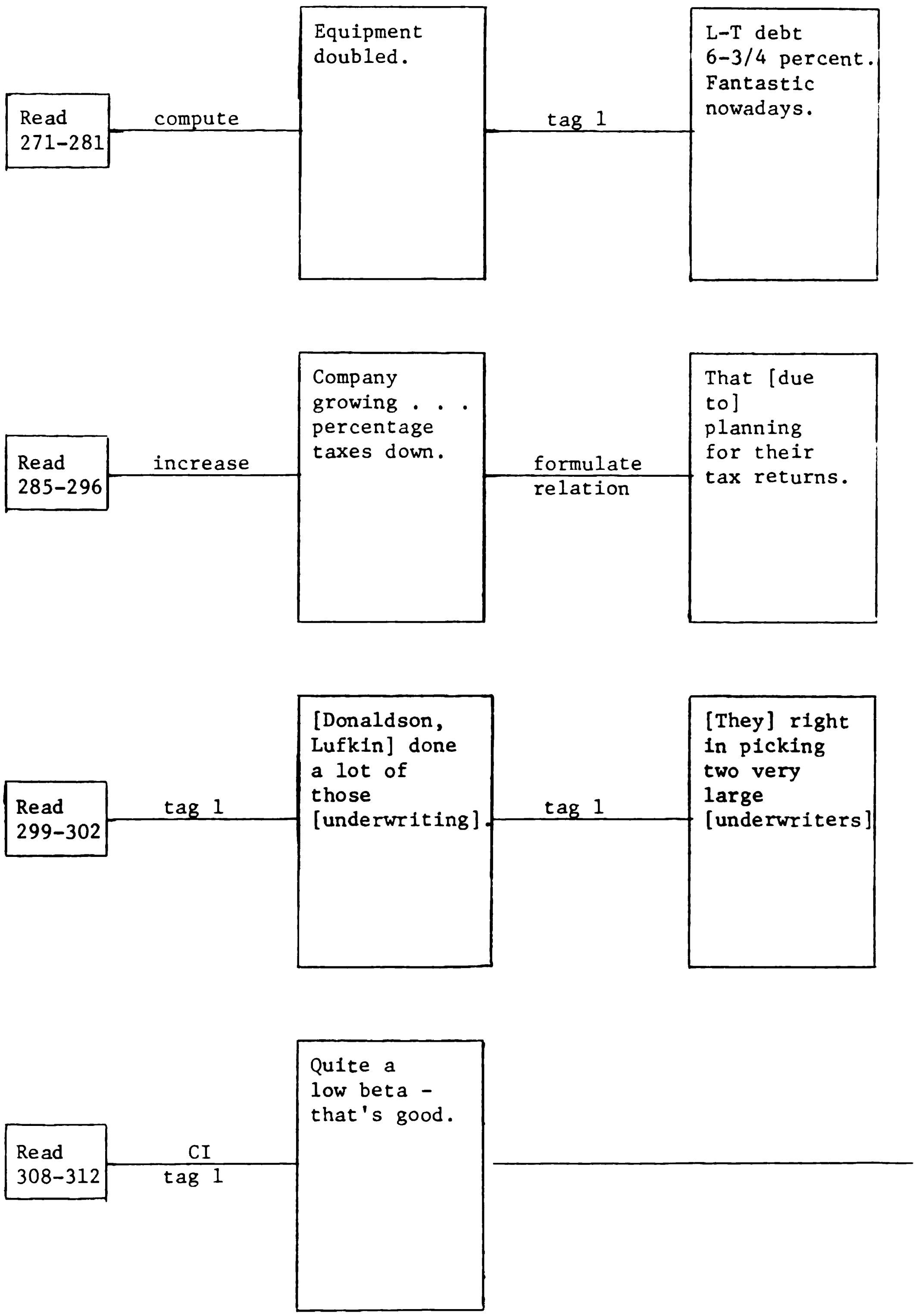


Figure 18 (cont.)

formulate problem

Company sell shares. Not pay dividends. [They] don't have much debt, low mortgage. If they don't have a big turnover of key people. Company could be quite a mover. Product has a very, very good market. This is a fast-moving industry. They keep costs in line. Should be a good company - solid company.

Start

[Company] produces hardware and software - important

Firm is competitive since it is staying in business with competitive bids

Defense relation good

Sales - steady pattern of growth; fantastic this period

EPS increasing at good rate; slowed some

Company really growing

Shares traded right away - good; suspension makes price go down

No dividends - more and more stockholders do not like the risk of no dividends

[Not] much long-term debt - which is good (refutes loss)

Sales, costs progressively moved up

NI as ratio of sales . . . dip some years - grown; but not substantially

No inventory buildup . . . keep costs down, probably good position

NI declined . . . because costs are up

Costs . . . down . . . now starting back up . . . costs back up make a lower percent

Growth greater, explains why no inventory . . .

Maintenance fees increased

Cost of sales rose dramatically [current year]; costs rather big . . .

Income taxes increased . . . that's why pretax income increased but after-tax . . . income substantially lower . . .

Profit sharing would [cause] drop in figures

Price range from $50K to $600K - which is good; diversify

Government biggest . . . source and user of computers . . . keep good bids . . . help

Ratio of 1:4 of new business from customer's already satisfied - good

Five . . . large contracts . . . five years . . . good

Suppliers larger companies

[They have] new competitors; others . . . been out

Board in 30's and 40's . . . young age

Have good people . . . diversified . . . important

Protocol Model of S6

Figure 19

Figure 19 (cont.)

[Stock option plan] leverage to keep key employees . . . good

Money advanced [in employment contracts] very substantial sums . . .

Stock traded NASDAQ . . . good

CPA's report . . . normal

Some assets . . . substantial increase

Lease [increase] and temporary investments [increase] substantial

Liabilities two-and-a-half times as big . . .

Interest expense - down

Debt - down

S/E - growing

Statement of changes - supports a growing company

Haven't picked up much debt . . . liabilities grown . . .

FIFO [inventory]: good for inflationary times . . . better margins . . .

