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The Ohio State University, Ph.D., 1972
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AN EXPERIMENTAL STUDY OF STUDENT DECISION-MAKING EFFECTIVENESS IN A COMPUTER-ASSISTED CASE STUDY LEARNING ENVIRONMENT

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

William Sturtevant Sargent, Jr., B.B.A., M.B.A.

The Ohio State University 1972

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VITA


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PUBLICATIONS


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CHAPTER I

INTRODUCTION

In a recently issued series of reports, the Carnegie Commission on Higher Education has assessed and predicted the environment within which higher education will operate during the 1970's and beyond. The Commission estimates that the nation's colleges and universities will experience a 50 per cent increase in enrollment by 1980. However, increases in funding for higher education will not keep pace with the rising enrollments, resulting in a projected $10 billion difference between funds available to colleges and universities and the funds required, given the present educational structure and existing levels of educational productivity and effectiveness.

Although noting that the federal government had spent $2.5 billion for technological experiments during the 1966 through 1969 period, the Commission called for "an all-out effort by the government, educational communities and industry to accelerate the development and utilization of new instructional technology in higher education."^1

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^1"Carnegie Report Calls for Cuts in Higher Education Funds," Columbus Dispatch, June 16, 1972, p. 8A.

^2"Report Predicts Radical Teaching Aids This Century," Columbus Dispatch, June 1, 1972, p. 26A.
In *The Age of Discontinuity*, Drucker discusses the coming impact of the knowledge explosion and the application of technology in education:

The educators still talk of minor changes, of adjustments and improvements. Few of them see much reason for radical changes. Yet education will in all likelihood be transformed within the next decades by giant forces from without.

It will be changed, first, because it is headed straight into a major economic crisis. It is not that we cannot afford the higher costs of education; we cannot afford its low productivity. 3

The primary foundation for the widespread application of technology to improve educational productivity and effectiveness will be the computer. Although computerization of the administrative and clerical functions of colleges and universities is widespread, computer-assisted instruction is still in its infancy. However, a number of forces are operating to accelerate the development and implementation of computer-based education and training systems. Recent research on learning has made it clear that "individualized instruction is a necessity, not a luxury." 4 Only the computer offers a technology whereby instruction can be individualized and tailored to a student's specific abilities, needs, and progress. A second factor is that current and projected developments in computer hardware

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and the development of low-cost time-sharing terminal equipment will foster the development of education resource networks. Students will be able to use information and educational software without regard to institutional boundaries or geographic location. One educator foresees that technological developments will result in "enriched concepts of learning and education, new roles for professors, new 'tools of the trade,' and new perspectives on the constitution of a university, its campus facilities, faculties, and classes."^5

Silberman has reviewed a number of problems which must be overcome if the potential of the computer as an instructional device is to be realized. Major forces hindering the process include the inertia of professional educators; the investments necessary to develop and secure the computer equipment and to design the educational materials; and the present organization of the education system. However, "the primary obstacle to the introduction of computer-assisted instruction is not technological; it is our ignorance of the process of instruction."^7

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^6 Charles E. Silberman, "Technology is Knocking at the Schoolhouse Door," Fortune, LXXIX, No. 8 (August, 1966), pp. 120-125+, passim.

^7 Ibid., p. 203.
Background of the Study

Business educators and management trainers have used one form of computer-assisted instruction since the mid-1950's: the management or business game. Fabian and Jackson developed an economic simulation game for use in an undergraduate economics course at the University of California-Los Angeles in the fall of 1956. The teaching objectives of the game were:

1. To demonstrate the basic economic concepts
2. To give the students an appreciation of how to perform a marginal analysis in a dynamic environment.

The enthusiastic student reaction to the game encouraged the authors to develop and extend the model. Descendant models of the original game, now known as the U.C.L.A. game, are still in use.

The first practical, computerized management game was developed in 1957 by the American Management Association. The Top Management Decision Simulation was designed to be a component part of the Association's Executive Decision-Making Program, with the objective of providing "a learning experience in which participants could increase their understanding of the decision-making process and

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sharpen their analytical skills."\textsuperscript{10}

The acceptance of gaming by students, educators, and management trainers was immediate and enthusiastic, and literally hundreds of decision simulations have since been developed to provide synthetic experience in decision-making and business management. In a 1967 survey of American Association of Collegiate Schools of Business members, 94 per cent of the respondents reported using one or more decision simulation exercises in their curriculum.\textsuperscript{11} The most common reasons cited for using simulation exercises include: the high levels of student interest and involvement; the opportunity to integrate concepts in a dynamic, responsive systems framework; the ability to incorporate the temporal dimension into classroom exercises; the experience of living with past decisions; and the experience in group decision-making and strategy formulation and execution.\textsuperscript{12}

Business decision simulations can be classified into three complementary but distinct categories. The top management or total enterprise exercises are complex,
competitive-environment simulations in which participant teams manage companies to compete for share-of-market, profits, and other types of performance objectives. The pedagogical objectives include providing participants with group decision-making experience and with an integrative view of business management. The U.C.L.A. Management Game, INTOP, Carnegie Tech Management Game, and the Harvard Management Game are representative total enterprise games.13

A second category of decision simulations focuses on one or a few functional areas of business management, such as marketing, finance, or physical distribution. The primary objectives of the functional simulations are similar to the objectives of the total enterprise exercise, although the participants' attention is directed toward integrating the activities of a specified function area. Marksim, Finansim, Prosim, and M.S.U. Loga are representative functionally-oriented decision simulations.14


The third category of decision simulations focuses specifically on one or a few concepts within a functional area. Concept simulations are the newest and potentially most valuable type of decision simulation. The pedagogical objective of concept simulations is to enable participants to develop and/or test their understanding of the concepts or areas represented in the simulation. The exercises can be designed to provide all of the motivational and analytical benefits of more complex, competitive exercises, but allow the student to develop his understanding of the subject matter at his own pace and in his own way. From an educational perspective, concept simulations may be useful to provide the transition between the acquisition of facts and concepts—using either conventional methods or with computer-based programmed instruction units—and the application and integration of this knowledge in the dynamic, integrative and complex environment of functional and total enterprise decision simulations. The controlled environment of a concept simulation may also provide a valuable laboratory for studying the learning process and for conducting research in decision-making.

Despite the widespread use of and positive attitudes toward decision simulations, little research has been done to provide guidelines to designers and users of simulation exercises concerning the implications of design and application decisions on student performance, attitudes, and satisfaction. The pressures to improve the productivity
and effectiveness of higher education in the 1970s will provide additional impetus to incorporate decision simulations as an integral component of business education. Basic research focusing on how best to design and use decision simulations to achieve instructional objectives is required to fully realize their educational potential.

**Purpose of the Study**

The primary purpose of the study was to conduct exploratory research concerning the effect(s) of selected decision simulation design and application characteristics on student decision-making effectiveness. Specifically, the research focused on the effect(s) and interactions of 1) the amount of information feedback, and 2) the requiring of written assignments on decision-making effectiveness. The research was conducted with a concept simulation case study used as an assignment in a case study course.

The major research questions were:

1. What is the relationship between the amount of information feedback from the simulation model and student decision-making effectiveness?

2. What is the relationship between requiring or not requiring the written justification of decision strategies and student decision-making effectiveness?
3. What are the interaction effects of amount of information feedback and written assignment requirements on student decision-making effectiveness?

In addition, data on selected demographic, attitude, and experience variables were collected and examined for possible correlative relationships with decision-making effectiveness.

A secondary purpose of the study was to provide experimental data concerning the role of concept decision simulations as an instructional tool and as a vehicle for conducting research in decision-making. The experimental data were examined to provide guidelines and suggestions concerning the design and classroom use of concept simulation exercises.

From an education theory perspective, the study was directed toward examining the effect(s) of differences in the learning environment of the simulation exercise. The learning environment is defined by the combination of stimuli acting on and perceived by the student in a learning situation.\textsuperscript{15} Chapter II discusses at length the concept of the learning environment and the role of information feedback and written assignment requirements in decision simulation exercises.

Scope of the Study

The study was exploratory and experimental in nature, and was primarily concerned with analyzing the relationships between decision-making effectiveness on a concept simulation case study and 1) amount of information feedback from the case study simulation model, and 2) the requiring or not requiring of written assignments focusing on the student's decision strategy objectives and justification.

Two levels of information feedback--full and limited--and two levels of written assignment requirements--yes and no--were used for the experiment. Decision-making effectiveness was examined with respect to three criterion variables: annual dollar revenue; annual dollar profit; and profit as a per cent of revenue.

The research data were collected using a concept simulation case study exercise designed for the research project and used as an individual student assignment in a senior-level, two-section, marketing management case study course. Seventy-four students completed the case study assignment to provide the research data base for the study.

Hypotheses

The research hypotheses were based on the major research questions discussed previously. Four major hypotheses were constructed to detect differences in decision-making effectiveness attributable to the experimental
variables. Three data groups were used in the analysis: data group one included the combined results of the two course sections; data group two included only the results of Section A students; and data group three included only the results of Section B students. Each of the major hypotheses was tested with respect to each of the data groups and to each of the three performance criterion variables.

The objective of the first major hypothesis was to determine if the median performance scores among the four learning environments had been drawn from statistical populations with different medians.

H.1 There are no significant differences among the median performance scores for the four learning environments.

The objective of the second major hypothesis was to determine if one of the experiment variables dominated the other with respect to its influence on decision-making effectiveness, i.e., was one variable more influential irrespective of the level of the other variable?

H.2 There are no significant differences in median performance scores between the learning environments when the environments are grouped and examined with respect to:

1. Full information vs. limited information.
2. Written assignment vs. no written assignment.

The objective of the third major hypothesis was to determine the influence of level of information feedback on
decision-making effectiveness, given a common level of the written assignment requirement.

H.3 There are no significant differences in median performance scores between learning environments having different levels of information feedback and a common level of written assignment requirements, as follows:

1. Full vs. limited information: Written assignments.

2. Full vs. limited information: No written assignments.

The objective of the fourth major hypothesis was to determine the influence of written assignment requirements on decision-making effectiveness, given a common level of information feedback.

H.4 There are no significant differences in median performance scores between learning environments having different written assignment requirements and a common level of information feedback, as follows:

1. Written vs. no written assignments; full information.

2. Written vs. no written assignments; limited information.

Methodology

The case study used as the research vehicle was a retail inventory management exercise designed for the experiment and programmed for the Ohio State University time-sharing
terminal system.

The design objective of the case study was to create a realistic, simplified and non-competitive simulation environment within which selected cost trade-off relationships involved in retail inventory management were emphasized. The simulation model allowed the student to "manage" the inventory ordering and review function of a retail store for four quarters of operation. The impact of the students' inventory review and ordering strategy on the financial and operating performance of the store was used as the evaluation criterion for measuring decision-making effectiveness.

Two levels of information feedback and two levels of written assignment requirement were used in the experiment to define the four learning environments shown in Exhibit I.

Exhibit I
Characteristics of the Learning Environments

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<th>Level of Information Feedback</th>
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<th>Limited</th>
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<td>Written Assignment Required?</td>
<td>Yes</td>
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<td></td>
<td>No</td>
<td>X2</td>
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<td>X3</td>
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<td></td>
<td>X4</td>
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For example, a student completing the case study assignment in learning environment X1 was 1) required to
submit in advance a written report justifying his decision strategy and forecasting its effect on the model and 2) received all available information from the simulation model. At the other extreme, a student in learning environment X4 was not required to submit a written justification report and received limited information about the effectiveness of his strategy.

A separate-sample, pretest-post test, cross-sectional design was used for the experiment. The experiment was conducted in a two-section, senior-level Marketing Management case study course, using the case study as an individual student assignment. Each student was randomly assigned to complete the case assignment under one of the four learning environments shown in Exhibit I, above. Questionnaires were used to gather information about selected student experience, demographic, and attitude variables. Students were given a two-week limit to complete the case assignment, subject to the constraint that only one simulation session per day was allowed.

Analysis of the performance and questionnaire data was conducted using selected nonparametric statistical techniques available with the Nonparametric Statistical Analysis Program. The major research hypotheses were tested using the Mann-Whitney U test. Additional research activities with the study data were conducted using the Mann-Whitney U test and the Kendall Coefficient of Rank Correlation test.
Contributions of the Study

The study provides useful information to individuals interested in utilizing computer-assisted case studies or simulation exercises in academic and business education and training programs, and to research personnel in various academic and business disciplines.

Specific contributions of the study include:

1. An analysis of the extent to which different levels of information feedback effect student decision-making effectiveness on a computer-assisted case study.

2. An analysis of the extent to which written assignment requirements used in conjunction with a computer-assisted case study effect student decision-making effectiveness.

3. An analysis of the relationship(s) between selected demographic, experience, and attitude variables and student decision-making effectiveness on a computer-assisted case study.

4. An evaluation of student attitudes toward the use of a concept simulation case study as a method of instruction.

5. An evaluation of the potential of concept simulation case studies as a methodology for
conducting research in learning processes and decision making.

6. An analysis of differences between students in two sections of the same course with respect to their attitudes toward and decision-making effectiveness on the case study assignment.

Limitations of the Study

The presence of the following factors may limit the generalization of the study findings.

1. The research data are based on a computer-assisted case study designed and programmed for the study, and the findings may not be generalizable to other computer-assisted case studies or simulation exercises, or to different versions of the same case study.

2. The course used for the experiment was judgmentally selected from the Marketing courses available at The Ohio State University during Winter Quarter, 1972. Findings from the study may not be generalizable to other situations due to the non-random nature of the selection process and to the particular orientation of the course.

3. Students participating in the experiment were informed that different students would receive different levels of information feedback from
the model, and that some students would be required to submit written assignments and others would not. The interaction of students receiving various combinations of the experimental variables may have induced motivational or behavioral changes influencing student performance and attitudes which might not be present under other circumstances.

4. Both sections of the selected marketing course were used for the experiment. The difference in scheduled meeting hours and the unknown nature of the section selection process among students may limit the generalization of the study findings to other situations.

**Organization of the Research**

Chapter II summarizes the results of the literature search upon which the study was based. The chapter focuses on the concept of a learning environment and its application to decision simulations and reviews the theoretical and empirical foundations underlying the selection of the experimental variables.

Chapter III presents the research design and methodology of the study. Topics covered include: Basic design considerations in classroom-based research environments; the study research design; questionnaire design; the case study; the simulation model; the establishment of the learning
environments; the decision-making effectiveness criteria; the experimental procedures; and data collection and analysis activities.

Chapter IV contains the findings of the study. The results of the tests of the research hypotheses and other findings from the study are presented.

Chapter V contains a general summary of the study and presents the conclusions and implications drawn from the hypothesis test results and from the other findings. The conclusions and implications are discussed with respect to education and training instruction and research. The chapter concludes with suggestions for further research.
CHAPTER II

THE LEARNING ENVIRONMENT AND DECISION SIMULATIONS:
CONTRIBUTIONS FROM THE LITERATURE

The objective of this chapter is to present the findings of the literature search undertaken for the study. The chapter is divided into two sections. The first section discusses the concept of the learning environment and its application to decision simulation exercises in terms of 1) establishing learning objectives, 2) designing the exercise, and 3) administering the exercise activities. Section two reviews the literature to define the role of the experimental variables in decision simulations. A brief overview of educational theory with respect to each variable is presented. The section also contains a discussion and summary of specific applications of information feedback and written assignments in decision simulations.

The Learning Environment

Introduction

A concept common to the many theories proposed to explain the learning process is that of the learning environment. The learning environment is the combination of
stimuli acting on and perceived by the individual.\textsuperscript{1} The two major schools of contemporary learning theory—behavioristic stimulus-response conditioning theorists and Gesalt-field theorists—have quite different explanations concerning how the learning environment is perceived, i.e., how and why learning takes place.\textsuperscript{2} In general, stimulus-response theorists see the individual as a neutral-passive or reactive organism that responds to changes in specific stimuli. If the stimuli applied are carefully selected, the individual will develop the proper response to the stimulus, i.e., he learns. Gestalt-field theories see the individual as neutral-active or neutral-interactive, i.e., the individual responds to the total environment, rather than to specific stimuli. Changes in stimuli induce learning by changing the pattern or relationships of the environment. The Gestaltists emphasize meaning, organization, integration, and pattern of stimuli as primary determinants of learning.

In general, stimulus-response and Gestalt theory proponents agree that, for a given situation, some stimuli are more effective in inducing learning than others. In effect, the relationship between the application of


particular stimuli and learning behavior is at least partially deterministic, i.e., non-random. Therefore, the role of the educator is primarily that of managing the learning environment—combination of stimuli—to increase the probability of improving individual learning behavior.3

Learning Environment Dimensions in Decision Simulation

The relationship between the concept of the learning environment and decision simulations is important for two reasons. First, the power and flexibility of the computer enables the designer of a decision simulation to construct an extremely complex environment. For example, the Carnegie Tech Management Game allows students to make decisions in twelve functional and operational areas of the simulated firm, for a maximum possible total of over 300 decision variables per playing period.4 Second, it is extremely difficult to determine 1) which aspects of the simulated environment are effective in inducing learning, and 2) the types of learning taking place. In discussing the educational dimensions of simulation exercises, Greenlaw, et al.

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commented that:

... business simulation is proving to be a teaching tool that often provides benefits in excess of those upon which the user is counting. Just as it is difficult to categorize these benefits and ascribe them to particular model designs and administrative conditions, so it is difficult to restrict them in practice. As one experienced manager who participated in simulation training with one of the authors has stated, 'Everyone seems to have learned different things; I think you learn what you as a unique individual need to learn.'

The general design objective of a simulation exercise is to provide a synthetic environment which is a meaningful abstraction of some process, situation or environment. The primary education or training objective is to enable participants to translate learning experiences gained from the simulation back to the relevant process, situation, or environment.

For a specific education or training situation, the effectiveness of a decision simulation exercise depends upon three primary factors: The isolation and definition of specific training, learning, or behavioral objectives; the selection or design of a decision simulation to achieve the objectives; and the administering of the exercise as part of the total training program. Each of these factors is subject to control by the educator/administrator/trainer,

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6Ibid.
and each factor defines important dimensions of the learning environment.

In discussing the definition of objectives, Greenlaw, et al. note that:

... there are many different kinds of learning which may be fostered by the use of management games; in designing [the set of objectives for] a simulation, the instructor should consider carefully which of these he is aiming at. Does he want to teach the use of a specific decision rule, such as the economic order quantity? Does he wish to induce attitudinal change and insight in the area of group dynamics and interpersonal relationships in decision-making? Is it his objective to provide a group of middle management executives with an integrating decision-making experience in which they will have to consider all major aspects of the operation of a total enterprise? Or is it his goal to give executives performing in one functional area of management an opportunity to experience synthetically the operating problems of those involved in another, and thus to foster empathy through role reversal?

Assessing the role of the game administrator, Thorelli and Graves emphasize the critical nature of the task of setting objectives:

The single most crucial task facing the game administrator is to determine as specifically as possible the purpose of running the simulation. In the early years of gaming an ill-defined purpose may have mattered little in view of the sheer novelty and general excitement of participation and a widespread feeling that the experience of playing any management game was somehow vaguely beneficial. With the development of games for a broad range of specialized as well as general uses, with the fad quality worn off, and with the increasing sophistication as to what may be accomplished by various types of simulations under different conditions of play, there is no longer any excuse for not thinking through the problem of objectives. This is all the more urgent as educators more

generally flock to the notion that a balanced educational program requires an integrated mix of simultaneously used techniques (lectures, games, etc.).