Equipment . . . doubled

Long-term debt - 6-3/4 percent; fantastic nowadays

Company grown . . . percentage taxes down . . . [due to] planning for . . . return

Donaldson Lufkin . . . done a lot [of underwriting]; [company] right in picking two very large [underwriters]

Low beta . . . good

Company sells shares . . . not pay dividends

Don't have much debt

If no turnover of key people, could be quite a mover

Product has very, very good market

Fast-moving industry

Keep costs in line, should be a good solid company

Firm Specific Decision

Start

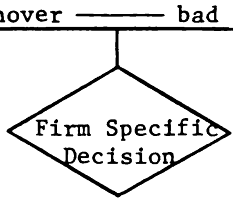
Offering size:	660,000 shares or less	good
	more than 660,000 shares	bad
Company manufacturer:	yes	important
	no	?
Sales by competitive bids:	yes	firm competitive
	no	?
Company tied in military:	yes	good
	no	bad
Sales:	increasing growth greater than 17 percent	fantastic
	growth rate less than 17 percent	bad
Debt:	less than 2 percent	good
	more than 2 percent	bad
Shares tradeable right away (rule 144):	yes	good
	no	bad
Dividends:	yes	good
	no	bad
NI as percent of sales:	increasing	good
	changing	bad
Costs:	stable, decreasing	good
	increasing	bad
Product price range:	from $50,000 to $600,000	good
	less than above range	bad
Contracts in process:	five or more	good
	less than five	bad
Repeat business:	more than 20 percent	good
	less than 20 percent	bad
Suppliers:	large	good
	small	bad
Competition:	new companies	?
	older companies	?
Board diversified, young:	yes	good
	no	bad

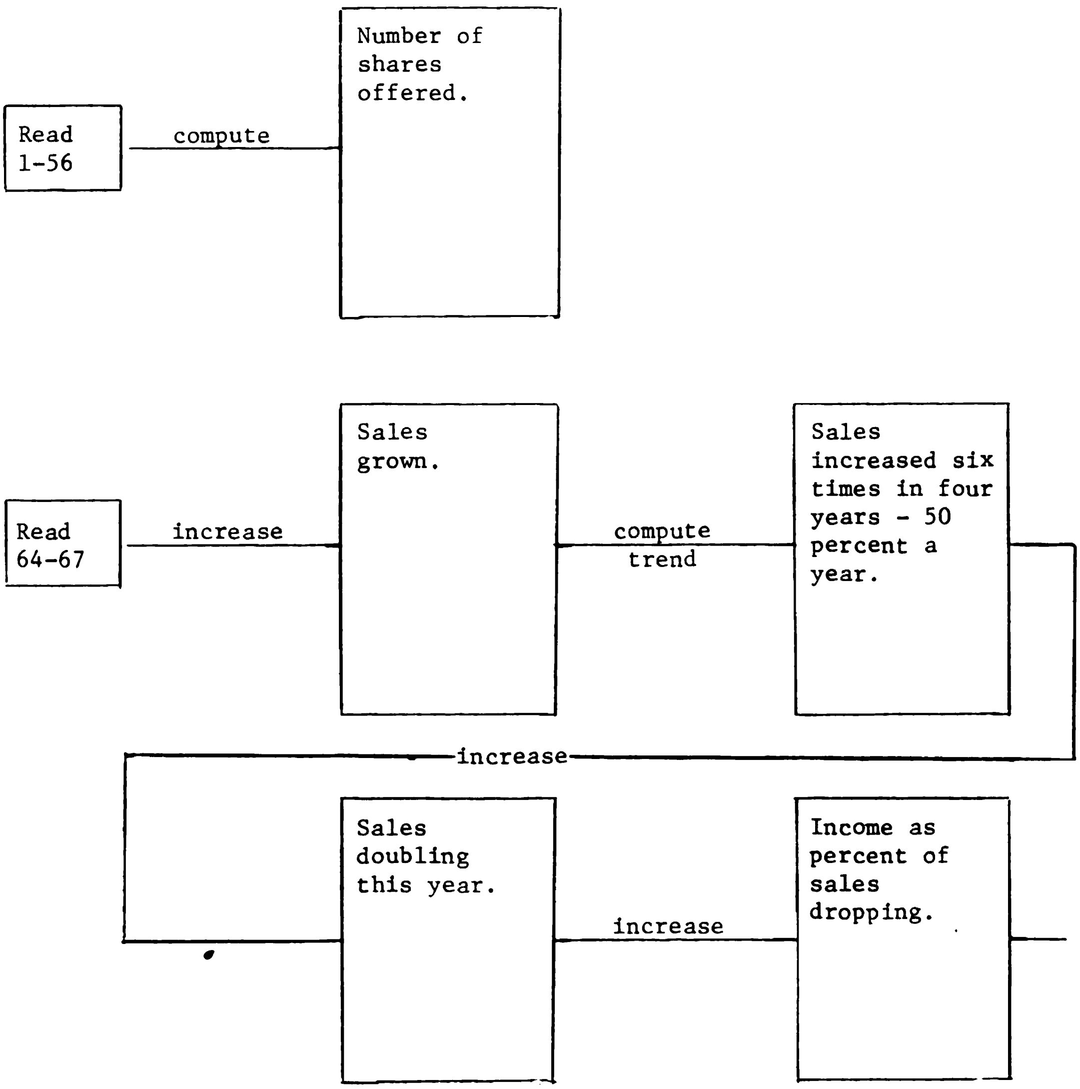
Derived Model of S6

Figure 20

Figure 20 (cont.)

Stock option plan:	yes	good
	no	bad
Stock traded NASDAQ:	yes	good
	no	bad
CPA report:	normal	good
	not normal	bad
Inflation/NI effects:	rising prices - FIFO	good
	falling prices - FIFO	bad
Net asset base:	growing	good
	not growing	bad
Underwriter:	well-known	good
	unknown	bad
Beta:	less than 1.6	good
	more than 1.6	bad
Industry:	high growth	good
	low growth	bad
Key management:	stable	good
	turnover	bad

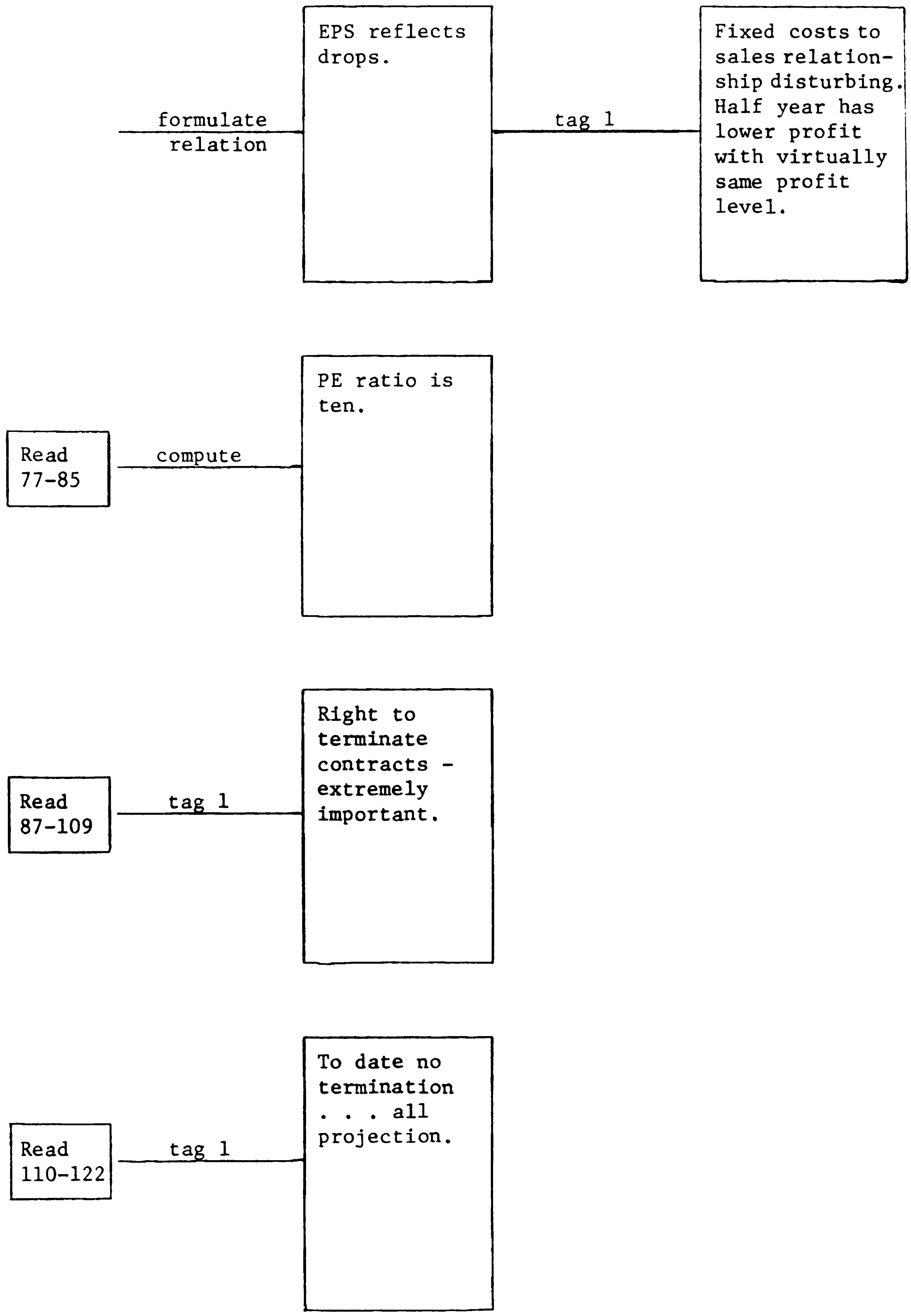




Problem Behavior Graph of S7

Figure 21

Figure 21 (cont.)



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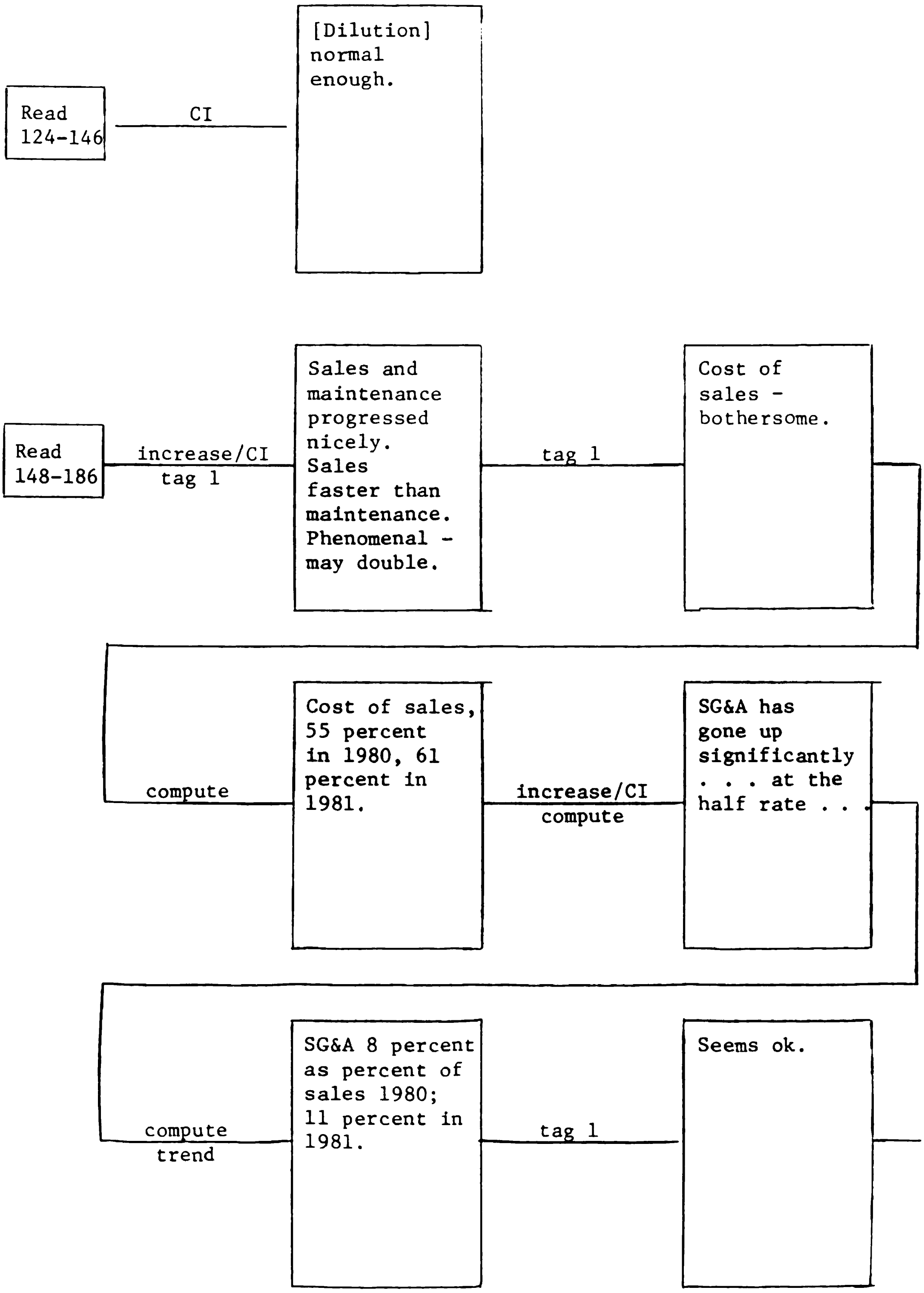