In describing the background and objectives of the Carnegie Tech Management Game, Cohen, et al. state that "Our objective in designing the Carnegie Tech Management Game was to provide an environment in which these [management] abilities might be developed." The abilities include
1) an ability to set goals and to define them operationally, 2) an ability to abstract, organize, and use information from a complex and diffuse environment, 3) an ability to forecast and plan, 4) an ability to combine the role of generalist and specialist, and 5) an ability to work effectively with other people.

The definition of objectives provides the basic framework of the learning environment in terms of direction. The objectives also provide guidelines or, in some cases, imperatives concerning the design or selection of the decision simulation. For example, if one objective is to provide participants with experience in integrative decision-making for several functional areas, the decision simulation's orientation and implementation must allow the

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participants to assume an organizational role consistent with the objective, i.e., top management.

The design or selection of a decision simulation provides the primary foundation for meeting the defined objectives and for operationalizing the learning environment. Key considerations include:

1. At what level or levels of management will decision making take place?
2. Will the participants' results be partially determined by other players—an interactive setting—or will they compete against nature?
3. Will the simulation be oriented to a specific industry or type of industry?
4. Should the simulation be able to accommodate individual or group decision making?
5. How many players will be able to play simultaneously, either in a common marketplace or in isolation?
6. How many and what type of decisions will or can be made?

7. Will the simulation be compatible with or support other activities—e.g., bargaining and negotiation, in-basket exercises, in-depth role-playing, and so on?

8. What types and kinds of information will be available to participants?

9. Is a substantial degree of realism or fidelity with respect to a specific industry necessary?¹¹

Each of the above decisions, and others, serves to define the environment within which participants will be involved and will determine, in great measure, the degree to which the objectives will be achieved.

The third factor defining the learning environment of a decision simulation exercise is the administrative dimension. The administrative dimension refers to activities or actions which the game administrator can use to define and enrich the environment of the game. Thorelli and Graves in particular emphasize that:

The effectiveness of management simulations—like that of any other educational technique—depends in large part on the skill and imagination with which they are used. For all games a certain administrative effort is required merely to keep the play going. To maximize the learning potential of a game, the input of administrative know-how and insight into educational processes needed is substantially

¹¹See, for example, Cohen, et al., op. cit., Chapters 1, 2, 9; Greenlaw, Herron, and Rawdon, op. cit., Chapters 1, 3; James L. McKenney, Simulation Gaming for Management Development (Boston: Harvard Press, 1967), Chapters 2, 3, 4; Thorelli, op. cit., various chapters.
greater than for routine play. The good game administrator must have some of the qualities of an entrepreneur; in many respects he may well be likened to the producer of a play.12

Beyond the minimum administrative effort involved in play maintenance, their experience with the INTOP simulation leads them to conclude that:

There are several determinants of the desirability of additional effort. Ceteris paribus, it seems to be true that (a) the more complex the model the greater the yield in terms of educational experience from such efforts, (b) the greater the degree of integration between the game and other elements of an educational program (or course), the greater the need for such efforts, and (c) the greater the number and extent of qualitative factors the administrator wishes to introduce in the course of the simulation the greater the additional effort.13

Lalonde and Herniter have also reported on the administrative dimension of decision simulations. Their experience in developing and using a number of relatively simple simulation exercises lead them to conclude that:

It is important that a well developed case and an orientation and critique session accompany the simulation. If the case is not developed and these sessions not carefully presented, there is a tendency for the problem runs to deteriorate into a "game" and the point of the whole process becomes clouded.14

12Thorelli, op. cit., p. 139.
13Ibid., p. 140.
In complex simulations, Cohen, et al. indicate that external, non-quantitative tasks may be mandatory, since "One of the problems with a game as rich in 'numbers' and 'structure' as the Carnegie Game is to keep the analytic, essentially quantitative tasks from dominating the game."  

The following citations are intended to highlight the types of administrative enrichment strategies which have been reported in the literature. Administrators for the Carnegie Game have been concerned with providing more intensive role-playing situations. The simulation model is designed to enforce a division of labor within a team by providing large amounts of data per playing period---between 1,000 and 2,000 items---and by reporting the information by function, i.e., production, marketing, and finance. The role-playing aspects of the exercise are reinforced through the use of a Board of Directors for each team. The teams are required to report to the Board frequently concerning their stewardship of the company's assets and prospects. In addition, teams needing additional funding are sometimes required to convince a "banker" of the merit in their request. Additional strategies have included: Having first-year graduate students in accounting.

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15 Cohen, et al., op. cit., p. 77.
16 Ibid., p. 10.
audit the records and performance of the game participants;\textsuperscript{17} simulating union problems to be resolved through bargaining and contract negotiations with a representative of the "union";\textsuperscript{18} and creating a stock market in which students in a finance course could buy and sell shares in the competing companies and, hopefully, generate realistic external appraisals of the teams' performance.\textsuperscript{19}

Additional administrative strategies reported in the literature include using in-basket exercises,\textsuperscript{20} increasing the complexity of the game by adding new decision variables or constraints,\textsuperscript{21} allowing teams to hire "management consultants,"\textsuperscript{22} and so on. In a study of business game play conducted at Purdue, teams received monetary rewards based on their game profits.\textsuperscript{23} The reported effectiveness of various enrichment activities is based primarily on observational data. However, two general conclusions can be drawn. The effectiveness of a particular

\textsuperscript{17}Ibid., pp. 85-91.
\textsuperscript{18}Ibid., pp. 91-95.
\textsuperscript{19}Ibid., pp. 95-98.
\textsuperscript{20}Thorelli, op. cit., p. 195.
\textsuperscript{21}Mckenney, op. cit., p. 27.
\textsuperscript{22}Thorelli, op. cit., p. 194.
enrichment activity seems to be a function of 1) the degree to which the activity supports the instructional objectives defined by the administrator, and 2) the degree to which the exercise can be integrated with the decision simulation activities in a realistic and supportive manner.

McKenney has reported on research studies conducted at Harvard Business School using the Harvard Management Game. The research focused on the role of team organization and faculty boards of directors in influencing student attitudes, performance, and satisfaction. The results indicate that 1) variations in how the team members are assigned and organized, and 2) the role and attitudes of the directors can have a significant effect on student attitudes and performance.24

Starbuck and Kobrow report on a research study focusing on the effects of assigning advisors to assist students teams. In general, no significant differences were noted in profit performance between advised and unadvised teams, although advised teams did achieve higher average profits. Further analysis of the data lead the authors to conclude that "The advised teams made less profit early in the game but increased their profits more rapidly and were making more profit late in the game. Thus, the difference between advised and unadvised teams' profit might well

24McKenney, op. cit., p. 132.
have been statistically significant had the experiment continued for a longer period."\textsuperscript{25}

Despite the acknowledged importance of the learning environment aspects of decision simulations, there has been little published research directed toward this area.\textsuperscript{26} The increasingly important role which decision simulations may play in business education in the 1970s will require extensive research and attention if the full potential of this instructional technique is to be realized.

The Experimental Variables

The objective of this section is to provide an overview of 1) the role of information feedback and 2) the use of written assignment requirements in decision simulation exercises. In general, the literature in the area of simulation exercises is very superficial, with an emphasis on "how we use our game." Therefore, the discussion of the variables will focus on the following areas: A brief review of relevant theory from the educational literature; general discussions and illustrations drawn from the few authoritative sources available; and citations from relevant research studies.

\textsuperscript{25}Starbuck and Kobrow, op. cit., p. 29.

Theory and Role of Information Feedback

The educational literature offers little of substance to individuals concerned with assessing or predicting the effects of differences in information feedback levels in a simulation exercise. The theoretical foundations and research results are oriented primarily toward conventional classroom situations and, with some modifications, to computer-based programmed instruction applications.

Information feedback falls under the classification of knowledge of results in the educational research area. The literature discusses knowledge of results in terms of three primary variables: The immediacy of the feedback—delay factor; the specificity of the feedback—level of detail and accuracy; and the effect of combinations of these two factors.

In reviewing the knowledge of results literature, Edwards and Scannel note that:

When a student is given knowledge of his progress, this influences his attitude and/or approach to further study . . . . The facilitating effects of knowledge of results have been noted for years . . . . Periodically since 1900, research bearing on the power of noted progress has appeared, although, . . . , the research effort has been rather unsystematic. Under most classroom conditions students receive information about progress only sporadically and at infrequent intervals. Whatever facilitating effects accompany specific knowledge are largely neglected by such procedures. Immediacy
of knowledge, specificity, and effects are factors still not clear at this time.27

After reviewing some recent research studies in the area, they concluded that, "Further research needs to be conducted on quality and degree. Thus far, knowledge has been relatively complete or relatively absent. Conditions need to be arranged so that degrees from zero to complete knowledge are co-varied with immediacy and delay."28

One critical problem in transferring knowledge of results theory and research to decision simulations is that the educational theorists assume that there is one correct answer. In a decision simulation of any reasonable complexity, there are usually a number of strategies which will lead to a satisfying conclusion of the exercise. In addition, different individuals or different teams may have different performance objectives or expectations—e.g., maximum dollar profits versus an acceptable level of return on invested capital—so that, in a very real sense, each team must determine whether the response received from the simulation model is correct—i.e., the decision strategy produced the desired results—with respect to the team's objectives. A third problem is that the


28Ibid., p. 171.
information feedback from the model may be ambiguous in terms of the team's ability 1) to determine if the previous strategy accomplished the desired results, 2) to define reasonable hypotheses to explain the reason(s) for the success or failure of the previous strategy, and 3) to decide how the team can improve its strategy in subsequent decision periods.

In the simulation gaming literature, Greenlaw, et al. discuss the role of information feedback in terms of two primary effects. First, information feedback can serve to help create and maintain the illusion of reality. In this sense, information feedback can serve to reinforce the role(s) which the simulation exercise attempts to create for the participants. The quantity, types, and report formats of the simulation model's output can attempt to replicate the information situation which might confront a manager or management team in an industry setting. Second, it may enable the players to make more effective decisions. With respect to the second point, they are apparently considering the effect of additional optional information, e.g., the purchase of market research reports, rather than the basic level of information feedback from the simulation model.

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29 Greenlaw, Herron and Rawdon, op. cit., p. 88.
Commenting further on the relationship of information to decision-making effectiveness, they note that:

In determining how much and what kinds of information should be provided the players, the game designer may find himself on the horns of dilemma. If too little information is available, it may be difficult or impossible for the players to do an adequate job of analysis and decision-making. On the other hand, if too much information is provided, the game model and the relationships incorporated therein may be so obvious that much of the challenge of the simulation experience may be lost ... there is no clear-cut answer as to how much of what kinds of information should be made available in any particular game ... 

In a later discussion of the problems and prospects of business simulations, they also note the tendency to increase the complexity of the simulation—both in terms of decisions required and of information feedback—to the point where the primary result is "obscuring the obvious." 31

In many decision simulations, the integrity of the model will be preserved by using stochastically-modified structural equations or by the future actions of competing teams. Moreover, in many cases, the problems associated with participants' discerning the structural characteristics of the model or with overwhelming participants with information are, in fact, key aspects of the objectives of the exercise. In a simulation exercise that attempts to

30 Ibid.
31 Ibid., pp. 248-249.
closely replicate an actual operating environment or process, a key learning objective of the exercise may be to enable students to "discover" the underlying determinants of the effectiveness of their strategies. In presenting decision simulations designed by Greenlaw and Hottenstein, and by Smith, Estey, and Vines, the player's instructions contain the structural equations of the simulation model as an aid to analysis and strategic planning.\(^{32}\)

Thorelli and Graves discuss the INTOP strategy concerning amount of information feedback and state that:

INTOP possesses another important feature of realism in the very wealth of information generated in the course of the simulation. The torrential flow of data has two important effects. It teaches participants that selectivity is of the essence. . . . [but] Even when a team has decided what data are most relevant to its activities it will find that systematic ordering and processing of these raw materials is a powerful area of payoff in "professional" management.\(^{33}\)

McKenney discusses the information feedback strategy of the Harvard Management Game as follows:


\(^{33}\)Thorelli, op. cit., p. 172.
The results of the simulation are produced as accounting statements, using common business terminology. The vocabulary of the report is similar to the teaching materials of the Harvard Business School MBA curriculum. All the information is intended to be meaningful to the operation of the simulated firm. It is felt the quantity of data provides a rich enough search problem without the complexity of irrelevant information.

In summary, the literature indicates that there is probably a lower limit to the amount and types of information feedback given to participants below which intelligent analysis and decision-making are inhibited or impossible. The upper limit is primarily a function of 1) the degree of complexity of the simulated environment, 2) the amount of time allowed the participants to analyze the results of the previous period and to define their next set of decisions, and 3) the objectives of the simulation designer and/or administrator.

A survey of the literature with respect to specific decision simulations reveals three primary strategies for information feedback. The first two strategies are implemented through the design specifications of the simulation model, while the third strategy is based on the needs and desires of the administrator.

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McKenney, op. cit., p. 45.
The first strategy involves designing the simulation model to provide the same quantity and types of information to each team or participant, with no provision for ordering additional information, such as market research reports. Decision simulations using this strategy eliminate the need for participants to determine if additional information or reports might be useful for improving decision-making. In effect, the simulation designer eliminates the value versus cost of information dimension from the simulated environment.

The second strategy is to provide each team or participant with a standard set of reports and/or information, but to allow players to order additional information from the simulation model for a fee. Almost invariably, the purchase of additional information feature is used in exercises where teams are competing in a common marketplace; the optional reports focus on research

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36 See, for example, Cohen, et al., op. cit., p. 31; Paul S. Greenlaw and Fred W. Kniffin, Marksim: A Marketing Decision Simulation (Scranton, Pa.: International Textbook Company, 1964), pp. 16-17; Thorelli and Graves, op. cit., pp. 78-79.
information about the marketplace and about the actions and results of the team's competitors. In most cases, the reports are priced by the game designer, and the team may be limited as to the number of optional reports ordered per decision period. The report information usually contains a random term to introduce a degree of uncertainty and error into the information.

The third strategy must be implemented by the administrator, and is based on the availability to him of information not available to all participants or to any participants. At a minimum, the administrator will have access to information concerning the performance of each team or participant and his past decision strategy. He can utilize the information in a number of ways to provide additional information to participants.

In sessions with the INTOP Game at the University of Chicago, the administrators have published newsletters containing items of information submitted by the companies—which may be true, partially true, or completely false—and information items designed to direct participants' attention to various aspects of the developing situation. In particular, impending changes in the simulation model

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38 Thorelli and Graves, op. cit., pp. 60, 179, 362-365.
parameters are announced via rumors, industry gossip items, or forecasts produced by the administrator. A subscription to the newsletter is optional, and costly, for each team. An additional strategy used with INTOP is to allow teams to negotiate for desired information, with the administrator representing a management consulting or market research firm. Other strategies noted in the literature include the posting of team rankings based on one or more performance indicators and issuing special memos to participants concerning various aspects and developments of the exercise.

In summary, the administrator can significantly influence the environment—and perhaps the results—of the exercise through the judicious use of various information feedback strategies.

Only one reported research study was located which focused on the role of information in decision-making. Babb and Eisengruber used the Purdue Dairy Management Game to examine "the effect of information on ability to make profits." The Purdue Dairy Management Game is designed to closely replicate the environment of the dairy management industry. Participating teams were composed of

39 Ibid., p. 73.
dairy managers. Five information conditions were used for the experiment: complete information; no information on sales and profits; no distribution cost information; no information except for competitors' prices; and complete information two months old. The experimental design was structured so that "During the course of the game, level of information was rotated among participants so that two completely informed participants were always competing with two poorly informed rivals." The participants were informed in advance of the game about the experiment, and were given a schedule of the information conditions for each period of play.

The results of the experiment with respect to the general and specific findings were:

1. In all cases, there was greater profit variation among participants than there was among levels of information or the degree to which participants were informed.

2. The level of information regarding sales did not conclusively affect the participants' ability to achieve profits. Sales information appeared to affect the level of profits less than the other types of information.

3. Distribution cost information did significantly affect managers' ability to make game profits.

4. Substantial profit differences were observed between information situations involving total lack of information and information two months old. Participants had better profits with lagged information than current information; apparently because participants became more

\[41\] Ibid.
aware of the need to make changes when they received lagged information, after having an information void the previous two months.42

Whether the conclusions reached by Babb and Eisengruber can be extended to other situations is open to question. First, the participants were dairy managers involved in a detailed and high-fidelity simulation of the dairy management industry. Therefore, the general setting of the exercise and the types of decisions to be made were familiar to the participants. Second, a parallel experiment using student participants indicated that the effect of information was more apparent with students than with dairy managers, but "this was expected since managers can rely on experience and are familiar with the industry."43

No additional information on the results of the experiment was reported.

Theory and Role of Written Assignments

The written assignment variable requires that some students must respond to the case not only in terms of the decision values which they feel will improve the performance of the model, but must also provide an overt—in this case, written—response concerning his reasoning process and objectives for the given set of decision values. Although most of the education research do e concerning

42 Ibid., p. 127.
43 Ibid., p. 157.
student response modes does not directly relate to the type of environment or degree of complexity involved in the experiment, the following citations summarize the current thinking and knowledge about student response modes.

In an article entitled "Instructional Research: Some Aspects of Its Status," Lumsdaine reviews the entire field of educational research done to date, and rejects most of the work as being either methodologically or assumptively defective.

One then gets down to the relatively few findings in which significant differences are reported, of which he will still find that very few are replicated. Of the small number of these, perhaps most are in the field of the role of active response of students. Even here, however, it is difficult to say much more than simply that some forms of student responding under certain circumstances can prove quite helpful. The conditions under which one form or another of responding can help how much are still far from clear.\(^4\)

Smith focuses more directly on the use of written responses in programmed instruction as a motivating and reinforcing technique.

Some information on the question of active response has come from research in programmed instruction. Here it has been shown that active response in the form of writing the answer as compared with simply "thinking" it does not pay off when the subject matter is very simple but does pay off when the subject matter is complex or difficult. Experiments

in problem solving indicate that students may solve problems more quickly if they engage in overt verbal behavior concerning their hypotheses and solution processes than if they keep them to themselves (this does not imply that the verbalizations have to be correct). 

In an experiment focusing on the problem solving process, Smith reports that:

Exemplar 10: In another problem solving experiment two groups of students were given the same puzzle to work out. One group was asked to respond overtly regarding their individual hypotheses or strategies while they attempted to solve it. The other group was not asked to respond overtly in this manner. The correctness of the verbal responses of the first group was not crucial. They were not rewarded in any way for correct responses or given any information on their correctness. The group which responded overtly was still found to solve the problem quicker on the average than the other group. Evidently, active overt verbal responding during the solution was facilitating in this case. Yet in another experiment where young children were asked to put together a number of known facts to solve a problem, it was found that giving hints during the solution process interfered with the solution in some cases; the verbal hint seemed to interfere with whatever mediation process they were using and to cause them to operate less efficiently. 

A review of the literature of simulation and gaming indicates that written assignments have been used to achieve four primary objectives: First, students may be required to submit written statements of strategy and objectives in order to provide a benchmark for evaluating their performance; second, written assignments pertaining

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45 M. Daniel Smith, op. cit., p. 35.
46 Ibid., p. 132.
to specific techniques or concepts help to integrate the exercise with other course materials or with other courses in the curriculum; third, written assignments are used to direct participants' attention to particular aspects of the exercise; and fourth, written assignments are used to motivate students to thoroughly study and learn the exercise materials, such as general constraints on decision strategies, rules of play, and so on.

Early experience with the U.C.L.A. Game as reported by McKenney provides insight into the philosophy and strategy of early gaming efforts.

It was suggested to the students that a brief written statement concerning their goals and policies might aid the success of their firms. The gaming credo of the time seemed to be minimum interference with student performance in the simulated environment, since any interference might inhibit student involvement and abort the objectives of the exercise. As more gaming experience was accumulated, this credo proved absolutely wrong. Assignments, if in consonance with the simulated environment, seem to induce more conscientious involvement and do not detract from the objectives. In fact, assignments are essential if the exercise is to achieve its potential as a learning experience.47

McKenney has also reported on the results of an experiment to evaluate alternate strategies for improving gaming effectiveness at Harvard.

It was felt there were two alternatives for improving the game for the students, either requiring more reports or making the model more "realistic." To gain further experience, two separate classes of

47McKenney, op. cit., p. 19.
ninety men were enrolled in a game. One class was required to submit more written comments during the session and the other was to deal with a more complex simulated environment.

On the basis of HBS Faculty observation of the different procedures, enrichment by additional reports during the sessions seemed far more effective. The reports required the student to analyze what he was doing and made the Faculty more aware of what was happening in the simulation. The students experimented with analytical techniques with the game data to complete the reports which provided a basis for classroom discussions in the various courses. The conclusion of this comparison supports the experience of war gaming that, given a simulation game, more time should be spent on how to use an environment than on a continued enrichment by effort in modeling.48

Comments by members of the Harvard faculty concerned with implementing the Harvard Management Game indicate that written assignments focused on specific aspects of the game generate a considerable amount of student reflection and analytical effort that might not otherwise be forthcoming. Representative written assignment topics have included sales forecasting, the bases for the firm's pricing policy, sources of funds and cash flow analysis, and definition of the firm's production scheduling rule and the rule's relationship to the firm's overall objectives.49

In reviewing the role of the INTOP administrator, Thorelli and Graves suggest that the following written documents be submitted by each team: A detailed statement

48 Ibid., pp. 26-28, passim.
49 Ibid., pp. 92-94.
of the firm's objectives, stated in terms of product and geographic areas of operations, target market(s), and forecasts of future financial and operating positions; an organization chart defining each team member's general authority and responsibility area(s); and a detailed job description for each team member.50

In summary, the use of written assignments in conjunction with decision simulations offers the administrator a powerful and flexible tool for directing and focusing the attention and energies of participants before, during, and after the exercise. However, few reported research studies bearing on the impact and effects of written assignments have been conducted.

Summary

The chapter presented the findings of the literature search with respect to the three areas of interest of the study: The learning environment; the role of information feedback in the learning process; and the role of written assignments in the learning process. Each area was discussed in terms of education and learning theory, reported usage in decision simulation and gaming exercises, and relevant research studies and findings.

A brief review of the education literature focused on the concept and importance of the learning environment in the learning process. The learning environment of a decision simulation was shown to be defined by three primary factors: The objectives the administrator wishes to achieve by using the simulation; the characteristics of the decision simulation; and the supplementary activities conducted in conjunction with the exercise. Each of these areas was discussed in detail using examples from the literature.

Information feedback from the simulation model was first discussed in terms of knowledge of results research studies reported in the education literature. The topic was then developed with respect to the role of information feedback in decision simulations. The three basic strategies of information feedback reported in the literature were presented and illustrated.

The uses of written assignments as a facilitating aspect of student learning and problem solving activities were summarized. Relevant references from the literature of simulation and gaming were presented and illustrated to provide guidelines relating to how written assignments have been used in conjunction with decision simulation exercises.
CHAPTER III

RESEARCH DESIGN

The objective of this chapter is to present the research design and experimental procedure aspects of the study. The chapter contains nine sections. The first section presents the general nature of a research design and discusses conducting research in a classroom environment. The second section focuses on the study experimental design. The third section details the design and construction of the study questionnaires. The fourth section summarizes the case scenario and discusses the participants' role and objectives. The fifth section discusses the simulation model program developed for the study. The sixth section discusses the nature and implementation of the experimental variables. The seventh section presents the performance criteria used to measure decision-making effectiveness on the case study. The eighth section presents the procedures and sequence of events in the experiment. The ninth section summarizes the data collection and analysis activities of the study.

Introduction

A research design is the overall operational pattern or framework which specifies the methods, procedures, and
event sequences to be used to gather data needed to investigate the research questions.¹ Fundamental to the selection or definition of a research design is the degree to which the design provides internal and external statistical validity relative to the research questions being investigated. Internal validity refers to the extent to which the design neutralizes or minimizes extraneous forces which might act on the experiment in such a way as to provide plausible rival hypotheses to explain the results of the experiment.² External validity refers to the degree to which the results of the experiment can be generalized and applied to other situations. In general, external validity is a function of the degree to which the composition of the sample can be assumed to be representative of the population from which it was drawn or to which the results are to be projected.³

Experimental research conducted in a classroom environment involves the consideration of dimensions not normally present in more conventional research environments. In terms of external validity, the primary problem is that the experimenter normally has no control over the selection of the


³Ibid.
students enrolled in a particular course. Therefore, it is
difficult or impossible to define the relevant character-
istics of the statistical population of which the class is
a sample. A second and related problem is that it is
impossible to determine if the class is a random sample of
the unspecified population. Therefore, the researcher must
assume that the class represents a non-random sample from
an undefined or only partially-defined statistical popu-
lation.

The primary threat to internal validity in longitu-
dinal studies is that students are in frequent contact
over an extended period of time. Therefore, changes in
attitudes, behavior, or performance may be attributable to
student interaction, rather than to the presence of the
experimental variables.

Educational research specialists have devised a
number of research design techniques which can strengthen
the statistical validity of classroom-based research
studies. Four research design techniques, discussed
below, were used in the initial design specifications for
the study. However, the control group design technique
became infeasible and was dropped from the final design
specifications.

\[4\] See, for example, ibid.
Treatment group randomization provided the primary basis for the internal validity of the study. Treatment group randomization was achieved by randomly assigning each student to one of four learning environments used for the study. The objective of the technique was to statistically equate the composition of the samples exposed to the different learning environments.

Internal validity was also strengthened by using a separate-sample research design. The experiment was conducted simultaneously in two sections of the same course. The objective of the technique was to replicate the experiment in a different classroom environment in order to provide statistical control for conditions or events which may have occurred in one classroom but not the other.

A pretest, no pretest technique was used in conjunction with the separate-sample aspect of the research design. One section received a pretest questionnaire, while the other section did not. The objectives of the technique were 1) to determine if the administration of a pretest questionnaire sensitized students to the experiment, and 2) to provide a measure of changes in student attitudes about case analysis that might be attributable to the experiment case study.

The initial research design included a control group course. The control group course was to be pretested and post tested, but not subjected to the experiment. The
objective was to provide a benchmark for detecting differences in student attitudes toward case analysis between the experimental and the control group course which might be attributable to the experiment case study. The control group aspect of the design was abandoned when the use of a "voluntary return" questionnaire generated an insufficient number of responses to provide an adequate basis for comparing the control group attitudes data with data for the experimental groups.

Experimental Design

The experimental design used for the research is classified as a separate-sample, pretest-post test, cross-sectional design. The separate-sample designation indicates that two or more sampling units—in this case, class sections—not defined by the random selection of subjects were used. The pretest-post test designation indicates that one of the sampling units received a pretest, experimental treatment, post test sequence. The cross-sectional designation indicates that each of the treatment groups was exposed to a different combination of measurements and experimental variables.

Two levels of information feedback and two levels of written assignment requirements were used to define the four learning environments for the experiment. The learning environments are shown in Exhibit II.

5Ibid., p. 53.
Each cell of the treatment matrix shown in Exhibit II represents a specified combination of levels of the treatment variables. For example, a student assigned to complete the case study within learning environment X1 was required to submit a written assignment before each simulation session and received all available information from the simulation model. The levels of information feedback are labeled "full" and "limited," reflecting the relative amount of information reported to the student by the simulation model. The written assignment requirement is labeled "yes" and "no," indicating whether a student completing the case study assignment in a specified learning environment was or was not required to submit a written assignment.

The experimental design is presented symbolically in Exhibit III.
### Exhibit III

**Experimental Design of the Study**

<table>
<thead>
<tr>
<th>Section</th>
<th>Group</th>
<th>Treatment Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>R 01 X1 02</td>
</tr>
<tr>
<td>A</td>
<td>2</td>
<td>R 01 X2 02</td>
</tr>
<tr>
<td>A</td>
<td>3</td>
<td>R 01 X3 02</td>
</tr>
<tr>
<td>A</td>
<td>4</td>
<td>R 01 X4 02</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>R X1 03</td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>R X2 03</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>R X3 03</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>R X4 03</td>
</tr>
</tbody>
</table>

The terms and symbols are defined as follows:

1. **Section** letters identify the two sections of the course used in the experiment.
2. **Group** numbers identify a collection of students that received a specified combination of measurements and experimental treatments.
3. **Treatment Sequence** indicates the temporal order of the experimental measurements and treatments.
4. **R** indicates that a random process was used to assign individual students to a specific learning environment.
5. **01** indicates the administration of the pretest questionnaire to students in Section A.
6. X₁, X₂, X₃ and X₄ indicate the particular learning environment within which students in the group completed the case study. The X₁ through X₄ symbols are identified in Exhibit II above.

7. O₂ indicates the administration of the Section A form of the post test questionnaire.

8. O₃ indicates the administration of the Section B form of the post test questionnaire.

In summary, each student in Section A was randomly assigned to one of the four learning environments, completed a pretest questionnaire, conducted the case study simulation sessions under defined conditions of information feedback and written assignment requirement, and completed a post test questionnaire. Each student in Section B completed the same sequence of events, but was not pretested.

Questionnaire Design

Questionnaires were administered to each section to gather data on selected demographic, experience, and attitude variables for each student participating in the experiment. The questionnaire variables were judgmentally selected to provide information about relationships which might clarify, amplify or supplement the findings of the study with respect to the research questions discussed previously.

The following types of information were collected for each student participating in the experiment.
I. Academic Grade Average
   A. By major field of study
   B. Last three quarters

II. Experience
   A. Computers and business gaming
   B. Case study analysis

III. Attitudes
   A. Case study analysis as a teaching method
   B. Specific attitudes about the case study used for the experiment

IV. Other Data
   A. Suggested improvements for the case study used for the experiment
   B. Comments

One pretest and two post test questionnaire forms were constructed for the study. Two post test questionnaire forms were necessary due to the need to collect the demographic and attitude data from students in Section B which students in Section A provided on the pretest questionnaire. The three forms and their contents are listed below.

I. Section A Pretest
   A. Academic grade averages
   B. Experience with computers and business gaming
   C. Experience with case study analysis
   D. Attitudes about case study analysis as a teaching method

II. Section A Post Test
   A. Attitudes about case study analysis as a teaching method
   B. Attitudes about the case study used for the experiment
C. Suggested improvements for the case study used in the experiment
D. Comments

III. Section B Post Test

A. Academic grade averages
B. Experiences with computers and business gaming
C. Experience with case study analysis
D. Attitudes about case study analysis as a teaching method
E. Attitudes about the case study used for the experiment
F. Suggested improvements for the case study used in the experiment
G. Comments

The three questionnaires are presented in Appendix A.

The attitude questions were scaled with a modified form of the semantic differential scale developed by Osgood, Suci, and Tannenbaum. The student responded to each question or statement by checking one of several predefined responses, ranging from highly positive to highly negative. The technique allowed the student to indicate both the direction and the intensity of his feelings or attitudes about the statement or question. The response categories used in the questionnaire were: strongly agree, agree, somewhat agree, somewhat disagree, disagree, and strongly disagree.

The attitude questions about case study analysis were judgmentally selected to cover a number of possible favorable and unfavorable dimensions. The questions

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focusing on the experiment case study were selected to provide data about the case study materials and simulation model and about student attitudes toward the case materials and simulation model.

The Case Study

The case study used for the experiment was designed specifically for the research and programmed for the Ohio State University time-sharing terminal system. The design objective of the case was to establish a realistic but simplified problem-solving environment focused on selected aspects of inventory management and transportation. The analytical and learning aspects of the case study were reinforced by the non-competitive nature of the simulation model, i.e., the results of a student's decision strategy were not dependent upon or affected by the decision strategies or results of other students. The case materials are presented in Appendix B.

The scenario of the case focused on the problems encountered by Phoenix Industries in attempting to expand its retailing operations beyond its traditional Midwest sphere of operation. The San Francisco store was established as a pilot operation to determine if the company's product line and merchandising philosophy were viable bases for expanding to the West Coast. The demand for the company's products at the San Francisco store had been satisfactory. However, the company had been unable to control
the inventory supply function, resulting in a history of unprofitable operation. The inability to coordinate order size, order frequency, and transportation mode policies had resulted in periodic swings from excessive inventory levels to out-of-stock conditions. At the conclusion of the scenario, the Board of Directors had agreed to continue the San Francisco operation for one year to determine if the inventory problems could be corrected. The President appointed the student as the new manager of the store for the one-year period. The student's objective was to define an inventory review and ordering strategy by the end of four simulated quarters of operation which would profitably meet customer demand requirements. A diagram of the general problem situation facing the student/manager is presented in Exhibit IV.

At the beginning of each simulated quarter of operation, the student defined an inventory ordering and review strategy using the decision variables shown in Exhibit V. The decision variables enabled the student to define when and how often store inventory was reviewed, when and how large an order was placed, how the order was to be transmitted to the factory, and how the order was shipped to the store. The definition and functions of the division variables are presented and discussed in the case materials contained in Appendix B.
Exhibit IV
Flowchart of Physical Product and Information Flow

Transportation Modes: Truckload; less-than-truckload; air freight.
Communication Modes: Telephone; mail.
Public Warehouse: Used when store--1,800 unit capacity--is full.
Exhibit V

Simulation Model Decision Variables

<table>
<thead>
<tr>
<th>Order Strategy 1:</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant Order Quantity (units)</td>
<td>200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Order Strategy 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Formula Adjustment Factors</td>
</tr>
<tr>
<td>Formula x factor (multiplier)</td>
</tr>
<tr>
<td>Formula +– factor (units)</td>
</tr>
<tr>
<td>Minimum order size (units)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Variables:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days in Demand Average (days)</td>
</tr>
<tr>
<td>Review Inventory Every ___ Days (days)</td>
</tr>
<tr>
<td>Low Stock Point (units)</td>
</tr>
<tr>
<td>Cancel If Order Due in ___ Day (days)</td>
</tr>
<tr>
<td>Shipment Mode (Use 1, 2, or 3)</td>
</tr>
<tr>
<td>1. Priority order by air; normal by truck</td>
</tr>
<tr>
<td>2. All orders shipped by truck</td>
</tr>
<tr>
<td>3. All orders shipped by air</td>
</tr>
<tr>
<td>Communication Mode (Use 1, 2, or 3)</td>
</tr>
<tr>
<td>1. Priority orders telephoned; normal orders mailed</td>
</tr>
<tr>
<td>2. All orders sent by mail</td>
</tr>
<tr>
<td>3. All orders sent by telephone</td>
</tr>
</tbody>
</table>
The Simulation Model

The model was programmed in PL/I level F compiler language for the IBM System 370, Model 165 computer system. The simulation model consisted of five programs which controlled various aspects of the simulation session. The program listings and explanations are shown in Appendix E.

Model characteristics such as demand sequences, report frequencies, and decision variables were defined separately in a Student Data Record file. Therefore, the simulation model can represent different simulation environments by using different values in the Student Data Records file. For the experiment, only the written assignment requirements and information feedback levels were varied. The Student Data Record file format and the file construction program and explanations are presented in Appendix F.

Each value entered by the student was checked by the program for logical consistency and for the specific limits associated with each variable. Errors were detected by the program and required correction by the student before the program proceeded to the next required item. All simulation session results and memorandum contents were recorded for later analysis.

The student used the time-sharing terminal to execute the simulation program. The program conducted a
dialogue with the student to determine the decision variable values to be used to simulate the operation of the store for the current quarter. The program then simulated the operation of the store on a day-by-day basis, using the decision values entered by the student to review and order inventory. The results of the quarter's operations were reported to the student in the form of financial and operating reports. The reports, discussed in the next section, provided the basis for the student's evaluation of the effectiveness of the strategy and for the definition of his strategy for the next quarter of operation.

**Experimental Variables**

The case scenario established the basis for differences in information feedback levels and written assignment requirements among the students completing the case study assignment. Several alternative suggestions for improving the inventory management situation at the San Francisco store had been advanced by the store manager and by various members of management. Most of the alternatives proved to be ineffective in correcting the problems. As the case scenario closed, the President was considering two remaining alternatives.

1. Should the company expand the present information system in order to provide more operating and financial data to the San Francisco store?
2. Should the company require the store manager to submit a written report setting forth his strategy and rationale for the next quarter and analyzing the results of the previous quarter's operation?

Each student participating in the experiment was informed of the President's decisions during the practice session with the simulation program which preceded the four quarterly simulation periods. The objective of the practice session was to familiarize the student with the operation of the time-sharing terminal and to provide him with experience in using the simulation program.

The information feedback from the simulation model was in the form of management reports. The "Weekly Operations Report" was received by all students. The objective of the report was to allow the student to examine the dynamic interaction of his inventory strategy and the simulation model. The report consisted of a one-line summary of the values of selected model variables every five simulated days during the 60-day quarter.

The "Quarterly Financial Statement" was also received by all students. The report was an income statement summarizing the current quarter and year-to-date financial results of the store. The report expense categories corresponded to the major decision areas involved in defining the inventory ordering and review strategy.
The "Quarterly Operations Statement" was received only by students completing the case study under conditions of full information. The report contained supplemental information concerning the current quarter and year-to-date statistics in the following areas: sales, inventory, orders, and shipments. Some of the information in the report could be derived from the "Weekly Operations Report" and the "Quarterly Financial Statement." The remaining information in the report can be considered a differential advantage which the students receiving the report command over the students not receiving the report. Samples of the three reports are presented in Appendix C.

If a student was required to submit a written assignment, the simulation program printed out a memorandum format on the time-sharing terminal. The memorandum contained two sections: analysis of previous period(s); and strategy and forecast for current period. The student typed a report to management on the terminal. The simulation program stored the text of the memorandum to provide a permanent record of each student's responses. The memorandum format is presented in Appendix C.

**Decision-Making Effectiveness Criteria**

The exploratory nature of the study and the multifaceted character of decision-making effectiveness precluded the selection of one particular indicator which
could be justified a priori as being the most effective or realistic possible measure of performance. Therefore, three performance criteria were used to evaluate student decision-making effectiveness on the case study assignment.

The annual dollar revenue performance criterion indicated the extent to which the students in a given learning environment remained in-stock during the four quarters of simulated operation. The simulation program generated identical demand patterns and quantities for each student during each sequential quarter of operation. Therefore, maximum obtainable sales revenue for each quarter was a known quantity. Sales revenue levels below the maximum figure for each quarter were a direct function of the degree to which unit demand was not satisfied. The learning environment ranks with respect to sales revenue reflected the relative success of each learning environment group in remaining "in-stock" during the year.

The annual dollar profit performance criterion provided an absolute measure of profitability. Dollar profitability was a function of gross sales revenue and controllable expenses, since the cost of goods sold and fixed expenses were known and constant at $2 per unit and $7,000 per quarter, respectively. The average unit demand per quarter was 6,000 units. Therefore, the students faced an approximate break-even volume of 3,500 units with respect to fixed costs and unit cost of goods sold. Beyond
3,500 units, the $2 difference between the retail price and the cost per unit provided the gross margin dollars from which variable costs were paid and any profits recovered. The learning environment ranks with respect to dollar profit reflected the success of each learning environment group in generating dollar profits without respect to sales revenue.