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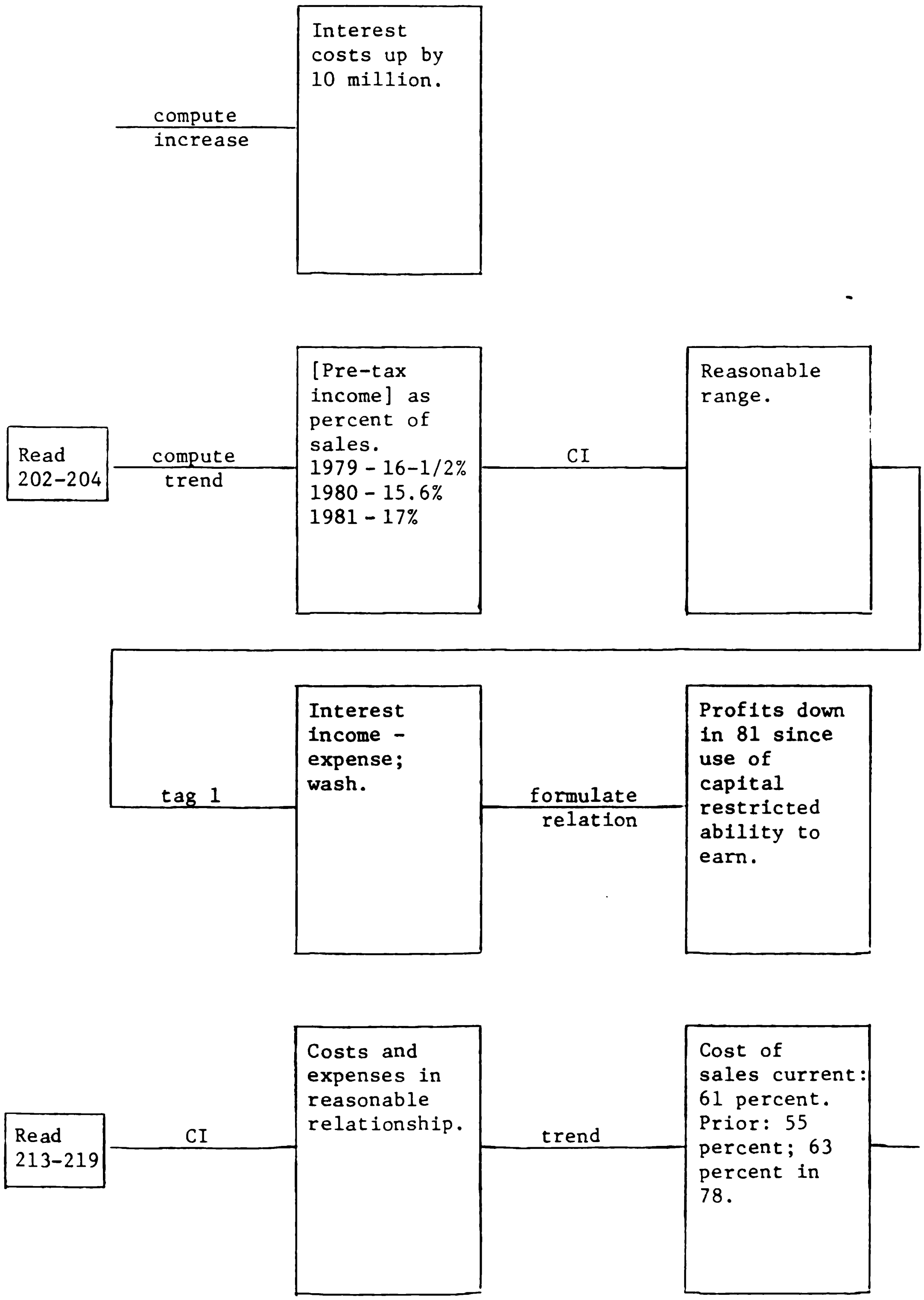