The annual profit as a per cent of annual sales revenue performance criterion provided a relative measure of profitability, since it related dollar profits to sales revenue. This criterion measured the effectiveness of the decision strategies in controlling expenses relative to sales revenue. The learning environment ranks with respect to profit as a per cent of sales reflected the relative success among the four groups in terms of median profit percentages.

Each performance variable provided a different approach to various dimensions of the decision-making effectiveness of the four learning environment groups. In addition, comparisons between and among the variables provided a more complete analysis of the relationships among the revenue and profit figures generated by student participants during the experiment.

**Experimental Procedure**

The experiment was conducted in a senior-level, Marketing Management case study course. Both sections of the course were taught by the same member of the Marketing faculty, and both sections used the same cases in the same
sequence. Total enrollment in both sections was eighty-five students. Seventy-four students completed all of the simulation runs and questionnaires and were used in the data analysis phase of the study. The remaining eleven students either did not complete one or more simulation sessions or did not complete one or both questionnaires.

The seventy-four students were distributed among the sections and learning environments as shown in Exhibit VI.

Exhibit VI

Classification of Sample Observations by Section and Learning Environment

<table>
<thead>
<tr>
<th>Learning Environment</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>13</td>
<td>7</td>
<td>16</td>
<td>6</td>
<td>42</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
<td>9</td>
<td>6</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>16</td>
<td>22</td>
<td>14</td>
<td>74</td>
</tr>
</tbody>
</table>

Student class enrollment cards were used as the source data for the Student Data Record computer program. The program randomly assigned each student to one of the four learning environments and then constructed a Student Data Record, keyed by student identification number, for each student. The Student Data Record was used by the simulation program to store the results of each student's simulation sessions. The program and explanation are presented in Appendix F.
The pretest questionnaire was administered to students in Section A during the middle of the quarter. The case study materials, shown in Appendix B, were distributed to both sections during the next week. Part of a class session was devoted to reviewing the case materials, discussing the operation of the time-sharing terminal, and answering questions about the assignment. The students had two weeks in which to complete the practice session and the four simulation sessions, subject to the constraint that only one simulation session could be run per day. The post test questionnaires were administered to both sections of the course a few days after the conclusion of the assignment period.

Data Collection and Analysis

The research data base for the data analysis phase of the study consisted of selected information from the pretest and post test questionnaires and from the Student Data Record File. The questionnaire responses for each student were coded on machine-readable forms to produce a punch card deck. Selected performance information for each student completing the case study assignment was extracted from the Student Data Record File and merged with the questionnaire response card deck. The merged data file was the data base from which the findings of the study were drawn.
The first phase of the data analysis activities focused on testing the research hypotheses concerning the influence of the experimental variables on student decision-making effectiveness on the case study. Visual inspection of the revenue and profit data indicated that the distributions were skewed, thereby invalidating the application of parametric statistical techniques. Therefore, two non-parametric statistical techniques contained in the Non-parametric Statistical Analysis Program available on the Ohio State University computer system were used to analyze the data. The research hypotheses were tested using the Mann-Whitney U statistic. The Mann-Whitney U test is a rank-order statistical technique which determines the probability that two samples were drawn from statistical populations with the same median.⁷

The second phase of the data analysis activities focused on examining the performance and attitudes data for relationships which might clarify, supplement, or refine the conclusions drawn from tests of the research hypotheses. The Mann-Whitney U and Kendall Rank Correlation Coefficient statistical measures were used to perform the analysis. The Kendall Rank Correlation Coefficient is a nonparametric correlation procedure which determines the

degree of association between two variables. A discussion of the computation methods for the statistical tests is presented in Appendix G.

**Summary**

A separate-sample, pretest-post test, cross-sectional research design was used to gather the data. The treatment variables used to define the four learning environments of the case study were 1) amount of information feedback--full and limited--and 2) written assignment required--yes and no. Individual students in two sections of a Marketing Management case study course were randomly assigned to complete the case study within one of the learning environments. The case study used for the experiment was designed for the research study and focused on selected aspects of inventory management.

Nonparametric statistical analysis techniques were used to test the research hypotheses and to examine student demographic attitude and experience data for relationships with decision making effectiveness.

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CHAPTER IV

PRESENTATION OF FINDINGS

The objective of this chapter is to present the empirical findings of the study. The chapter consists of three sections. The first section briefly reviews the experimental framework, decision-making effectiveness criteria, and statistical procedures of the study. The second section presents the results of the research hypotheses tests. The final section discusses other findings of the research.

Introduction

The learning environments were defined by the four combinations of two levels of each of the two experimental variables. The learning environments characteristics are summarized in Exhibit VII.

Exhibit VII

Characteristics of the Learning Environments

<table>
<thead>
<tr>
<th>Level of Information Feedback</th>
<th>Full</th>
<th>Limited</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written Assignment Required?</td>
<td>Yes</td>
<td>X1</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>X2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X4</td>
</tr>
</tbody>
</table>

73
Each of the four major research hypotheses was tested with respect to three performance criteria—annual dollar revenue, annual dollar profit, and annual profit as a per cent of annual revenue—with the following data groups: combined results of Sections A and B; results of Section A only; and results of Section B only. The tests using the combined results of the two sections provided an indication of the extent to which the treatment variables influenced performance without regard to possible differences between the two sections of the course. The tests using the results of each section separately provided a basis for determining whether the influence of the variables differed between the two sections.

The Mann-Whitney U statistic was used to test each of the hypotheses for statistical significance. The U statistic, discussed in Appendix G, was calculated for each pairing of learning environment groups and provided the basis for determining the statistical probability that the two groups were drawn from universes with identical medians. The exploratory nature of the study and the lack of previous research with respect to these variables justified a less rigorous level of significance than is used in most research studies. A .10 one-tail level was used as the critical value for rejecting the null hypothesis.
Hypothesis Tests

Evaluation of Hypothesis H.1

The objective of the first major hypothesis was to determine if the median performance scores among the four learning environments had been drawn from statistical populations with different medians.

H.1 There are no significant differences among the median performance scores for the four learning environments.

Table 1, below, and Table 10, Appendix D, present the general and detailed results, respectively, of testing the hypotheses with respect to each of the performance criteria using the three data groups. Cell values in the table indicate the rank-order of the median performance scores, with the highest performance score listed at the left. The cell superscripts indicate that one or more relationships at the defined level of significance were found.

Table 1 indicates that the null hypothesis was supported with respect to the following data groups and performance criteria: combined sections--annual dollar profits and profits as a per cent of revenue; and Section B--annual dollar revenue. One or more differences in median annual dollar revenue performance scores were significant at the .10 level in the combined sections data group. One or more significant differences in median performance scores were significant at the .05 level in the following
tests: combined sections—annual dollar revenue; Section A—annual dollar revenue, annual dollar profit, and profit as a per cent of revenue; Section B—annual dollar profits, and profit as a per cent of revenue.

TABLE 1.—Hypothesis H.1: Results of tests of the null hypothesis that there were no significant differences in median performance scores among the learning environments—by data group, by performance criterion

<table>
<thead>
<tr>
<th>Performance Criteria</th>
<th>Annual Revenue ($)</th>
<th>Annual Profit ($)</th>
<th>Profit/Revenue (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section(s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>( X_4 - X_2 - X_3 - X_1 ) (^b,c)</td>
<td>( X_1 - X_3 - X_2 - X_4 )</td>
<td>( X_1 - X_2 - X_3 - X_4 )</td>
</tr>
<tr>
<td>A only</td>
<td>( X_2 - X_4 - X_3 - X_1 ) (^c)</td>
<td>( X_2 - X_3 - X_1 - X_4 ) (^c)</td>
<td>( X_2 - X_3 - X_4 - X_1 ) (^c)</td>
</tr>
<tr>
<td>B only</td>
<td>( X_1 - X_4 - X_2 - X_3 )</td>
<td>( X_1 - X_3 - X_4 - X_2 ) (^c)</td>
<td>( X_1 - X_3 - X_4 - X_2 ) (^c)</td>
</tr>
</tbody>
</table>

\(^a\)Table values indicate the group or groups having higher median performance, in order from left to right.

\(^b\)\( P < .10 \), one-tailed test.

\(^c\)\( P < .05 \), one-tailed test.

Evaluation of Hypothesis H.2

The objective of the second major hypothesis was to determine if one of the treatment variables dominated the other with respect to its effect on performance, i.e., was
one variable more influential irrespective of the level of the other variable?

H.2 There are no significant differences in median performance scores between the learning environments when they are grouped and examined with respect to:

1. Full information vs. limited information.
2. Written assignment vs. no written assignment.

Table 2, below, and Table 11, Appendix D, present the general and detailed results, respectively, of the hypothesis tests. Table 2 indicates that the null hypothesis of no significant difference between the full information and limited information learning environments was supported with respect to the following data groups and performance criteria: combined sections—annual dollar profit, and profit as a per cent of revenue; Section B—annual dollar revenue. Differences in median performances scores were significant at the .10 level in the following tests: Section A—annual dollar profit, and profit as a per cent of revenue. Differences in median performance scores were significant at the .05 level in the following tests: combined sections—annual dollar revenue; Section A—annual dollar revenue; and Section B—annual dollar profit, and profit as a per cent of revenue.

Table 2 indicates that the null hypothesis of no significant difference between the written assignment and no written assignment learning environments was supported for all data groups and performance criteria.
TABLE 2.—Hypothesis H.2: Results of tests of the null hypothesis that one variable was not dominant with respect to its effect on performance—a by data group, by performance criteria

<table>
<thead>
<tr>
<th>Section(s)</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual Revenue ($)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Information (X1,X3)</td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>(X2,X4)$_{c}$</td>
</tr>
<tr>
<td>A only</td>
<td>(X2,X4)$_{c}$</td>
</tr>
<tr>
<td>B only</td>
<td>(X2,X4)$_{c}$</td>
</tr>
<tr>
<td>Written Assignment (X1,X2)</td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>(X1,X2)</td>
</tr>
<tr>
<td>A only</td>
<td>(X3,X4)</td>
</tr>
<tr>
<td>B only</td>
<td>(X1,X2)</td>
</tr>
</tbody>
</table>

\(^a\)Table values indicate the group or groups having higher median performance.

\(^b\) P < .10, one-tailed test.

\(^c\) P < .05, one-tailed test.
Evaluation of Hypothesis H.3

The objective of the third major hypothesis was to determine the effect of level of information feedback on performance, given a common level of the written assignment requirement.

H.3 There are no significant differences in median performance scores between learning environments having different levels of information feedback and a common level of written assignment requirements, as follows:

1. Full vs. limited information; written assignment.
2. Full vs. limited information; no written assignment.

Table 3, below, and Table 12, Appendix D, present the general and detailed results, respectively, of the hypothesis tests. Table 3 indicates that the null hypothesis of no significant difference between the full and limited information learning environments requiring the submission of written assignments was supported with respect to the following data groups and performance criteria: combined sections—all three performance criteria; and Section B—annual dollar revenue. Differences in median performance scores were significant at the .05 level in the following tests: Section A—all three performance criteria; and Section B—annual dollar profit, and profit as a per cent of revenue.

Table 3 indicates that the null hypothesis of no significant difference between the full and limited
information learning environments not requiring the submission of written assignments was supported for all data groups and performance criteria.

**TABLE 3.--Hypothesis H.3: Results of tests of the null hypothesis that there were no significant differences in median performance scores attributable to level of information feedback, given a common level of written assignment requirements--by data group, by performance criterion**

<table>
<thead>
<tr>
<th>Section(s)</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual Revenue ($)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Full (X1)--Limited Information (X2): Written Assignment</strong></td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>X2</td>
</tr>
<tr>
<td>A only</td>
<td>X2_&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>B only</td>
<td>X1</td>
</tr>
<tr>
<td><strong>Full (X3)--Limited Information (X4): No Written Assignment</strong></td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>X4</td>
</tr>
<tr>
<td>A only</td>
<td>X4</td>
</tr>
<tr>
<td>B only</td>
<td>X4</td>
</tr>
</tbody>
</table>

<sup>a</sup>Table values indicate the group or groups having higher median performance.

<sup>b</sup><sub>P < .10</sub>, one-tailed test.

<sup>c</sup><sub>P < .05</sub>, one-tailed test.
**Evaluation of Hypothesis H.4**

The objective of the fourth major hypothesis was to determine the effect of written assignments on performance, given a common level of information feedback.

H.4 There are no significant differences in median performance scores between learning environments having different written assignment requirements and a common level of information feedback, as follows:

1. Written vs. no written assignments: full information.
2. Written vs. no written assignments: limited information.

Table 4, below, and Table 13, Appendix D, present the general and detailed results, respectively, of the hypothesis tests. Table 4 indicates that the null hypothesis of no significant difference between the written and no written assignment learning environments receiving full information was supported with respect to the following data groups and performance criteria: combined sections—all performance criteria; Section A—annual dollar profit, and profit as a per cent of revenue; and Section B—annual dollar revenue. Differences in median performance scores were significant at the .10 level in the following tests: Section B—annual dollar profit, and profit as a per cent of revenue. The difference in median annual dollar revenue for Section A was significant at the .05 level.

Table 4 indicates that the null hypothesis of no
significant difference between the written and no written assignment learning environments receiving limited infor-
mation feedback was supported for all data groups and per-
formance criteria.

TABLE 4.--Hypothesis H.4: Results of tests of the null hypothesis that there were no significant differences in median performance scores attributable to written assignment requirements, given a common level of information feedback--by data group, by performance criterion.

<table>
<thead>
<tr>
<th>Performance Criteria</th>
<th>Annual Revenue ($)</th>
<th>Annual Profit ($)</th>
<th>Profit/Revenue (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section(s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Written (X1)—No Written (X3) Assignment: Full Information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>X3</td>
<td>X1</td>
<td>X1</td>
</tr>
<tr>
<td>A only</td>
<td>X3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>X3</td>
<td>X3</td>
</tr>
<tr>
<td>B only</td>
<td>X1</td>
<td>X1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>X1&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Written (X2)—No Written (X4) Assignments: Limited Information

<table>
<thead>
<tr>
<th>Section(s)</th>
<th>Performance Criteria</th>
<th>Annual Revenue ($)</th>
<th>Annual Profit ($)</th>
<th>Profit/Revenue (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A and B</td>
<td>X4</td>
<td>X2</td>
<td>X2</td>
<td></td>
</tr>
<tr>
<td>A only</td>
<td>X2</td>
<td>X2</td>
<td>X2</td>
<td></td>
</tr>
<tr>
<td>B only</td>
<td>X4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>X4</td>
<td>X4</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Table values indicate the group or groups having higher median performance.

<sup>b</sup>P < .10, one-tailed test.

<sup>c</sup>P < .05, one-tailed test.
Other Findings

The primary objective of this section is to present the findings of the data analysis activities undertaken to supplement, clarify, and amplify the results of the hypothesis tests. The results of the findings are presented in five major subsections: 1) student demographic and experience characteristics; 2) case study method attitudes; 3) pretest-post test case study method attitude comparisons; 4) student attitudes toward the experiment case study; and 5) recommended changes in the experiment case study.

Response frequency counts, the Mann-Whitney U test, and the Kendall Rank Correlation Coefficient Test were used to examine the data. Where appropriate, relationships were statistically tested using a .10 one-tailed critical level. The use of the term significant in the text denotes a relationship tested and found to be statistically significant at the .10 level.

Student Demographic and Experience Characteristics

Students in the course selected for the experiment were extremely homogeneous with respect to the limited amount of demographic information collected by the questionnaires. Tables 14, 15, and 16, Appendix D, present the detailed findings of the analysis. All of the students were seniors and were registered for seven or more credit hours. Ninety-six per cent of the students were Marketing Management majors, and all but one were undergraduates.
Students in Section A reported significantly higher overall point-hour averages in Marketing than Section B students. Also, the marketing point-hour average variable was positively and significantly related to the profit-based performance criteria. However, no significant differences were found between the two sections in terms of the performance criteria measures.

Approximately 35 per cent of the students reported having no previous computer experience of any type. Approximately 40 per cent had time-sharing terminal experience, and 45 per cent had played a computerized decision game. Students in Section B were significantly less likely to have had time-sharing terminal experience than students in Section A.

In terms of case study experience, almost 90 per cent of the students had used cases in their course work, and 34 per cent reported having taken a case study course. Section A students reported a significantly higher median experience percentage for previous case analysis experience.

Correlation analysis of the demographic variables with the performance criteria indicated that the marketing point-hour average was positively and significantly related to the profit-based criteria for Section A, but not for Section B. In addition, previous computer decision simulation experience was positively and significantly related to all three performance criteria for Section A students, and was negatively and significantly related to the
profit-based criteria for Section B students. However, none of the correlation relationships "explained" more than 15 per cent of the variance in any of the performance criteria.

Analysis of the learning environment groups with respect to the demographic and attitude variables indicated that the groups were essentially comparable.

**Student Attitudes Toward Case Analysis**

Tables 17 and 18, Appendix D, present the results of the analysis focused on student attitudes toward the case study method. Students' attitudes toward the case study method were highly positive; ninety-three per cent indicated that the case method is a useful supplement for most courses. Written assignments in conjunction with case studies were reported to be highly beneficial in motivating students to identify key problems and to conduct a comprehensive analysis. Major problems with the case study method include inadequate discussion and resolution of case assignments, the inability to implement and test a solution or strategy, and a perceived lack of information about the available alternatives.

Significant attitude differences between students in the two sections were noted with respect to preference for team versus individual analysis, perception of adequacy of case information, and satisfaction with case discussion and resolution. Almost 60 per cent of the students agreed that they would prefer to work with a team on a case assignment and that most case studies do not contain enough
information to make a reasoned analysis of the alternatives. Students in Section A were significantly more likely to agree with the above statements. Only 28 per cent indicated that they were usually satisfied with the final disposition of a case assignment, with Section B students indicating significantly less satisfaction with case assignment resolution procedures than Section A students.

The response analysis of the case study method attitude questions revealed a number of significant differences in the response patterns among the learning environment groups. One or more significant differences in the median response value for each of the case study method attitude questions were noted. Analysis of the data did not indicate whether the differences could be attributed to performance on the case study or to the differences in the learning environments used for the experiment. This point is developed further with respect to the comparative analysis of Section A pretest-post test case study method attitudes.

**Comparative Analysis of Pretest-Post Test Case Study Method Attitudes**

A comparative response analysis was conducted of the pretest-post test case study method attitudes questions answered by Section A students. Tables 19 and 20, Appendix D, contain the results of the analysis. Although the response percentages were not statistically tested, the agreement percentages were relatively constant for most
questions, and usually varied by five or less percentage points. Noted exceptions include the following: a 12 point increase in the agreement percentage concerning the preference for team analysis on case study assignments; a 7 point increase in the agreement percentage that the students prefer a case study that focuses on one or two specific topics; and a 43 point decrease in the agreement percentage that the students are usually satisfied with the resolution and disposition of conventional case study assignments.

In general, the post test responses by Section A and Section B students with respect to the three categories noted above were essentially identical with the exception of the team analysis preference. Students in Section A showed a 25 percentage point preference for team analysis of case assignments—69 per cent versus 44 per cent. The relative similarity of the response patterns between the sections indicates that the pretest did not effect the attitudes of Section A students.

**Student Attitudes Toward the Experiment Case Study**

Tables 21 and 22, Appendix D, present the results of the analysis of student attitudes toward the case study. The case study was viewed as a valuable contribution to the course by 55 per cent of the students. However, improvements are needed in the case study materials, and the need for a demonstration of the time-sharing system was indicated. A majority of the students agreed that the current level of complexity of the case study, i.e., number of decision
variables, should be maintained, and that the case study should continue to be noncompetitive. However, there were significant differences in the course sections' attitudes toward these questions. Section A students tended to have more positive attitudes toward decreasing the complexity of the model, while Section B students were more positive toward making the simulation model competitive.

Approximately half of the students agreed with the statement that the information feedback from the model was not sufficient for effective decision-making. The response to this question varied significantly between the sections and among some of the learning environment groups. In particular, students in Section A were more likely to agree that the information feedback level was not adequate for decision-making purposes. The learning environment group ranks in terms of agreeing that the information feedback level was not sufficient were as follows, with the highest level of agreement listed first: \( \chi_4, \chi_2, \chi_3, \chi_1 \). Groups receiving limited information—\( \chi_4 \) and \( \chi_2 \)—were significantly more positive in perceiving the information to be inadequate. Also, students receiving limited information and not required to submit a written assignment, i.e., \( \chi_4 \), were significantly less satisfied with the information feedback than any other group.
Student Recommendations About the Case Study

After the completion of the experiment, students were asked to indicate what changes they would make in selected aspects of the case study simulation model. The response tabulations are presented in Tables 23 and 24, Appendix D. Students indicated a desire to gain more experience with the case study. In general, students reported that they would retain the one-quarter basic operating period of the model, but would increase the number of quarters of play. Approximately 60 per cent would retain the same number of decision variables per period, while 39 per cent would decrease the number of decision variables. Only 10 per cent of the students recommended not using the time-sharing system to operate the model. Approximately 40 per cent recommended using teams to complete the assignment in the future.

The students were also asked to recommend how often the simulation program should report the status of selected model variables in the Weekly Operations Report. Thirty per cent recommended issuing status reports more frequently; fifty-seven per cent recommended the five-day reporting cycle currently programmed in the model; and eleven per cent would lengthen the time between summary reports.

Summary

The chapter presented the empirical findings of the study with respect to the research hypotheses and to the
analysis of student demographic, experience, and attitude characteristics. The four major research hypotheses were tested with respect to three data groups, using three criterion values as indicators of decision-making effectiveness. Additional data analysis activities were undertaken to analyze student demographic, experience, and attitude data for findings which might supplement the results of the research hypotheses tests. In particular, differences in the attitude, experience, and demographic variables between the course sections and among the learning environment groups were examined to provide a basis for relating differences in the hypothesis test results by section and by learning environment to the characteristics of the groups.
CHAPTER V

CONCLUSIONS AND IMPLICATIONS FROM THE STUDY

Brief Summary of the Study

The increasing pressures to improve the productivity and effectiveness of the educational process coupled with the recent emphasis on individualized instruction will force educators to increasingly rely on computer-based instruction systems in the 1970s. However, the development and effective utilization of computer-based education systems must be based on accurate theoretical and experimental foundations concerning how people learn. Basic research on all facets of the learning process is necessary to provide the required foundation and structure for the development of effective computer-based instructional systems.

Business educators and management trainers have used one form of computer-assisted instruction since the mid-1950s: the decision simulation or business game. A decision simulation is essentially a case study combined with a computerized simulation model. The case study provides the setting and participant roles and the simulation model determines the results of the various decision
strategies. Therefore, the participants can gain various
types of experience in a synthetic but dynamic environment.

Despite the widespread use of and positive attitudes
toward decision simulations, little research has been done
to provide guidelines for designers and administrators of
simulation exercises concerning the implications of various
design and implementation decisions on student performance,
attitudes, and satisfaction. Additional research must be
conducted to explore and to realize the instructional
potential of decision simulations.

The primary purpose of the study was to conduct
exploratory research concerning the effect(s) of selected
decision simulation design and administrative character­
istics on student decision-making effectiveness. Specif­
ically, the research focused on the effect(s) and inter­
actions of two principal elements of the learning environ­
ment of a decision simulation: 1) the amount of infor­
mation feedback from the simulation model, and 2) the
submission of written assignments focused on the rationale
for student decision strategies. Student decision-making
effectiveness was defined in terms of three performance
criteria: Annual dollar revenue; annual dollar profit; and
annual profit as a per cent of annual revenue. The research
was conducted with a computer-assisted case study designed
for the research and used as an individual assignment in a
case study course.
A secondary purpose of the research was to evaluate the educational and research potential of the type of case study used for the research. The case study was a specific type of decision simulation classified as a concept simulation. A concept simulation focuses on one or a few concepts within a functional area with the objective of allowing the participant to develop and/or test his understanding of the concepts represented in the model. Concept simulations are essentially an intermediate step between frame-by-frame programmed instruction exercises and the complex, competitive-environment decision simulations widely used in business and management training.

The case study developed for the research focused on selected aspects of inventory management in a retail store setting. Each student participant assumed the role of store manager. The objective of the exercise was to improve the store's profitability by improving the inventory review and ordering decision rules to increase the in-stock position and by controlling expenses relative to sales revenue. The simulation model enabled the student to simulate the effect(s) of his decision strategy on the financial and operating performance of the store.

Two levels of information feedback—Full and Limited—and two levels of written assignment requirements—written assignments required and written assignments not required—were used to define the four learning environments used for
the experiment. A separate-section, pretest-post test cross-sectional experimental design was used to provide the statistical framework and controls for the study.

A senior-level, two-section Marketing Management case study course was judgmentally selected for the experiment. Eighty-five students were enrolled in the course at the start of the experiment; seventy-four students completed all of the simulation runs and questionnaires and were included in the research data base of the study. Each student in the course was randomly assigned to complete the case study within one of the four learning environments. The case study was assigned as an individual project to be completed independently within a two-week period of time.

The case scenario defined the student's role as that of a newly-appointed store manager for a retail outlet experiencing inventory control problems. The student's objective was to define an effective and efficient inventory ordering and review strategy by the end of four quarters of simulated operation.

The simulation model was programmed for the time-sharing terminal system at The Ohio State University. Each student completed five simulation sessions with the model. The first session was a practice run to familiarize the student with the operation of the time-sharing terminal and the simulation model. Each of the next four simulation sessions represented one quarter's operation of the retail
store represented in the case study. After the initial in-class briefing on the case study, each student worked independently within the two-week time period to formulate and simulate his decision strategies.

Four major hypotheses were defined for the study. Each hypothesis was designed to provide a unique perspective on the influence, if any, of the experimental variables on student decision-making effectiveness. Each hypotheses was tested with respect to the three performance measures—annual dollar revenue, annual dollar profit, and profit as a per cent of revenue—and to the three data groups—Section A only, Section B only, and both sections combined—defined for the study.

The research hypotheses and the results of the statistical tests are presented in Chapter IV and summarized in the following sections of this chapter. The hypothesis tests were conducted using nonparametric statistical procedures. In particular, the Mann-Whitney U test was used to analyze the research hypotheses data for significance. The Kendall Rank Correlation Coefficient, the Mann-Whitney U test, and frequency count programs were used to analyze the student demographic, experience, and attitude data collected to supplement the results of the research hypothesis tests.
Conclusions Regarding the Research Hypotheses

The objectives of this section are to briefly review the results of the statistical tests of the research hypotheses and to formulate conclusions concerning the influence, if any, of the experimental variables on student performance. Each major or supplementary hypothesis was analyzed with respect to the three data groups of the experiment—Section A results, Section B results, and combined results—and to the three performance criteria established to measure decision-making effectiveness—dollar sales revenue, dollar profit, and profit as a percent of revenue.

Each research hypothesis was designed to provide a unique perspective concerning the possible influence(s) of the experimental variables on decision-making effectiveness. Each hypothesis was constructed in statistical null form, i.e., it asserted that there were no statistically significant differences between or among the groups being compared. All tests were conducted with the Mann-Whitney U statistic and used a .10 one-tail critical level for rejection of the null hypothesis.

The discussions of the test results are focused primarily on the individual course section results and on the results with respect to the profit-based criteria. The primary function of the combined sections data group was to
provide a benchmark against which differences in the two sections could be compared. The primary objective of the dollar sales revenue criterion was to determine if the profit results were greatly influenced by the level of sales revenue.

The discussion of each research hypothesis is developed in the following sequence: 1) a brief statement of the objective(s) of the hypothesis; 2) the statement of the hypothesis; 3) a brief summary of the results of the statistical tests; and 4) conclusions concerning the implications of the results in terms of the experimental variables. The final paragraphs of this section present the general conclusions and implications drawn from the test results.

**General Learning Environment Effects on Decision-Making Effectiveness**

The objective of the first major research hypothesis was to provide a broad overview of the performance variations between the course sections and among the learning environment groups used in the experiment. The tests were concerned with determining 1) the median performance rankings of the learning environments and 2) the presence of one or more statistically significant differences in group ranks. The identification of specific inter-group
differences and the implications thereof was reserved for the remaining hypotheses.

**H.1** There are no significant differences among the median performance scores for the four learning environments.

The hypothesis was examined with respect to the three data groups and the three performance criteria, a total of nine tests. Table 1, Chapter IV, and Table 10, Appendix D, contain the general and detailed summaries, respectively, of the analysis. The results of the nine hypotheses tests are presented in Table 5.

**TABLE 5.**—Hypothesis H.1 test results summary

<table>
<thead>
<tr>
<th>Section(s)</th>
<th>Performance Criteria</th>
<th>Annual Revenue ($)</th>
<th>Annual Profit ($)</th>
<th>Profit/Revenue (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ranked Performance Scores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>(X_4-X_2-X_3-X_1)(^b^c)</td>
<td>(X_1-X_3-X_2-X_4)</td>
<td>(X_1-X_2-X_3-X_4)</td>
<td></td>
</tr>
<tr>
<td>A Only</td>
<td>(X_2-X_4-X_3-X_1)(^c)</td>
<td>(X_2-X_3-X_1-X_4)(^c)</td>
<td>(X_2-X_3-X_4-X_1)(^c)</td>
<td></td>
</tr>
<tr>
<td>B Only</td>
<td>(X_1-X_4-X_2-X_3)</td>
<td>(X_1-X_3-X_4-X_2)(^c)</td>
<td>(X_1-X_3-X_4-X_2)(^c)</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Table values indicate the group or groups having higher median performance, in order from left to right.

\(^b\)\(P < .10\).

\(^c\)\(P < .05\).

The null hypothesis was not supported in five of the six tests focused on the individual results of the two
sections. One or more significant differences were noted for all three performance criteria for Section A. Section B test results indicated one or more significant differences were found with respect to both of the profit-based performance criteria.

Within each section, learning environment group performance ranks were relatively consistent across the performance measures, but the influence of the experimental variables was not consistent. Specifically, Section A group performance ranks were consistent, but did not reflect a consistent influence for either of the experimental variables. In Section B, the group ranks were also consistent, but indicated that full information feedback of the store's financial and operating results exerted a positive influence on performance.

A comparative analysis of performance ranks between sections indicated that the groups not submitting written assignments exhibited a stable pattern of median rank performance. The "no written assignment" groups receiving full information ranked second in both sections and achieved higher median performance with respect to the profit-based criteria than the "no written assignment--limited information" groups.

However, groups submitting written assignments exhibited extremely volatile ranked performance shifts between sections and relatively stable ranked performance
patterns within sections for all three measures of performance. In particular, the group receiving full information and submitting written assignments dominated the performance rankings in Section B, while the similar group in Section A was last or next to last in all three performance measures. The limited information--written assignment group ranked first in all performance measures in Section A, while the similar group ranked last or next to last in all performance measures in Section B.

In summary, the test results of the first hypothesis indicate that the experimental variables were statistically significant influences on decision-making effectiveness on the case study assignment. However, the comparative analysis indicated that the relationships between the experimental variables and decision-making effectiveness were not consistent between the two sections. In particular, no clear pattern existed with respect to the variable-performance relationships in Section A, while full information was associated with higher median profit-based performance in Section B. The second major research hypothesis, discussed below, focused specifically on the information--written assignment dichotomy.

Dominance Analysis of the Experimental Variables

The objective of the second major hypothesis was to determine if one of the experimental variables dominated the
other with respect to its impact on decision-making effectiveness, i.e., was one variable more influential irrespective of the level of the other variable?

H.2 There are no significant differences in median performance scores between the learning environments when they are grouped and examined with respect to:

1. Full information vs. limited information.
2. Written assignments vs. no written assignments.

Both the full versus limited information groups and the written versus no written assignment groups were examined with respect to the three data groups and to the three performance criteria, a total of 18 tests. Table 2, Chapter IV, and Table 11, Appendix D, contain the general and detailed summaries, respectively, of the analysis. The results of the 18 hypothesis tests are presented in Table 6.

The null hypothesis was not supported for five of the six individual section tests focused on the effect of different levels of information feedback on performance. Specifically, Section A groups that received limited information achieved significantly higher median performance on all three criteria than the full information groups. In Section B, the pattern was reversed for the profit-based criteria, i.e., the groups that received full information achieved significantly higher performance than the limited information groups.
TABLE 6.—Hypothesis H.2 test results summary

<table>
<thead>
<tr>
<th>Section(s)</th>
<th>Performance Criteria</th>
<th>Performance Criteria</th>
<th>Performance Criteria</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Annual Revenue ($)</td>
<td>Annual Profit ($)</td>
<td>Profit/Revenue (%)</td>
</tr>
<tr>
<td>Full Information (X1,X3)—Limited Information (X2,X4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>(X2,X4)</td>
<td>(X1,X3)</td>
<td>(X1,X3)</td>
</tr>
<tr>
<td>A Only</td>
<td>(X2,X4)</td>
<td>(X2,X4)</td>
<td>(X2,X4)</td>
</tr>
<tr>
<td>B Only</td>
<td>(X2,X4)</td>
<td>(X1,X3)</td>
<td>(X1,X3)</td>
</tr>
<tr>
<td>Written Assignment (X1,X2)—No Written Assignment (X3,X4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>(X3,X4)</td>
<td>(X1,X2)</td>
<td>(X1,X2)</td>
</tr>
<tr>
<td>A Only</td>
<td>(X3,X4)</td>
<td>(X1,X2)</td>
<td>(X1,X2)</td>
</tr>
<tr>
<td>B Only</td>
<td>(X1,X2)</td>
<td>(X1,X2)</td>
<td>(X1,X2)</td>
</tr>
</tbody>
</table>

aTable values indicate the group or groups having higher median performance.

b \( p < .10 \)

c \( p < .05 \)

The null hypothesis was supported for all nine tests focused on performance differences between written assignment and no written assignment groups. In Section A, written assignment groups had generally higher dollar and per cent profit performance, but lower sales revenue. In
Section B, written assignment groups achieved generally higher median performance in all three criteria categories.

In summary, level of information feedback significantly influenced decision-making effectiveness on the case study assignment, although with differing effects between the two sections. Full information was positively associated with high performance in Section B, and was negatively associated with high performance in Section A. Written assignment requirements were associated with higher performance in both sections, but the differences between performance ranks were not statistically significant.

The Effect(s) of Information Feedback on Decision-Making Effectiveness

The objective of the third major hypothesis was to determine the influence of level of information feedback on performance, given a common level of the written assignment requirement.

H.3 There are no significant differences in median performance scores between learning environments having different levels of information feedback and a common level of written assignment requirements, as follows:

1. Full vs. limited information: Written assignment.

2. Full vs. limited information: No written assignment.
Each of the two groupings defined in hypothesis H.3 was examined with respect to the three data groups and to the three performance criteria, a total of 18 tests. Table 3, Chapter IV, and Table 12, Appendix D, contain the general and detailed summaries, respectively, of the analysis. The results of the 18 hypothesis tests are presented in Table 7.

TABLE 7.—Hypothesis H.3 test results summarya

<table>
<thead>
<tr>
<th>Section(s)</th>
<th>Performance Criteria</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Annual Revenue ($)</td>
<td>Annual Profit ($)</td>
</tr>
<tr>
<td>Full (X1)—Limited Information (X2): Written Assignment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>X2</td>
<td>X1</td>
</tr>
<tr>
<td>A Only</td>
<td>X2c</td>
<td>X2c</td>
</tr>
<tr>
<td>B Only</td>
<td>X1</td>
<td>X1c</td>
</tr>
<tr>
<td>Full (X3)—Limited Information (X4): No Written Assignment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>X4</td>
<td>X3</td>
</tr>
<tr>
<td>A Only</td>
<td>X4</td>
<td>X3</td>
</tr>
<tr>
<td>B Only</td>
<td>X4</td>
<td>X3</td>
</tr>
</tbody>
</table>

aTable values indicate the group or groups having higher median performance.

bP < .10.

cP < .05.

The null hypothesis was not supported for five of the six tests focused on performance differences between full and limited information groups submitting written assignments in the two course sections. In Section A, the limited
information group achieved significantly higher performance in all three performance measures. In Section B, the full information group achieved generally higher sales revenue and significantly higher dollar and per cent profits.

The null hypothesis was supported for all of the tests focused on performance differences between groups receiving different levels of information feedback and not submitting written assignments. In both sections, the group receiving limited information achieved generally higher sales revenue and generally lower dollar and per cent profit levels than the full information group.

In summary, Section A students that submitted written assignments made more effective decisions when receiving limited information, while Section B students submitting written assignments made more effective decisions when receiving full information. In both sections, the full information—no written assignment groups achieved generally higher profit performance than the limited information—no written assignment groups.

The Effect of Written Assignment Requirements on Decision-Making Effectiveness

The objective of the fourth major hypothesis was to determine the influence of written assignment requirements on decision-making effectiveness, given a common level of information feedback.
H.4 There are no significant differences in median performance scores between learning environments having different written assignment requirements and a common level of information feedback, as follows:

1. Written vs. no written assignments: Full information.
2. Written vs. no written assignments: Limited information.

Each of the two groupings defined in hypothesis H.4 was examined with respect to the three data groups and to the three performance measures, a total of 18 tests. Table 4, Chapter IV, and Table 13, Appendix D, contain the general and detailed summaries, respectively, of the analysis. The results of the 18 hypothesis tests are presented in Table 8.

The null hypothesis tests with respect to the influence of written assignments on groups receiving full information indicated significant differences between the two sections. In Section A, the full information--no written assignment group achieved significantly higher sales revenue levels and generally higher profit performance than the full information--written assignment group. In Section B, the full information--written assignment group achieved generally higher sales revenue and significantly higher profit performance than the full information--no written assignment group.
TABLE 8.—Hypothesis H.4 test results summary

<table>
<thead>
<tr>
<th>Section(s)</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual Revenue ($)</td>
</tr>
<tr>
<td>Written (X1)—No Written (X3) Assignments: Full Information</td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>X3</td>
</tr>
<tr>
<td>A Only</td>
<td>X3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>B Only</td>
<td>X1</td>
</tr>
<tr>
<td>Written (X2)—No Written (X4) Assignments: Limited Information</td>
<td></td>
</tr>
<tr>
<td>A and B</td>
<td>X4</td>
</tr>
<tr>
<td>A Only</td>
<td>X2</td>
</tr>
<tr>
<td>B Only</td>
<td>X4</td>
</tr>
</tbody>
</table>

<sup>a</sup>Table values indicate the group or groups having higher median performance.

<sup>b</sup><sub>p</sub> < .10.

<sup>c</sup><sub>p</sub> < .05.
The null hypothesis was supported with respect to all tests focused on performance differences between groups that received limited information and that experienced different levels of written assignment requirements. In Section B, the no written assignment—limited information group achieved generally higher performance on all three criteria. In Section A, the group that submitted written assignments achieved generally higher performance on all criteria than the no written assignment group.