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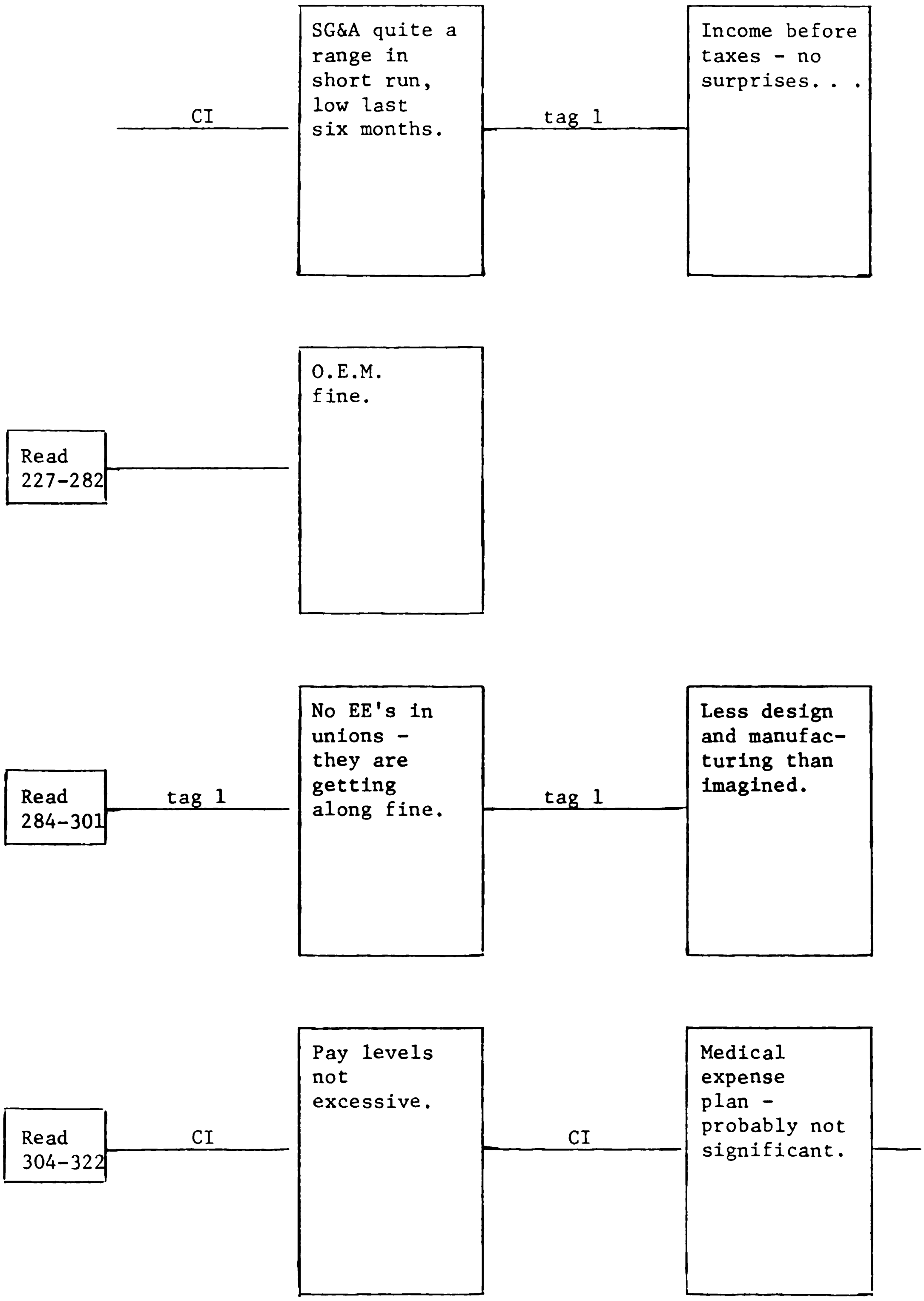

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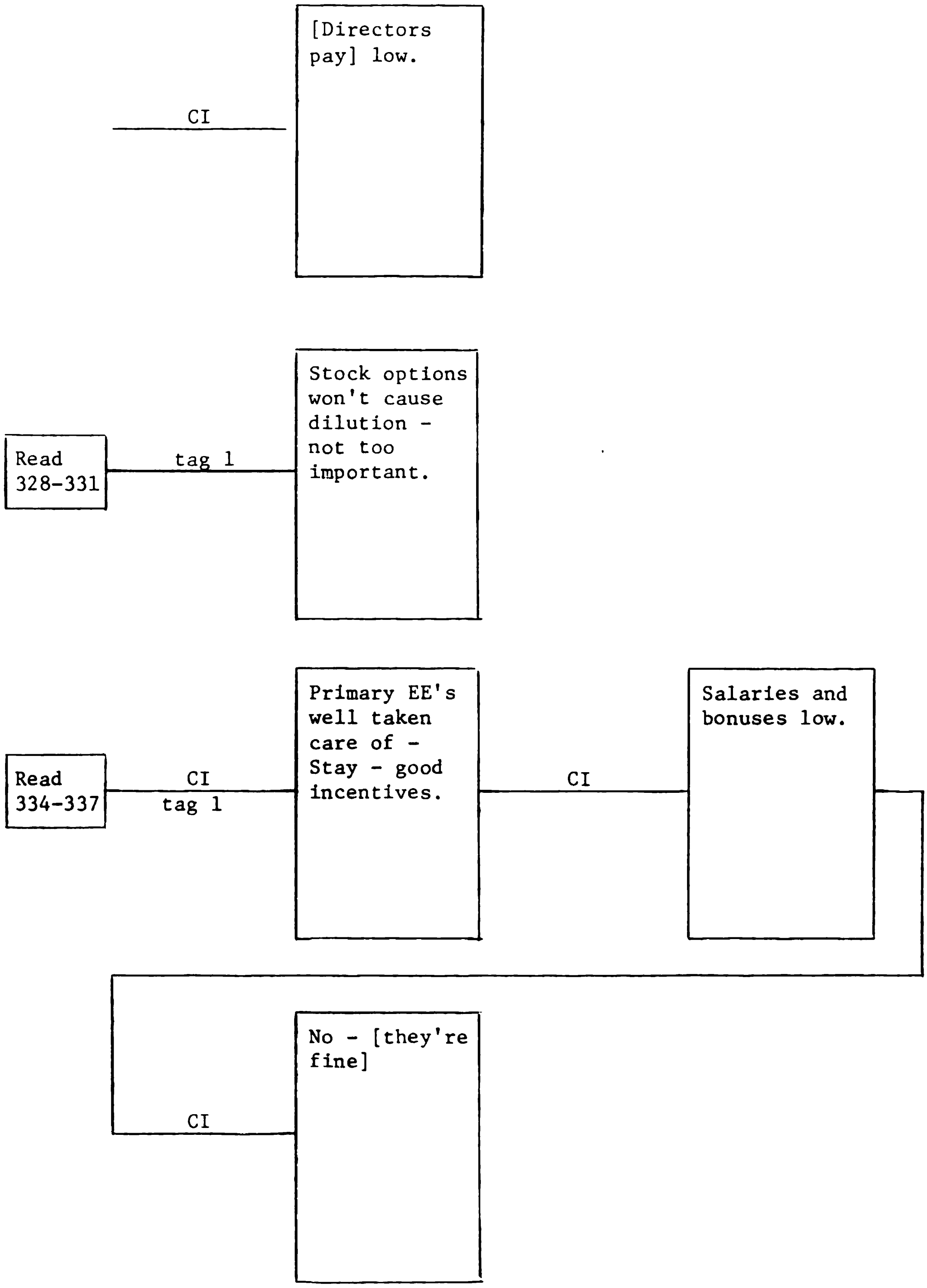