In summary, the results of these tests confirm earlier indications that the response of the two sections to differences in levels of the treatment variables was dissimilar. In Section A, full information resulted in generally higher performance levels only when a written assignment was not required. In Section B, full information used in conjunction with written assignments was associated with significantly higher profit performance levels. Between groups receiving limited information, Section A students generally performed better when required to submit written assignments, while Section B students generally performed better when not required to submit written assignments.

**General Summary and Conclusions**

The results of the hypothesis tests provide the basis for the following conclusions concerning the influences of
the experimental variables on student decision-making effectiveness on the case study assignment:

I. Significant differences in decision-making effectiveness were noted which can be attributed to the influence of the experimental variables.

II. The impact and effect(s) of the variables differed significantly between the two sections of the course.

III. In both sections, level of information feedback from the simulation model exerted the predominant influence on decision-making effectiveness.

IV. The effect of level of information was significant only when combined with submission of written assignments.

A. In section A, the limited information--written assignment group achieved significantly higher performance in all respects than the full information--written assignment group.

B. In Section B, the full information--written assignment group achieved significantly higher performance in all respects than the limited information--written assignment group.

C. In both sections, performance differences between groups that received different levels
of information feedback and that were not required to submit written assignments were not significant.

Conclusions Regarding Other Findings of the Research

The objectives of this section are to summarize and to draw conclusions from the other findings of the study. The section is divided into three subsections: Participant demographics, experience, and case study method attitudes; participant attitudes toward and recommendations concerning the experiment case study; and a general summary and conclusions.

Participant Demographics, Experience, and Case Study Method Attitudes

The demographic and experience profiles of the two sections were essentially comparable. Significant but numerically small differences were noted with respect to case study experience and to previous experience with time-sharing systems. Section A students reported significantly higher marketing point-hour averages, and their performance on the case study was positively and significantly associated with their point-hour averages. There was no relationship between performance and grades for Section B students.

Almost 90 per cent of all students had some form of case analysis experience and 34 per cent had taken a case
study course. Of the nine students that reported no previous case analysis experience, all were in Section B. Despite the differences noted above, no significant differences between the two sections were noted with respect to the performance criteria.

Student attitudes toward the case study method were measured on the post test questionnaires and were highly positive. Over 90 per cent indicated that case analysis was a useful supplement in most courses. Written assignments in conjunction with case assignments were reported to contribute to better problem identification and to more comprehensive analysis. Most students indicated they were dissatisfied with the discussion and resolution of most case assignments, the amount of information contained in cases, and the inability to "test" a solution or strategy. Students in Section B were more likely to prefer working alone on a case, to perceive case information as being adequate for analysis, and to be dissatisfied with case discussion and resolution.

The learning environment groups were comparable in terms of the demographic and experience variables used in the study. However, analysis of the Section A pretest case method attitudes questions revealed a number of significant attitude differences among the learning environment groups. Analysis of the combined sections post test questionnaires revealed significant attitude differences among learning environment groups for each of the case method attitude
questions. Some of these differences existed among the learning environment groups in Section A prior to the experiment. However, it was not possible to analyze these differences with respect to the experiment because 1) no pretest attitude measures were taken for Section B students and 2) the students completed a number of conventional case study class assignments during the span of the research.

The pretest-post test case method attitudes of Section A students were relatively stable, with two exceptions: A 12 point increase occurred in the agreement percentage concerning the preference for team analysis on case assignments; and a 43 point decrease occurred in the agreement percentage that the students are usually satisfied with the resolution and disposition of conventional case assignments, i.e., many Section A students were much less satisfied with the feedback on conventional case studies after completing the experiment case study.

In summary, demographic and experience characteristics were essentially comparable between sections and among the learning environment groups. Some differences were noted in case method attitudes by section and numerous differences were noted among the learning environments. The data were not adequate to provide relationships concerning possible influences of the experiment case study on student attitudes toward the case study method. However, students in Section A were notably less satisfied with the resolution
and disposition of conventional case assignments after completing the experiment case assignment.

**Participant Attitudes Toward and Recommendations Concerning the Experiment Case Study**

The case study was viewed as a valuable contribution to the course by 55 per cent of the students. However, improvements are needed in the case study materials, and the need for a demonstration of the time-sharing system was indicated. Most students agreed that the current level of complexity and the non-competitive nature of the model should be maintained.

Approximately half of the students agreed that the information feedback from the model was not sufficient for effective decision-making. The learning environment groups that received limited information was significantly less satisfied with the feedback level of the model than the other groups, while the full information-written assignment group was the most satisfied with the feedback level.

Over 50 per cent of the students indicated a desire to increase the number of decision periods to gain more experience with the model. Sixty per cent indicated that they would retain the types and number of decision variables currently implemented in the model, and 90 per cent recommended using the time-sharing system to complete the assignment. Less than half the students recommended using teams to complete the case study.
The overall thrust of the students' attitudes and recommendations indicated that the case study provided a positive learning experience for most students. Improvements in the case materials, an increased number of decision periods, and a formal demonstration of the time-sharing system should improve its education contribution and research potential in the future.

General Summary and Conclusions

The objective of this section was to present additional information gathered during the research which might help to clarify, supplement, or explain the results of the hypotheses tests. The following conclusions are presented with respect to this section:

1. There were no significant differences in demographic and experience factors among the four learning environment groups defined for the study, although some differences were noted between the course sections.

2. There were significant differences between the sections with respect to case study method attitudes, particularly with respect to preference for team analysis, perceived adequacy of case information, and satisfaction with case discussions and resolution.
3. The experiment case study may have significantly and negatively affected Section A students' reported satisfaction with the feedback received on conventional case study assignments. In analyzing the pretest-post test case method attitudes questions, Section A students agreeing or strongly agreeing that they were satisfied with the feedback received on conventional case studies decreased from 36 per cent on the pretest to 2 per cent on the post test. The percentage disagreeing or strongly disagreeing with this statement increased from 7 per cent on the pretest to 50 per cent on the post test.

4. Most students would have preferred to gain more experience with the case study. The practice session and the four decision periods may not have been sufficient to allow many students to develop a satisfactory decision strategy.

5. With respect to perceived adequacy of information feedback from the model, the experimental variables were associated with significant perceptual differences among the learning environment groups.
Conclusions and Implications of the Study

Chapter II presented the findings of the literature search undertaken to provide a foundation for the research. Theoretical, observational and research citations were presented to define and explore the role of the learning environment in the learning process, with particular emphasis on decision simulation exercises. The research findings of the study both confirm and extend these literature discussions concerning the importance of the learning environment with respect to decision-making effectiveness and to participant attitudes and perceptions.

In general, the research results revealed a number of significant differences in decision-making effectiveness which could be attributed to variations in the learning environment of the decision simulation. In addition, the simultaneous replication of the experiment in two sections of the same course provided a statistical control dimension for the experiment which led to the conclusion that the observed learning environment influences were not dependent upon a particular classroom environment to be effective.

The results of the study extend the literature by providing experimental data on the observed performance differences associated with specified variations in the learning environments. Of greater interest, however, the analysis revealed that two particular learning environments
replicated in two sections had similar levels of influence on performance, but opposite effects. However, the data gathered for the experiment was not sufficiently comprehensive or properly structured to determine the reasons for this difference.

The level of information feedback from the simulation model was the primary environmental influence on performance. However, the use of written assignment requirements contributed substantially to the influence of level of information feedback on performance. In general, most performance differences between groups receiving different information feedback levels and submitting written assignments were statistically significant, while performance differences between groups receiving different information feedback levels and not submitting written assignments were not statistically significant.

Few specific conclusions can be formulated with respect to the relationships among demographic, experience, and attitude variables and performance on the case assignment. However, significant differences in some of these variables were observed between the course sections and among the learning environments. In particular, Section A students reported significantly higher marketing point-hour averages, and their performance on the case study was positively and significantly correlated with their point-hour average. However, no grade-performance relationship was found for Section B students. One conclusion
tentatively supported by the pretest-post test attitudes analysis is that students using a simulation-based case study may become disenchanted with the static environment and nebulous resolution procedures associated with conventional case study assignments.

A secondary objective of the study was to explore the instruction and research potential of concept simulations. Despite the exploratory nature of and judgmental basis for the design characteristics of the case study, no fundamental problems were encountered during the implementation of the experiment.

Student comments and observational data indicate that the students enjoyed the relative freedom of scheduling their own activities in connection with the case. Also, students readily accepted the fact that differences in information levels and written assignment requirements were part of the case. Student apprehension about the differential performance implications of full versus limited information levels was satisfied by computing grades on the basis of achieved performance within each learning environment group.

Student recommendations concerning the number of decision periods programmed in the model indicated that the development of a satisfactory decision strategy may require more than four quarters of operation. The primary implication is that the full effects of the experimental
variables may not have been realized within the number of
decision periods used for the experiment.

The use of time-sharing terminals to run the model
was enthusiastically supported by students, but some
complaints were voiced concerning terminal availability
during the more popular late morning and early afternoon
periods. The simulation program recorded the length of the
terminal sessions for each student. In general, the simu-
lation sessions for students not typing in a management
memorandum or receiving the third report from the model took
about 11-12 minutes. Students entering a memorandum and
receiving the additional report required about 20 minutes
per session. However, the model was programmed to provide
relatively constant activity—either student data entry or
model output—at the terminal, and no indications were
received that the simulation sessions were too long to
maintain student interest.

In summary, the experiment indicated that concept
simulations seem to be a viable instruction and research
methodology. However, careful attention to the design and
application aspects of the exercise will be required to
realize its potential.

In Chapter I, the five contributions listed for the
study focused on using an experimental or exploratory
approach to provide additional data on the learning
environment as a determinant of student decision-making effectiveness and on the use of individualized, computer-based decision simulations as an instruction and research methodology. However, from a broader perspective, the primary philosophical thrust of the study was concerned with the promulgation of an educational philosophy based on expanding the active role of the student in the learning process. An important but heretofore unstated conclusion of the study is that students seem to be well aware of the aspects of a learning situation which contribute to and which detract from the value of the experience from their individual points of view.

In the experiment, each student was master of his own destiny only in a very limited sense, i.e., with respect to scheduling terminal sessions and to defining his decision strategies. All of the remaining dimensions of the case study were defined and controlled—arbitrarily and judgmentally—by the researcher. However, as indicated by the student recommendations concerning the experiment case study, a wide diversity of opinion existed as to how each student felt the case study could be most effectively used.

It seems evident that, for many types of educational processes, it is probably impossible to predefine all or most of the relevant characteristics of the learning environment such that most or all of the students are operating in
individually-satisfying or optional learning situations. The challenge to education is to determine how to integrate the talents, abilities and interests of individual students into a learning situation--within a computer-based or a conventional classroom environment--while retaining the basic sense of direction and purpose necessary to realize educational objectives.

Suggestions for Further Research

The nature and results of the experiment and the student recommendations about the case suggest a number of research studies which would supplement, strengthen, and extend the findings reported here. The following suggestions are focused on experimental replication studies which could be conducted with the case study and simulation model developed for the research. The development and experimental applications of other types of concept simulation exercises is an obvious, but unstated, alternative.

The most basic suggestion is to conduct a full replication of the study using the same or similar questionnaires, the same version of the simulation model and case study, and the same experimental design. This strategy recognizes but ignores many of the limitations and problems reported here in favor of providing a parallel data base under conditions which closely duplicate the original environment of the study.
Additional research should be conducted on the role of student characteristics—demographics, experience, attitudes, and so on—as determinants of or influences on decision-making effectiveness. A crucial question to be answered here is whether there are key variables which are associated with differences in decision-making effectiveness within different types of learning environments.

Research focusing on the impact of the design characteristics of the model should be conducted. To facilitate research in this area, the design objectives of the simulation model were defined to enable the researcher to change any or all characteristics of the model easily and quickly, in most cases with no programming required. Suggested areas of concentration include: The number of decision variables; the number of decision periods; enforced delay periods between simulation sessions; options to purchase additional information; and changes in demand, cost and time parameters to simulate different environments.

The research directions discussed above should also be implemented in non-student environments, such as executive development programs.

Given the current level of knowledge about the learning process, decision-making, and the design and administration of computer-based decision simulations, any research work which is conducted under relatively strong experimental
controls and is reported to interested persons will provide a valuable addition to the small but developing research literature on computer-based decision simulation instruction.

Summary

The objective of this chapter was to provide a comprehensive overview of the research objectives, the experimental results, and the conclusions and implications drawn from the study. The chapter first presented a brief review of the background, purpose, and methodology of the study. Each of the major research hypotheses was then discussed in terms of research objectives, summary of results, and conclusions and implications. The third section focused on the other findings of the study and the conclusions and implications based on the analysis. The fourth section contained a comprehensive summary of the conclusions and implications of the study. The last section discussed directions for future research suggested by the findings of the study.
APPENDIX A

Questionnaires
INTRODUCTION

The experimental design of the study was implemented using questionnaires to gather data concerning the following categories: Selected student demographic characteristics; student computer and case study experience; student case study method attitudes; student experiment case study attitudes; and student recommendations about the experiment case study.

The pretest questionnaire for Section A collected the following information: demographic characteristics; computer and case study experience; and case study method attitudes. The post test questionnaire for Section A collected the following information: a repeated survey of student case study method attitudes; student experiment case study attitudes; and student recommendations about the experiment case study.

No pretest questionnaire was used for Section B. Therefore, the post test questionnaire form collected all of the demographic, experience, attitudes, and recommendations data listed in the first paragraph of this section.

The three questionnaire forms are presented in the following pages of this appendix.
Exhibit VIII

Section A Pretest Questionnaire

The purpose of this questionnaire is to survey student opinion about selected aspects of the O.S.U. Administrative Science program. Your responses will be combined with the responses of the other students completing the questionnaire, and will provide the data necessary for the statistical analysis phase of the project. Your name and student number are necessary to provide a tabulation key and to provide longitudinal continuity to the study. However, all questionnaire data will remain confidential, and only the composite statistical summary of the responses will be released.

I will appreciate your cooperation.

William Sargent
NAME: ___________________________ STUDENT I.D. NUMBER: ___________

Academic Class (check one):

_____ Freshman _____ Sophomore _____ Junior _____ Senior

_____ Graduate Student

Student Status this quarter (check one):

_____ Full-time (registered for 7 or more credit hours)

_____ Part-time (registered for 6 or less credit hours)

Major Field of Study (check one):

_____ Accounting

_____ Finance

_____ Management Science

_____ Marketing

_____ Public Administration

_____ Other please specify ____________________________

Overall point-hour average in major field of study (check one): 

_____ under 2.0 _____ 2.01-2.50 _____ 2.51-3.00 _____ 3.01-3.50

_____ 3.51-4.00

Overall point-hour average for all coursework during last 3 quarters (check one):

_____ under 2.0 _____ 2.01-2.50 _____ 2.51-3.00 _____ 3.01-3.50

_____ 3.51-4.00

Degree Program (check one):

_____ Bachelor's _____ Master's _____ Ph.D. _____ Non-degree

Number of the course in which you are completing this form: __________
Please check the appropriate response to each of the following questions, based on your experience prior to this quarter.

**COMPUTER EXPERIENCE:**

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I have written and tested ("debugged") a computer program.

I have used an existing computer program (BIMED statistical package, regression program, etc) to analyze a problem or case study.

I have taken a course or part of a course using computer-assisted instruction on a time-sharing terminal.

I have played a business or similar type of computerized decision game.

I have used a time-sharing terminal.

I have had no previous computer experience.

**CASE STUDY EXPERIENCE:**

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
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</table>

I have taken one or more courses in which case problems were used to illustrate the concepts presented in the course.

I have taken one or more courses consisting entirely of case problems, i.e., no new concepts or material was introduced.

I have not had any experience with case problem assignments.

**COMPUTER AND CASE STUDY EXPERIENCE THIS QUARTER:**

I am taking one or more courses using case studies this quarter.

I am taking one or more courses that use the computer this quarter.
Please check the response category that indicates the extent to which you agree or disagree with each of the following statements. Please answer each of the questions, even if you have had no personal experience with the situation represented.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Somewhat disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I believe that case study analysis is a useful supplemental teaching method for most courses in my major field of study.</td>
<td></td>
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<tr>
<td>I spend more time analyzing a case study when a written report or solution is required.</td>
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<tr>
<td>I prefer working with a team on a case problem, rather than working alone.</td>
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</tr>
<tr>
<td>I believe that I do a better job of getting to the key problem(s) in a case when a written report is required.</td>
<td></td>
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<tr>
<td>I prefer case studies that focus specifically on one or two problem areas.</td>
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</tr>
<tr>
<td>I feel that most case studies do not provide enough information to make a reasoned analysis of the available alternatives.</td>
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</tr>
<tr>
<td>I feel that most of the courses at the senior level in my major field of study should be case-oriented (at least 40% of course time spent on case analysis).</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>agree</td>
<td>Somewhat agree</td>
<td>Somewhat disagree</td>
<td>disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
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</tr>
<tr>
<td>I am usually satisfied with the feedback I have received on case problem assignments (graders comments, class discussions, etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>I often wish that I could &quot;test&quot; my case problem analysis and solution.</td>
<td></td>
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</tr>
</tbody>
</table>
Exhibit IX

Section A Post Test Questionnaire

I am again asking for your cooperation in connection with a survey of student opinion about selected aspects of the O.S.U. Administrative Science program. As before, your responses will remain confidential, but your name and student number are required for statistical tabulation purposes.

Thank you.

William Sargent

NAME: ___________________________ STUDENT I.D. NUMBER: ___________
Please check the response category that indicates the extent to which you agree or disagree with each of the following statements. Please answer each of the questions, even if you have had no personal experience with the situation represented.

<table>
<thead>
<tr>
<th>Strongly</th>
<th>Somewhat</th>
<th>Somewhat</th>
<th>Disagree</th>
<th>Disagree</th>
<th>Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>agree</td>
<td>agree</td>
<td>disagree</td>
<td>disagree</td>
<td>disagree</td>
<td>disagree</td>
</tr>
</tbody>
</table>

I believe that case study analysis is a useful supplemental teaching method for most courses in my major field of study.

I spend more time analyzing a case study when a written report or solution is required.

I prefer working with a team on a case problem, rather than working alone.

I believe that I do a better job of getting to the key problem(s) in a case when a written report is required.

I prefer case studies that focus specifically on one or two problem areas.

I feel that most case studies do not provide enough information to make a reasoned analysis of the available alternatives.

I feel that most of the courses at the senior level in my major field of study should be case-oriented (at least 40% of course time spent on case analysis).
<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Somewhat Agree</th>
<th>Somewhat Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Somewhat Agree</td>
<td>Somewhat Disagree</td>
<td>Disagree</td>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

I am usually satisfied with the feedback I have received on case problem assignments (graders comments, class discussions, etc)

I often wish that I could "test" my case problem analysis and solution.
Please check the response category that indicates the extent to which you agree or disagree with each of the following statements, based on your experience with the Phoenix Industries computer-assisted case study.

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Somewhat agree</th>
<th>Somewhat disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The case study materials answered most of the important questions I had about the case study and simulation model.</td>
<td></td>
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</tr>
<tr>
<td>The information contained in the case write-up was sufficient to make a reasoned analysis on which to base my first set of decisions.</td>
<td></td>
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</tr>
<tr>
<td>The amount and type of information reported by the simulation model was not sufficient to allow me to adjust my decision strategy and values to accomplish my objectives.</td>
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<tr>
<td>The simulation model reported more information than I felt I needed to make effective decisions.</td>
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</tr>
<tr>
<td>The case study would be more effective if the model were more complex (more decision variables, products).</td>
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</tr>
<tr>
<td>The case study would be more effective if the model were competitive, i.e., other students decisions affect my model, and vice-versa.</td>
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I feel that a formal demonstration of the use of the time-sharing terminal, in addition to the terminal section of the case write-up, would be beneficial.

Overall, I feel that the case study and simulation model made a valuable contribution to the course.

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<td>Length of each Decision Period</td>
<td>60 days</td>
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<tr>
<td>Total length of simulated period</td>
<td>240 days</td>
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<tr>
<td>Number of decision variables (varies with order option used)</td>
<td>7 - 9</td>
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</table>

Use time-sharing terminal to run the model. Alternatives: students punch and submit cards; students fill out decision sheets, give to instructor; terminal.

Students work individually (if you would use teams, state recommended team size) individually.

Number of days between reports of selected model variables | 5 days |

I would appreciate your entering any additional comments that you might have about the model, the case, and the use of the terminal.

COMMENTS:
Exhibit X
Section B Post Test Questionnaire

The purpose of this questionnaire is to survey student opinion about selected aspects of the O.S.U. Administrative Science program. Your responses will be combined with the responses of the other students completing the questionnaire, and will provide the data necessary for the statistical analysis phase of the project. Your name and student number are necessary to provide a tabulation key and to provide longitudinal continuity to the study. However, all questionnaire data will remain confidential, and only the composite statistical summary of the responses will be released.

I will appreciate your cooperation.

William Sargent
NAME: __________________________ STUDENT I.D. NUMBER: ____________

Academic Class (check one):
_____ Freshman   _____ Sophomore   _____ Junior   _____ Senior
_____ Graduate Student

Student Status this quarter (check one):
_____ Full-time (registered for 7 or more credit hours)
_____ Part-time (registered for 6 or less credit hours)

Major Field of Study (check one):
_____ Accounting
_____ Finance
_____ Management Science
_____ Marketing
_____ Public Administration
_____ Other please specify ____________________________

Overall point-hour average in major field of study (check one):
_____ under 2.0   _____ 2.01-2.50   _____ 2.51-3.00   _____ 3.01-3.50
_____ 3.51-4.00

Overall point-hour average for all coursework during last 3 quarters (check one):
_____ under 2.0   _____ 2.01-2.50   _____ 2.51-3.00   _____ 3.01-3.50
_____ 3.51-4.00

Degree Program (check one):
_____ Bachelor's   _____ Master's   _____ Ph.D.   _____ Non-degree

Number of the course in which you are completing this form: ____________
Please check the appropriate response to each of the following questions, based on your experience prior to this quarter.

COMPUTER EXPERIENCE:

<table>
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<tr>
<th>YES</th>
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I have written and tested ("debugged") a computer program.

I have used an existing computer program (BIMED statistical package, regression program, etc.) to analyze a problem or case study.

I have taken a course or part of a course using computer-assisted instruction on a time-sharing terminal.

I have played a business or similar type of computerized decision game.

I have used a time-sharing terminal.

I have had no previous computer experience.

CASE STUDY EXPERIENCE:

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<th>YES</th>
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I have taken one or more courses in which case problems were used to illustrate the concepts presented in the course.

I have taken one or more courses consisting entirely of case problems, i.e., no new concepts or material was introduced.

I have not had any experience with case problem assignments.

COMPUTER AND CASE STUDY EXPERIENCE THIS QUARTER:

I am taking one or more courses using case studies this quarter.

I am taking one or more courses that use the computer this quarter.
Please check the response category that indicates the extent to which you agree or disagree with each of the following statements. Please answer each of the questions, even if you have had no personal experience with the situation represented.

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Somewhat agree</th>
<th>Somewhat disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
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<tr>
<td>I believe that case study analysis is a useful supplemental teaching method for most courses in my major field of study.</td>
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<td>I spend more time analyzing a case study when a written report or solution is required.</td>
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<td>I prefer working with a team on a case problem, rather than working alone.</td>
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<td>I believe that I do a better job of getting to the key problem(s) in a case when a written report is required.</td>
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<td>I prefer case studies that focus specifically on one or two problem areas.</td>
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<td>I feel that most case studies do not provide enough information to make a reasoned analysis of the available alternatives.</td>
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<td>I feel that most of the courses at the senior level in my major field of study should be case-oriented (at least 40% of course time spent on case analysis).</td>
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<td>I am usually satisfied with the feedback I have received on case problem assignments (graders comments, class discussions, etc)</td>
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<td>I often wish that I could &quot;test&quot; my case problem analysis and solution.</td>
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Please check the response category that indicates the extent to which you agree or disagree with each of the following statements, based on your experience with the Phoenix Industries computer-assisted case study.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
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<td>The case study materials answered most of the important questions I had about the case study and simulation model.</td>
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<td>The information contained in the case write-up was sufficient to make a reasoned analysis on which to base my first set of decisions.</td>
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<td>The amount and type of information reported by the simulation model was not sufficient to allow me to adjust my decision strategy and values to accomplish my objectives.</td>
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<td>The simulation model reported more information than I felt I needed to make effective decisions.</td>
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<td>The case study would be more effective if the model were more complex (more decision variables, products).</td>
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<td>The case study would be more effective if the model were competitive, i.e., other students decisions affect my model, and vice-versa.</td>
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I would appreciate your entering any additional comments that you might have about the model, the case, and the use of the terminal.

COMMENTS:
APPENDIX B

Case Study Materials
Phoenix Industries, Limited  Student Assignment Sheet

February 14 Monday  Case materials distributed in class
Student Assignment for Wednesday is to read thoroughly
the case material

February 16 Wednesday  Class briefing and question and answer session about
case

February 17 through February 29  
Each student will make his simulation runs independently, as follows:

1st run - practice only - no results recorded
2nd run - Simulate operations for quarter 1
3rd run - Simulate operations for quarter 2
4th run - Simulate operations for quarter 3
5th run - Simulate operations for quarter 4

Notes and Comments
You will not be allowed to run the model more than once per day. Plan ahead.

Do not lose the printouts showing the results of your simulation runs. Duplicate
printouts will be very difficult to obtain on short notice.

Make your decisions ahead of time, not sitting at the terminal. If you are
required to submit an operations memo (enter data at terminal), write it out
in advance and proofread it.

Always logoff the terminal at the conclusion of your session, whether it has
ended normally or abnormally (error message, etc). If you do not logoff,
you will incur connect time changes and will make the logon number used
unavailable to other students.

Do not hesitate to ask me for assistance with terminal or program problems,
questions about the model or the assignment, or other matters. I can be
reached through the telephone numbers listed at the bottom of the Foreword
of the case write-up.
Exhibit XII
Case Study Write-up

PHOENIX INDUSTRIES, LIMITED
A COMPUTER-ASSISTED CASE STUDY
The objective of the Phoenix Industries, Limited case study and simulation model is to provide you with an opportunity to apply some of the concepts and techniques learned in the classroom to a "quasi-realistic" problem situation. Your task is to determine the most important factors which affect the San Francisco store inventory situation, to define an inventory ordering policy which reflects your judgment as to the importance of these factors, and to use the simulation model to "test" your solution. The performance objective of the case is to consistently improve the store's profitability each quarter by making successive changes, if necessary, to the inventory ordering and review policies.

It is important that you read carefully and understand fully the attached materials. Once you have entered into the model the values of the variables which define the store ordering and review policies, the simulation program will accurately and faithfully carry out your policy, regardless of the consequences. Therefore, please make sure that you carefully read all of the supporting material before you define a decision strategy. Also, use the flow diagrams to test your strategy before running the model.

I will be more than happy to answer any questions that you may have about the case. Call and leave a message at any or all of the following numbers:

8 to 5 Marketing Office : 422-8808
After 5 Home : 488-7509, or
Hagerty Hall Computer Center : 422-1441
William Sargent

The situation, events, individuals, and company depicted in the case are fictional products of the author's imagination, and should not be construed as representing any company or particular situation.
Jim Smith, President of Phoenix Industries, slowly closed the consultant’s report. “Well, John, you’ve had a chance to read the report, what do you think?”

John Rice, Marketing Manager for the company, paused for a moment and glanced briefly at some notations on the cover of his report. “Jim, Professor Bernard has done a fine job of documenting the situation, and his analysis makes sense. Even his recommendations look pretty good, on paper. But, I have one of the company’s best young managers thinking that we, you and I, have stranded him in an impossible job. When we told Steve to get the San Francisco outlet started, we were thinking of a three to six-months assignment. Steve took the job because he knew that the success of the operation would give him the inside track for the job of managing our expansion on the Coast. But, it has been 15 months, and it’s still a 50-50 chance every month as to whether we make any money out there. Look, Jim, we have 15 boutiques operational, 4 under construction, and we’re in the final planning stages on 3 more. We’re right on target with the five-year plan, except for this mess on the West Coast. Unless we can find a solution fast, I vote to kill the operation, at least for the present.”

“I know, John, I know. On one point, at least, I think we can relax. I called Steve last night and talked with him for over an hour. Whatever happens, he’s coming back here at the end of the year. I also made it clear that we don’t hold him responsible for the problems with the outlet. Instead of a purple heart, your department is generously treating him and Doris to two weeks in Hawaii late in January. Now, let’s get back to the primary problem. I’ve decided to call an Executive Committee meeting for tomorrow at 10. Professor Bernard will join us after lunch and go over his report and recommendations. Have your people go over this report with a fine-toothed comb and see if they agree with Bernard.”

Background of the Company

The first stockholder’s meeting of Phoenix Industries, Limited, was called to order around Robert Smith’s dining room table early one September evening in 1953. Capital assets consisted of several hundred dollars in savings, some workshop tools, and Mr. Smith’s talent for creating imaginative novelty and specialty items. Within two years, Mr. Smith was devoting his full time to the business, employed three full-time people, and had expanded the company’s marketing area from Columbus to all of Ohio and parts of Indiana, Pennsylvania, Kentucky, and Michigan.

The elder Smith’s strategy was simple and straightforward. Phoenix would manufacture low-cost, imaginative consumer novelty and specialty items, and sell direct to large department and discount stores and chains. This method of operation kept marketing and distribution expenses low, and enabled Smith to concentrate on the creative and production aspects of the business. The firm prospered during the 1950’s and early 1960’s, and sales of the 40-odd products in the company’s line reached $4 million by the mid-1960’s.
In 1967, Mr. Smith retired from active management of the firm and installed his son, Jim, as President and Chief Executive Officer. Jim's most pressing concern was to deal with the problems of foreign competition and with the growing pressure from Phoenix's larger retail customers to produce private label merchandise. In addition, he felt that the company had reached the point where the question of selling direct to consumers should be explored. Therefore, Jim ordered a staff study of the company's product lines, resources, customer base, and distribution system. Based on the results of the study, he defined and evaluated a number of alternative methods for implementing a consumer marketing program. The most promising alternative seemed to be to distribute the company's products through a network of small, company-owned, free-standing retail outlets called boutiques. After discussing the boutique concept with his father and other company executives, Jim recruited a small group of marketing people and produced a five-year marketing plan oriented around the boutique concept.

Implementing the Plan

The first three boutiques were located in large shopping centers in Ohio. Each shop carried a small number of complementary products from the company's product line, plus a small percentage of fill-in products purchased locally by each store manager. Each outlet's product mix was designed to satisfy three basic plan requirements. First, carrying a limited assortment of products enabled each outlet to stock each product line intensively, thus insuring that the boutique concept of narrow but intensive merchandising coverage was maintained. Second, limited assortments simplified the problems expected to be encountered in supplying the planned network of stores. Third, the policy enabled the company to implement its Planned Assortment Program.

The Planned Assortment Program was devised by Jim and John Rice to streamline the product distribution operations of the company. They grouped the company's products into 12 product "sets," each set consisting of product lines whose customer end-use characteristics and sales rates were similar and complementary. Each company boutique had a "theme," which determined which of the product sets were stocked. Decisions as to how many units of product to order from each product set were made by the store manager, but the specific characteristics of the individual units, such as size, color, and so on, were determined by the marketing staff on the basis of product availability, sales patterns at each outlet, and general market studies. The Planned Assortment Program relieved individual store managers of the problems involved with keeping detailed records at store level, and of forecasting expected demand for a large number of individual product styles. Despite some early implementation problems, the concept proved to be both feasible and economical.

By the end of the first year, all three stores were exceeding their growth and profitability targets, and three more store locations were selected. Within the next four years, the plan called for a minimum of 35 completed boutiques within the East Central portion of the country.
The San Francisco Boutique

With the implementation of the boutique plan proceeding smoothly, Jim turned his attention to expanding the company’s operations beyond the East and Midwest. Based on a favorable staff report about the applicability of the boutique concept to major West Coast markets, Jim and John Rice decided to open a boutique in San Francisco. Its anticipated success would provide a source of funds and experience for the development of a West Coast chain of stores. Although not accustomed to supporting retail operations outside of their Midwest marketing area, both men felt that only minor adjustments to standard operating practices would be necessary.

Steve Fuller was the natural selection for store manager. Steve was John’s right-hand man, and had personally managed the company’s second and third boutiques during their critical first months of operation. In addition, Jim and John realized that the anticipated success of the Coast operation would require the establishment of a Division office on the Coast, and they felt that Steve wanted and deserved a chance at the job. All three men agreed that the initial inventory policy would be to ship truckload quantities to the Coast, with an initial stock of product held in reserve in a San Francisco public warehouse. To simplify logistics problems, only one product set would be stocked. To allow Steve to concentrate on establishing and building the sales base of the outlet, no attempt would initially be made to establish efficient inventory control procedures.

The San Francisco outlet opened in mid-1970, and, as expected, the first few months were hectic. No major adjustments to the initial Planned Assortment mix structured for the store were found to be necessary. Some initial problems with the trucking firm were quickly ironed out, and Coast shipments were soon being dispatched at the planned rate. As expected, the inventory level in San Francisco fluctuated erratically, but an extensive safety stock was maintained in the public warehouse and no serious stock-out problems arose. The store’s unit sales curve passed through the projected breakeven point of 65 units per day during the fourth month. By the end of the sixth month, sales had stabilized at approximately 100 units per day. Steve felt that this represented a practical maximum for a store of this size, and Jim and John were satisfied that efforts to control the extremely high inventory costs currently being incurred would move the store to its targeted profit goals.

In January, 1971, Steve returned to Columbus to review the store’s first six months of operations with Jim and John. They agreed that the next three months should be spent in trying to stabilize the inventory situation, with particular emphasis on defining an inventory ordering policy that would provide adequate inventory levels within reasonable cost limits. Steve explained that the transit time for truck shipments varied widely, and that daily and weekly variations in demand compounded the problem. Steve’s strategy for the next quarter was to gradually allow the excessive stock level in the warehouse to liquidate itself and to begin using smaller shipments at more frequent intervals. The lower average inventory level and decreased use of public warehousing was expected to offset the higher transportation charges.

-3-
At the end of the next quarter, preliminary reports indicated that Steve's strategy had been only partially successful. The average inventory levels in the store and warehouse were down, but transportation costs were significantly higher, and the store had lost significant revenue due to stock-out problems. Steve indicated that using less-than-truckload shipments had not only increased significantly the transit time, which he had expected, but had also increased the variability of shipment arrivals, which he had not expected. Jim vetoed Steve's request to use air freight shipments to cover inventory stockouts, both because the company was not familiar with air freight shipping and due to cost considerations. However, Jim indicated that he would have the marketing people look into the air freight situation. Jim also took under advisement Steve's comment that it was difficult to analyze the situation with the limited amount of information he was receiving from the company's reporting system. Jim agreed to have the accounting and marketing people look into the possibility of providing more information about the inventory situation, but indicated that Steve should not expect any immediate changes.

In July, 1971, Steve flew to Columbus to review the year's operations with Jim and John. Despite one full year of operation, the inventory situation was still not solved, and the store had finished the year with a $13,000 loss. The staff studies indicated that the trucking firm's performance was within acceptable limits, and that while air freight inventory shipments might alleviate the problem, they would be expensive and might actually aggravate the problem.

Modifications to the company's computerized reporting system to accommodate Steve's request for additional information were estimated to cost $10,000, and might take 3 months to complete. John also indicated that his people were not completely convinced that the requested information would aid appreciably in solving the problem.

Pending further developments, Jim decided to relieve Steve of the inventory control task and turn it over to John's people. All three men agreed that outside assistance was necessary, and Smith contacted a marketing professor at a local university who had consulted with Jim's father on company problems. Professor Bernard's report, completed in mid-September 1971, was the subject of the conference between Jim and John Rice on the day preceding the Executive Committee meeting.

The Executive Committee Meeting

Much of the morning session of the Executive Committee meeting was devoted to the handling of the inevitable problems associated with the success of the original boutique plan, including a discussion of the company's planned production and employment activities. As the last item on the morning agenda, Jim opened discussion about the San Francisco outlet by announcing Steve's reassignment to headquarters. The announcement was well received by the group, since Steve was well-liked within the company, and many people had become
Increasingly distressed about his association with the unpopular and unprofitable outlet. Bernard's favorable report notwithstanding, most members of the committee felt that the company should close the outlet. John reported that his staff had been able to reduce the inventory fluctuations to some extent, but that they could not continue to "mother" one outlet at the expense of the remaining company operations.

During the afternoon session, Professor Bernard highlighted the results of his analysis. In particular, he concurred with an earlier observation of Steve's that part of the problem was due to the limited stocking capacity of the store. However, Bernard's primary conclusion was that none of the inventory ordering strategies used during the 15-month history of the operation had been thoroughly analyzed before implementation. Furthermore, no policy had been applied consistently for a sufficient period of time to allow an accurate evaluation of its effectiveness. John's staff concurred with Bernard's analysis.

Sensing that the executives were still undecided, Jim advanced the following plan for their consideration.

1. If Professor Bernard would agree to continue working with John's staff in defining some alternative inventory strategies, and

2. If a qualified individual could be found within the company who would accept the position of manager of the Coast outlet and would agree to implement an agreed-upon inventory plan, and

3. If the chances for success were determined to be 50-50 or better, then the Executive Committee would agree to underwrite the operation of the West Coast store for an additional year starting January 1, 1972.

In addition, Jim agreed to defer a decision on expanding the company's reporting system until such time as the above questions were resolved. Professor Bernard agreed to continue with the project and expressed his expectations of success. The proposal was approved by voice vote.

Your Assignment

It is now December 2, 1971. As a member of John Rice's marketing staff, you have been working closely with Bernard and other company personnel on preparing the final inventory strategy report. Having voiced your desire to move into line marketing operations and your interest in the San Francisco outlet to Bernard and Rice, you were nevertheless surprised...
to learn that they had discussed you with Jim Smith. Yesterday, you met with these three men to talk over your request, and Smith agreed to recommend to the committee that you be given the West Coast position, if the report is approved.

Your door opens and Smith and Rice walk into your office and offer their congratulations on your promotion. Rice suggests that you plan to be on the Coast by Monday, giving you three full weeks with Steve Fuller before you take full charge of the operation. Smith indicates that Bernard's report has been accepted by the committee, and that it will serve as the policy document for inventory management. However, the committee will meet next week to determine if the expansion of the reporting system and the operations memo recommendations will be implemented. You will receive a memo outlining your duties as Store Manager before you leave for the Coast. You will be notified of the committee's decisions about the operations memo and reporting system expansion before the first of the year. Good luck.
December 12, 1971

TO: San Francisco Store Manager

FROM: James B. Smith

SUBJECT: Policy Guidelines for Inventory Management

The purpose of this memo is to provide you with written guidelines concerning your position as Store Manager of our San Francisco boutique. As you know, the coming year is essentially a test of the company's ability to logistically support boutique-type retail operations on the West Coast. Therefore, the effectiveness of your inventory management policies during this period will determine the future course of our West Coast marketing program. Although it may seem unduly restrictive to require rigid adherence to your defined policy for at least one full quarter, we are convinced that this constraint on your actions is necessary if we are to improve our understanding of the dynamics of the problem.