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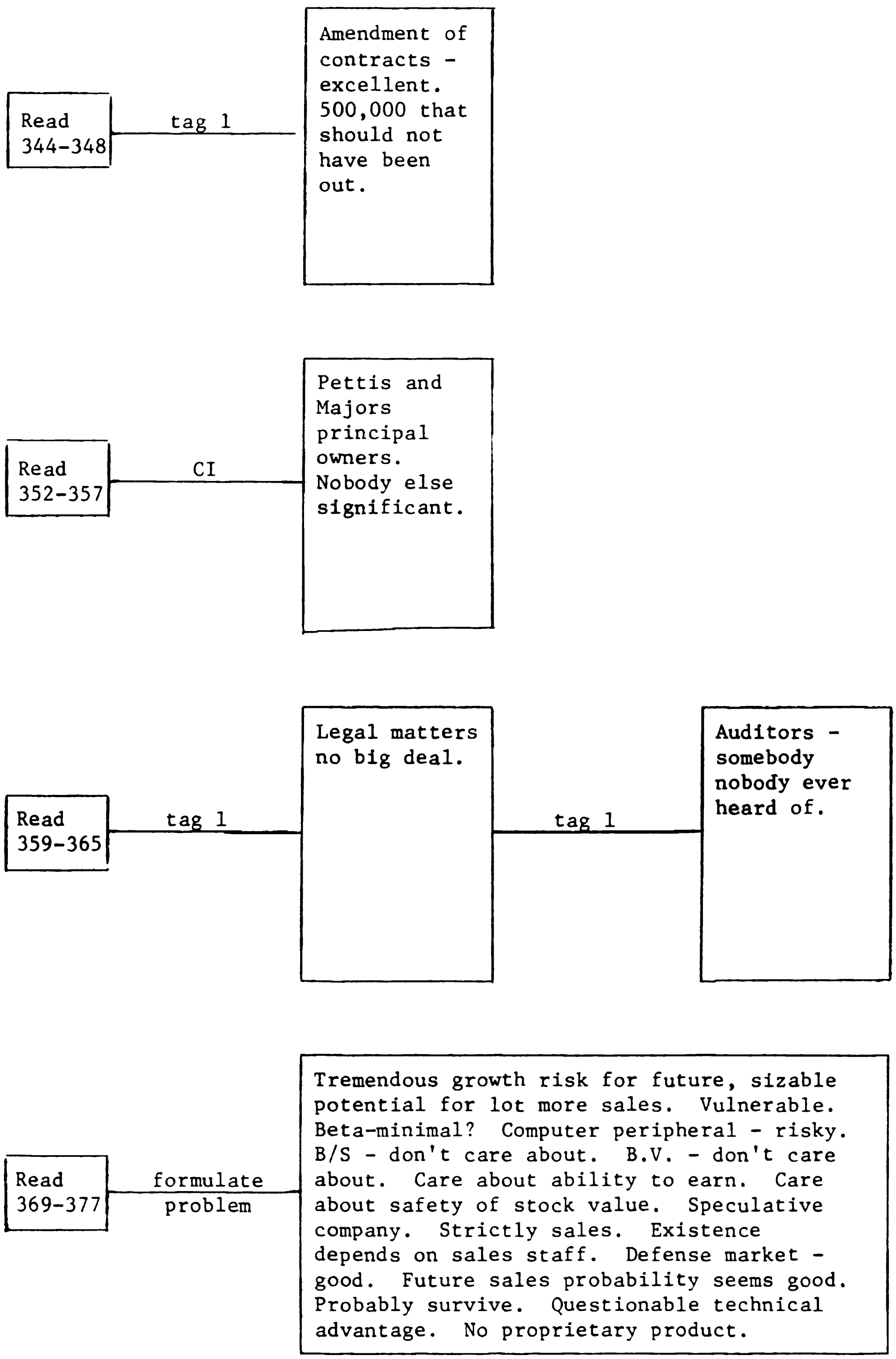


Start

Sales grown - increased six times in four years

Sales doubling this year

Income as percent of sales dropping

EPS reflects drop

Fixed costs to sales relationship disturbing - (one-half year has lower profit with virtually same profit level

P.E. ratio is 10

Right to terminate contracts - extremely important

No terminations to date

Dilution - normal

Sales and maintenance progressed nicely

Sales faster - phenomenal

Cost of sales - bothersome

SG&A gone up significantly . . . [trends] seem ok

[Pretax income as percent of sales] - reasonable range

Costs and expenses - reasonable relationship

SG&A - quite a range in short run

Income before taxes . . . no surprises

[Suppliers] - fine

[Employee relations] - getting along fine

[Company does] less design and manufacturing than imagined

Pay levels - not excessive

Director's pay - low

Stock options - [not dilutive]

[Firm has] good incentives for primary employees

Company controlled by P and M

Auditors - [unknowns]

[Firm] has tremendous growth potential

Risk of forfeiture sizeable

[Firm] vulnerable

Potential for lot more sales

Protocol Model of S7

Figure 22

Figure 22 (cont.)

Beta - minimal

Computer peripherals - risky

B/S - not important

Book value

Ability to earn [care about]

Speculative company

Strictly sales [company]

Existence depends on [quality] of sales staff

Defense market - good

Future prospects - seems good

Questionable technical advantage - no proprietary product

Firm Specific Decision

Start

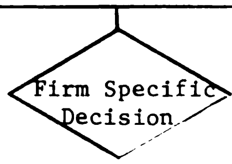
Sales:	increasing	fine
	not increasing	disturbing
Income as percent/sales:	increasing	fine
	not increasing	disturbing
Fixed costs to sales:	stable	fine
	increasing	disturbing
Contracts:	noncancellable	fine
	cancellable	disturbing
Cost of sales:	not increased more than 2 percent relative to sales	fine
	increased more than 2 percent relative to sales	disturbing
Dilution:	less than or equal to 33 percent	fine
	more than 33 percent	disturbing
Pretax income as percent of sales:	more than	fine
	less than	disturbing
After tax income:	no volatile changes	fine
	big changes	disturbing
Suppliers:	multiple	fine
	single	disturbing
Employee relations:	no labor unions	fine
	union	disturbing
Pay levels:	top pay less than $200,000	fine
	top pay more than $200,000	disturbing
Management incentives:	stock options, profit sharing	fine
	no stock options, profit sharing	disturbing
Company manufacturer:	yes	fine
	no	disturbing
Legal matters:	no lawsuits	fine
	lawsuits	disturbing
Auditors:	well-known	fine
	unknown	disturbing
Director's pay:	$1,000 or less	low
	more than $1,000	high
Company industry:	computer peripherals	risky
	other industry	not risky

Derived Model of S7

Figure 23

Figure 23 (cont.)

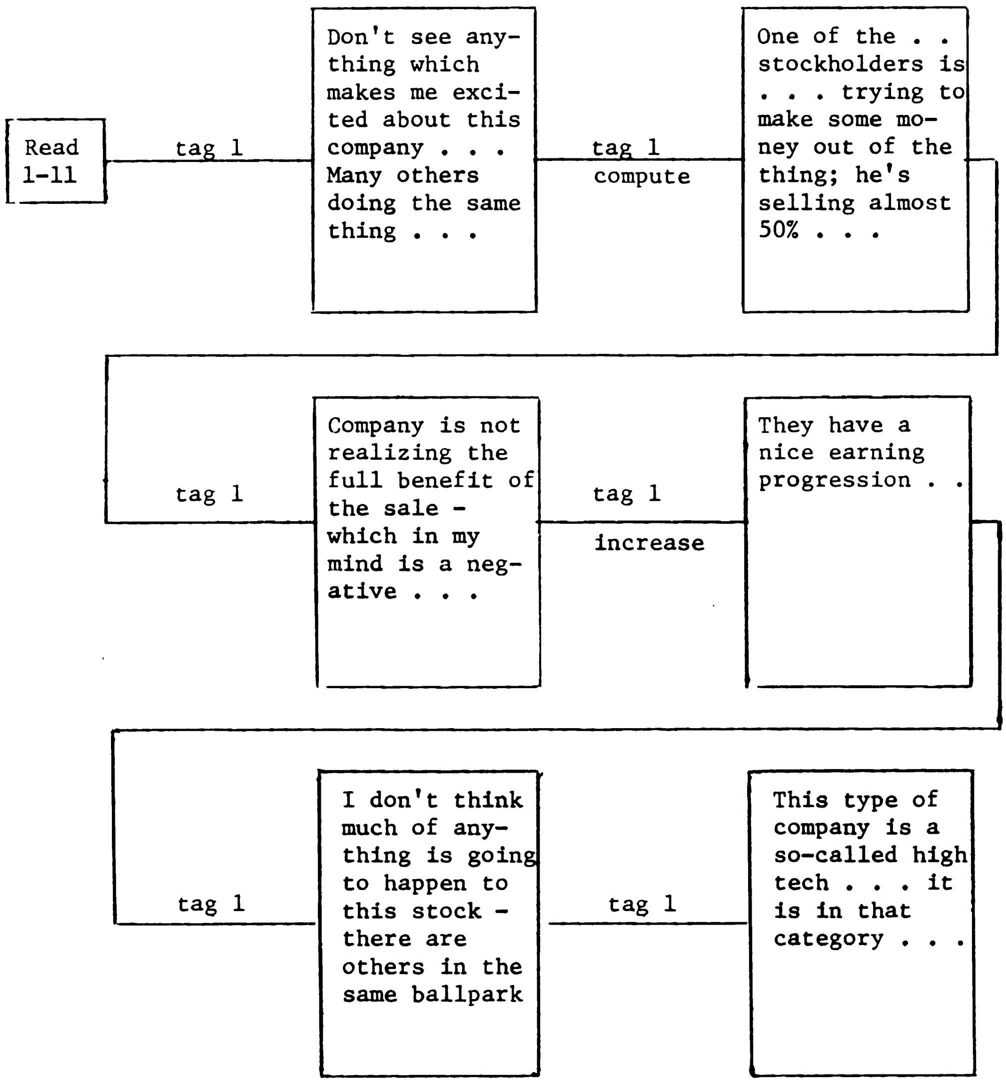
Growth potential:	past growth greater than 17 percent ——— fine past growth less than 17 percent ——— disturbing
Proprietary product:	yes ——— fine no ——— disturbing



APPENDIX II

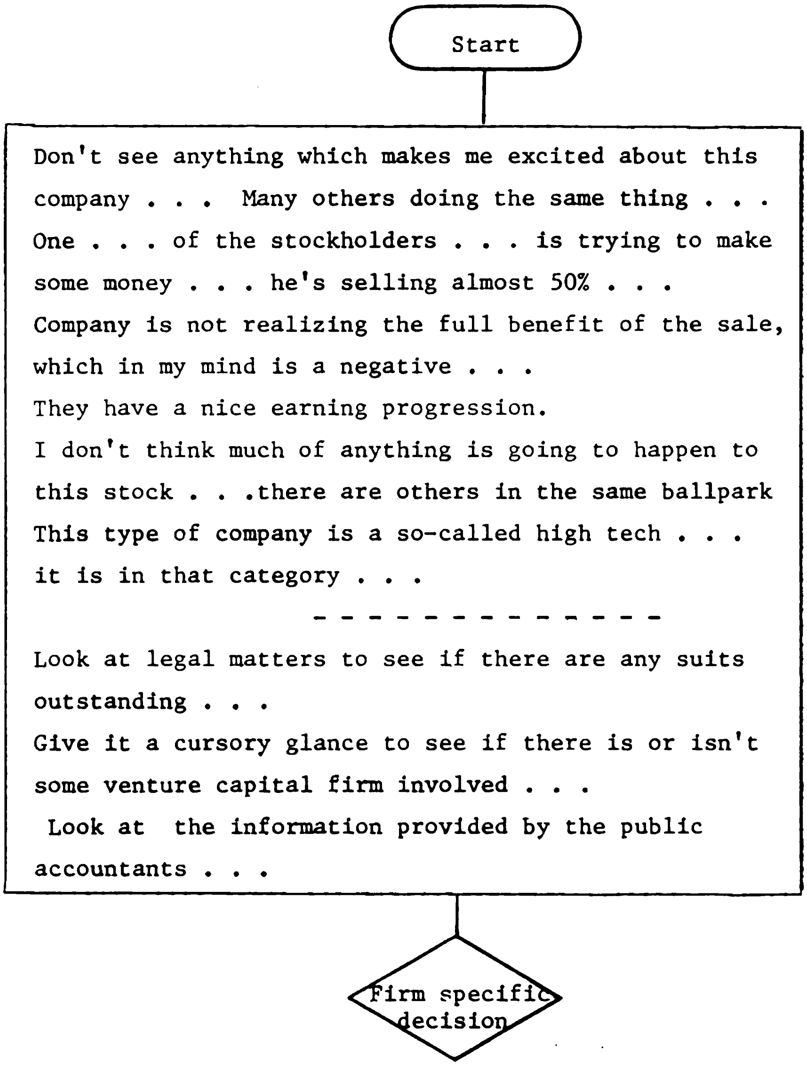
APPENDIX II

Reliability Models of S4



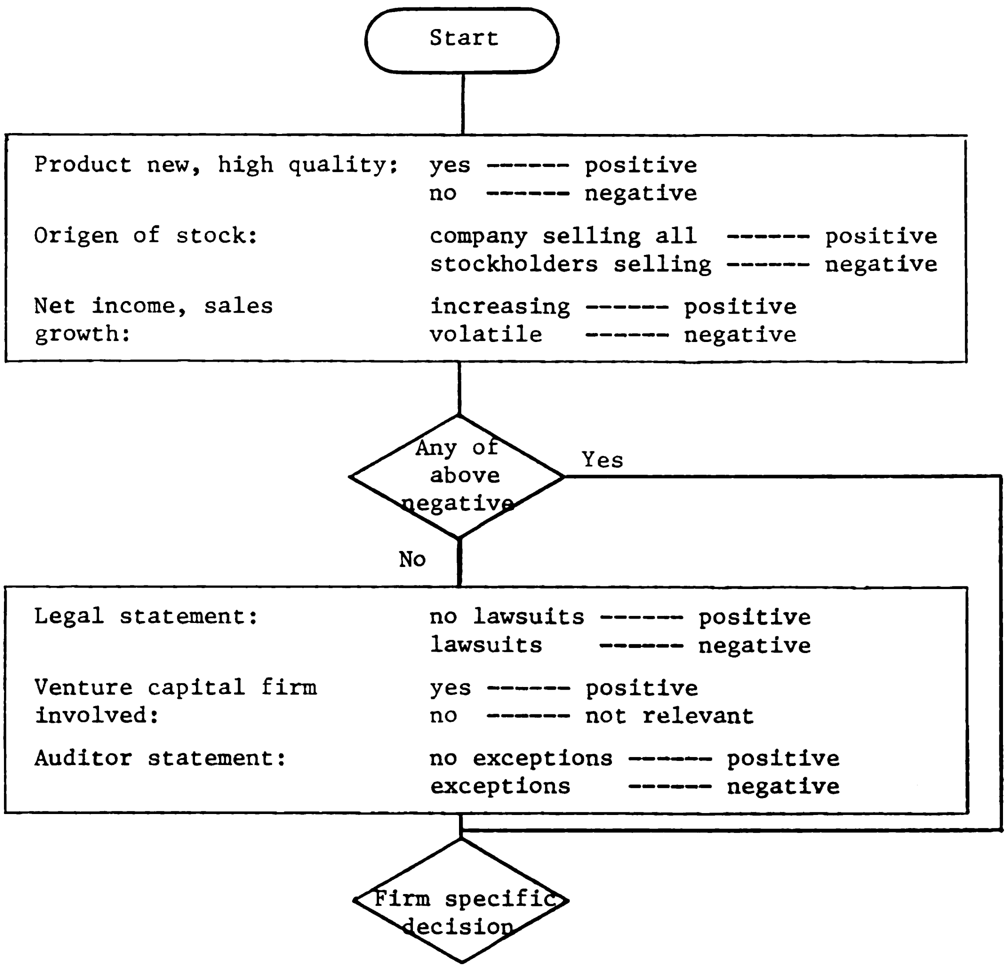
Problem Behavior Graph of S4-2

Figure 24



Protocol Model of S4-2

Figure 25



Derived Model for S4-2

Figure 26

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