The Executive Committee will be meeting next week to make a final determination concerning possible changes to the reporting system and concerning the implementation of the quarterly operations memo. You will be notified of their decision before the first of the year.

Best of Luck,

Jim
San Francisco Store Policy Summary

1. The responsibility for the definition and implementation of an inventory management review and ordering strategy will rest solely with the store manager, subject only to broad guidelines set forth in a succeeding section of this memo.

2. The basic unit of time for using an inventory strategy will be one calendar quarter. At the beginning of each quarter, the store manager will inform his clerical staff of the decision rule values to be used for reviewing and ordering inventory during the quarter. No changes in these values are to be made during the quarter. However, the manager will be free to retain or to alter any or all of these values in succeeding quarters.

3. When necessary, orders or partial orders may be diverted to the public warehouse for storage. However, the manager will instruct the warehouse to transfer inventory back to the store whenever any store storage space becomes available.

4. Product pricing and promotional policies are to remain constant during the year. No attempt should be made to correct inventory problems through the use of price changes or promotional efforts.

5. The store manager will select one of the two inventory review and ordering strategies discussed in the next section at the beginning of each calendar quarter. The specific numeric values of the variables will be selected by the manager, subject to the limiting values listed for the variables.

Inventory Review and Ordering Policies

There are two basic inventory ordering strategies available to the store manager. By selecting one of these policies as the basic mechanism for ordering inventory for a particular quarter, the manager provides values for the decision rules used by the clerical staff to control inventory review and ordering.

Policy 1: Constant Order Size

Order xxx units every time an order is placed with the factory. The Constant Order Quantity variable is defined by the manager, and may be any number of units from 200 to 3000.

Policy 2: Order Formula

The order formula policy involves calculating an order size as the difference between expected demand and expected supply, as follows:
Each time inventory is reviewed (a review day occurs), the clerk calculates an expected demand value based on the assumption that an order will not be placed today. Therefore, the period over which the expected demand will occur is

\[(\ell \text{ days until next review day}) + (\ell \text{ days necessary to order and receive units from factory})\]

\[
\text{expected demand} = \text{period of expected demand(\ell \text{ days, defined above})} \times \\
\text{average daily expected demand}
\]

The expected supply value is calculated as follows:

\[(\text{store inventory on-hand} + \text{on-order inventory units} + \text{warehouse inventory units})\]

\[
\text{therefore, expected demand} - \text{expected supply} = \text{the number of units we expect to be "short" over this period.}
\]

This number of units, if larger than 0, is then modified by the two "adjustment" variables whose values are defined by the manager. If the resulting order size is larger than the minimum order size specified by the manager, an order will be placed for that number of units. Otherwise, the order will be cancelled.

Refer to the flowchart for the specific event sequence and use of the decision variables in the review and ordering process.

**Inventory Policy Variables**

The notation ( ) indicates whether the variable is used for the constant order size policy (constant), the order formula policy (formula), or is used for both policies (both).

- **Constant Order Quantity (units) (constant)**
  - Limits: 200, 3000

- **Formula x factor (formula)**
  - Limits: .60, 1.50

- **Formula + factor (formula)**
  - Limits: -999, +999

- **Minimum Order Size (units) (formula)**
  - Limits: 0, 2500

- **Days in Demand Average (days) (both)**
  - Limits: 1, 15
  - If the order formula is used, this variable is used to calculate average daily demand based on a moving demand average for the previous \(xx\) days, where \(xx\) is the value selected for this variable.

- **Review Inventory every \(x\) days (days) (both)**
  - Limits: 2, 30
  - An inventory review will be conducted if \(x\) days have elapsed since the last inventory review, where \(x\) is the value of this variable.
  - Caution: using the constant order size policy, an order will always be placed as the result of a normal inventory review.
Low Stock Point (units) (both) Limits 0 2000

Inventory on-hand at the end of the day is compared to this value. If on-hand inventory is less than this value, an inventory review may take place (see flowchart).

Cancel if order due in x days (days) (both) Limits 0 30

If inventory on-hand falls below the low stock point, an inventory review will be conducted, unless an order is expected to arrive within the number of days specified by this variable.

Shipment Mode (use 1, 2, or 3) (both)
if 1 is selected: priority orders will be shipped by air, normal orders will be shipped by truck.
if 2 is selected: all orders will be shipped by truck.
if 3 is selected: all orders will be shipped by air.

Communications Method (use 1, 2, or 3) (both)
if 1 is selected: priority orders are sent by telephone, normal orders are sent by mail.
if 2 is selected: all orders are sent by mail.
if 3 is selected: all orders are sent by telephone.

NOTE: If an order is placed as the result of a priority inventory review, it is classified as a priority order. If an order is placed as the result of a normal inventory review, it is classified as a normal order.
Flow Diagram of Inventory Review and Ordering Process

This sequence of events will be performed by the store's clerical staff at the end of the day. Phrases in ( ) are abbreviations of decision variable names.

1. **Do Nothing**
   - **YES**
   - **NO**

2. **Is store inventory less than low stock value? (Low stock value)**
   - **YES**
   - **NO**

3. **Is an order due to arrive in x days? (cancel if due in)**
   - **YES**
   - **NO**

4. **Declare priority stock review**

5. **Order Policy?**
   - **YES**
   - **NO**

6. **Calculate order size**
   - **YES**
   - **NO**

7. **Multiply order size by factor x (formula x factor)**

8. **Modify order size by +/- factor (formula +/- factor)**

9. **Order size larger than min. order size? (min order size)**
   - **YES**
   - **NO**

10. **Select Shipment mode to be used for order (shipment mode)**

11. **Select method for sending order to factory (communications)**

12. **Next Review day = today + review period. (review inv. x days)**

13. **Average Daily Demand**

14. **END**

15. **Do Nothing**

16. **Cancel Order**
Proposed Format For Operations Memo

To: James B. Smith
From: Store Manager
Subject: Operations Memo for Quarter x

Section I: Analysis of Previous Period(s)

The Store Manager should type a brief analysis of the previous period's results, reasons why the inventory policy used during the period was successful or unsuccessful, and a summary of the inventory and sales position of the store at the end of the last quarter (beginning of this quarter).

Section II: Strategy and Forecast for Quarter x:

This section of the memo should contain the manager's strategy for inventory management during the present quarter, including how the previous policy has been altered, expected results of the policy, and a general forecast of the store's operating and financial position at the end of the quarter. In addition, the reasons for any significant changes in inventory policy - for example, switching from truck to air shipments - should be included.

Note: the simulation model will accept up to 36 typed lines of analysis for the entire memo (both sections). After completing the first section of the memo by typing ##, the program will print the section II header line and indicate how many lines are available for the second section's analysis.
Explanation of Quarterly Financial Statement Accounts

Sales Revenue (net)  self-explanatory
Cost of Goods Sold  self-explanatory
Gross Margin  self-explanatory

Truck and Air Costs
These values represent the actual charges incurred in shipping orders by each of these transportation modes.

Ordering Costs
This value is the sum of the costs of writing orders, the costs of sending the orders to the factory, and the costs of reviewing inventory during the quarter.

Inventory Charges
This charge reflects the cost of capital, risk of obsolescence and opportunity costs incurred due to the inventory carried by the store during the quarter.

Warehousing Charges
The value represents the sum of the storage and transit charges associated with using the public warehouse.

Corporate Service Allocation
This charge reflects the store's pro-rated share of corporate expenses not otherwise allocated in the other accounts.

Rent, Utilities, Salary, Misc
This is a fixed charge covering these expense items.

Net $ Contribution Before Taxes
This value represents the "profit" or "loss" generated by the store during the quarter as a result of its operations.
Using the Simulation Model

The simulation model supporting the Phoenix Industries case study is designed to be run from the IBM 2741 time-sharing terminal. The 2741 terminal is an IBM Selectric (ball) typewriter modified for time-sharing use. Carefully reading the following material should enable you to use the terminal with a minimum amount of misunderstanding and trouble. If a problem does occur, refer to the Error Handling section of the manual for a discussion of courses of action.

You will actually be dealing with two "programs" when you use the simulation model. The Time Sharing Option (TSO) program controls the access to the computer, and is the program which handles the logon and execution operations. When you have satisfied TSO that you are an authorized computer user and indicated the program that you wish to use, TSO turns over control of the computer and the terminal to the simulation model. This differentiation of control is particularly important when the handling of error conditions is discussed in a later section. A word of caution. The material in this terminal manual has been specifically oriented toward the operation of the Phoenix simulation model. If you encounter a problem and seek out a "local" time-sharing expert, be wary of suggestions that run contrary to or are not mentioned in this manual. I will make myself available to you for consultation or assistance as you may require it. I can be contacted via the telephone numbers listed on the Foreword of the case write-up.

Before beginning your terminal session, take a minute to familiarize yourself with the layout of the keyboard, paying particular attention to the location of the numeric keys (top row), the Return key, and the ' and . symbols. A common problem with time-sharing is to type the letter O for the number 0, or the lower case I for a 1. All numeric information must be entered using the top row of keys. All alphabetic information can be entered either in upper or in lower case letters. The computer automatically translates all alphabetic input into upper case, anyway.

Use the following checklist to conduct your simulation session.

1. Use the on-off rocker switch on the right-hand side of the keyboard to turn on the terminal.
2. Move the LCL-COM switch (located on the left-hand side of the terminal stand) to LCL (switch down).
3. Set the terminal margin stops to 0 and 105. Check to see that the paper supply is adequate (6+ sheets) and that the paper does not tear or bind as it moves to and through the terminal.
4. Depress the Return key, which will move the typing element to the left-hand margin.
5. Set the terminal spacing control (short silver lever located on top right-hand side of machine) to: single spacing (lever forward).
6. Move the LCL-COM switch to COM (switch up).
7. Remove the telephone handset, depress the TALK button (second from right), and dial 2-3100. On a busy signal, hang up and try again in a few minutes. If the computer is available, it will "answer" the call with a high-pitched tone. Depress the DATA button (far right), which will light, indicating the connection is complete.
8. Depress the Return key when the computer unlocks the keyboard of the terminal. Note: The terminal keyboard is always locked, unless the program is waiting for you to enter data through the keyboard. If you expect the keyboard to unlock, rest your finger on the space bar, which will space the typing element as soon as the unlocking action takes place. Then, backspace the typing element back to the left margin, and enter the required input.

In the following checklist steps, the computer messages printed on the terminal are in CAPITAL letters, while your input is in lower-case letters. Phrases in ( ) represent actions that you take, not typed input.

9. #IKJ53020A ENTER LOGON
10. logon xxxxxxx/mkt752 (depress Return key)
    where xxxxxxx is one of the following account numbers
        tc0159
        tc0160 NOTICE: account number consists of 2 letters and 4 numbers
        tc0161
        tc0162
        tc0163
        tc0164

11. If another student is currently running the model with this account number, the terminal will type
    LOGON REJECTED, USERID XXXXXX IN USE
    ENTER LOGON OR LOGOFF-
    select another account number and type in the logon message again.
    logon yyyyyyy/mkt752 (depress Return key)

12. When you finally select an available account number, the computer will type
    ENTER PROCEDURE NAME-
    you type
    pliuser (return)

13. The computer will type some informational messages, and then proceed with the logon process. If the computer is heavily loaded with work, the logon process may take a minute or so. You will receive the message LOGON PROCEEDING each minute until the process is completed. When the computer is ready for input, the terminal will type
    READY

14. This input line tells TSO the name of the program which you wish to run. Type it exactly as shown, including the ' and .
    exec 'cea570.phoenix.clist' (return)
    where 570 is a 3-digit number.
15. ENTER POSITIONAL PARAMETER-
16. type in the account number used in the logon process, e.g.
17. If you have successfully completed the sequence listed above, TSO will load the simulation model into the computer and turn control of the session over to the model.

18. The simulation model will greet you with the following message. PLEASE TYPE YOUR NAME (FIRST NAME, 1 SPACE, LAST NAME)

19. Type in your name, as indicated, and press the Return key.

20. From this point in the session, the simulation model will indicate what information it needs to complete the simulation of the store. The next item of information the program needs is your full and accurate student i.d. code (1 letter and 5 numbers). If you do not know your i.d. code, you will not be able to use the model.

As a cosmetic touch, the program will periodically ask you to advance the terminal paper to the top of the next page. This avoids crowding of the report and simulation information on the printout. Whether you actually move the paper or not (pull or roll the paper, do not use the return key), the computer will not continue until you type the word top and depress Return.

The first time that you use the model is designed to be a practice session. The results of the simulation run are not recorded, and the model values will be "reset" to their original values for your next run, which will actually implement your inventory policy "for the record". The objective of the practice session is to familiarize you with the terminal and with the program. However, the output information of the practice run will not be an accurate representation of what you will encounter during your first real run, as follows:

1. The simulate model will simulate only 30 days of operation, rather than a full 60-day quarter.
2. You will receive a daily summary report of operations, rather than the weekly reports issued in a record run.
3. The demand pattern of the model for the practice run is not similar to the demand pattern of the model for a record run. Therefore, do not accept the output of the practice run as being an accurate "test" of your inventory policy.

Since the practice run issues daily reports, you can audit the report to insure that the model is faithfully carrying out your inventory management and ordering strategy. You should be able to thoroughly define why the model did what it did, if you can not, you do not understand the inventory policies and decision rules well enough to make a record run. Reread the material and try again. If you don't figure it out the second time, contact me for assistance.

When the simulation run is completed, the program will automatically log you off the terminal, unless an error occurs. If you do not receive the logoff messages after receiving the SIMULATION COMPLETED message, close out the session by typing logoff. When the logoff messages are typed, turn off the terminal. Remember your printout.
Error Handling Procedures

There are essentially three types of error problems that may occur during a terminal session. The general nature of these errors and possible corrections are discussed below.

TSO Errors

As discussed previously, you are communicating with TSO until such time as the simulation model assumes control of the session, indicated by the terminal message asking for your name. TSO errors are primarily concerned with typing errors, such that it does not recognize what you have typed as a valid operation. If TSO encounters a phrase or word it cannot recognize, it will ask you to reenter it correctly. However, only the incorrect information need be entered. Do not enter any information that TSO has already accepted. For example, if you were to type te0159/mkt752, TSO would not find the password mtt752 in its records, since the correct password is mkt752. Therefore, it would ask you to enter a correct password, which in this case would involve typing mkt752 (return)

A TSO system error occurs when TSO needs something that is not currently available, such as a data file, etc. In these cases, you will receive messages such as FILE IN USE or FILE NOT AVAILABLE

In these cases, type logoff, and then immediately logon again using another account number. If messages of this type should occur more than once a session, logoff and leave messages at the telephone numbers listed on the back of the title page. Indicate whether I can reach you sometime within the next hour, and, if possible, drop off your printout in the Marketing Office for me.

Program Errors

Once you receive the message asking for your name, the program will handle and evaluate your input data. Most common errors (letter for number, number too large or small) and so on will result in the typing of a message indicating the nature of the error and asking you to reenter the information correctly. In these cases, the message printed will state the reason for the error indication. Always be sure that you understand why your input data was not acceptable before reentering the requested data.

If you make a typing error and discover it before pressing the return key, backspace the typing element to the incorrect character and type the data correctly. Backspacing to or over a character erases it, so you must reenter all of the characters you backspaced over before using the return key.

Error messages beginning with IHExxxxxx indicate errors that were not able to be handled by the program (they are fatal). In these cases (very rare), you will be logged off the terminal automatically. Study your printout carefully and, if you determine why the error occurred, logon on again and rerun the model. Your period results are not recorded until the program has successfully completed simulating the entire quarter. Once you receive the SIMULATION COMPLETED message, evaluate your output in preparation for the next quarter's operation.
Exhibit XIII
Financial and Operating Information

PHOENIX INDUSTRIES CASE INFORMATION

The following information should assist you in defining your inventory and management strategy for the San Francisco store.

Store Storage Capacity: 1,800 units (180 cartons)

Fixed Quarterly Expenses:

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate Service Allocation</td>
<td>$4,000</td>
</tr>
<tr>
<td>Rent, Utilities, Misc.</td>
<td>$3,000</td>
</tr>
<tr>
<td>Retail Price per Unit</td>
<td>$6.00</td>
</tr>
<tr>
<td>Unit Cost (charged to store)</td>
<td>$4.00</td>
</tr>
<tr>
<td>Order Writing and Processing Cost</td>
<td>$15.00</td>
</tr>
<tr>
<td>Cost of Store Inventory Review</td>
<td>$20.00</td>
</tr>
</tbody>
</table>

Inventory Carrying Cost

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Demand (units)</td>
<td>100 Average 80 minimum 125 maximum</td>
</tr>
</tbody>
</table>

Public Warehousing

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Cost per Carton per Day</td>
<td>$0.10 ($5 per day minimum)</td>
</tr>
<tr>
<td>Moving Product to and from Whse.</td>
<td>$15.00 per trip</td>
</tr>
</tbody>
</table>

TRANSPORTATION COST ($ per carton)

<table>
<thead>
<tr>
<th>Shipment Size</th>
<th>Truck</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 50</td>
<td>$8</td>
<td>$15</td>
</tr>
<tr>
<td>51-75</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>76-100</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>101-150</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>151-200</td>
<td>5</td>
<td>12</td>
</tr>
</tbody>
</table>

Order Cycle Time

The order cycle time consists of the length of time in days between writing the order in the store and receiving the shipment. The cycle time consists of the processing time (write order, send to factory and process order) and the shipment time. Use the following values in your analysis:

<table>
<thead>
<tr>
<th>Category</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Expected (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Processing Time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. telephone</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>b. mail</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>
Shipment Time | Minimum | Maximum | Expected (Average)
---|---|---|---
a. Less-than-truckload (175 crtns or less) | 7 | 14 | 10
b. Truckload | 5 | 10 | 7
c. Air | 3 | 5 | 4

Case Write-Up Corrections

Please make the following corrections to your case write-up handout to insure that your terminal sessions will proceed smoothly and efficiently.

Terminal Procedures

It is no longer necessary for you to logoff the terminal at the conclusion of your simulation session. The simulation model, whether it ends due to an error condition or to the normal completion of the simulation, will automatically logoff for you. Wait until you receive the two logoff messages (accounting cost information, and logoff message) and then turn off the terminal using the on-off rocker switch.

14. In Step 14 of the terminal procedures, use the following statement to execute the case study model:

```
exec 'cea5?0.xxxxxx.clist' (return)
```

where xxxxxx is the account number you used to logon, i.e., tc0159, tc0161, etc.

15. Step 15 and 16 should be deleted. You will not receive the ENTER POSITIONAL PARAMETER message, i.e., you should receive the "name" message from the case study model.

NOTE: You will not be allowed to run the case study between 9:30 and 10:30 each evening. If you try to execute the case during this time period, you will receive the file maintenance message and be logged off automatically.

Change the Hagerty Hall Data Center number listed at the bottom of the case write-up foreword from 2-1441 to 2-1851. I will be at this number for most of the evening during the two-week period.
APPENDIX C

Simulation Model Sample Printouts
This appendix contains reproductions of sample printouts from the simulation model. Two simulation sessions for a student receiving full information and required to submit written assignments are illustrated.

The first session is a practice session with the model. The practice session was designed to achieve the following objectives: 1) to familiarize the student with the use of the time-sharing terminal and system; 2) to familiarize the student with the operation of and the report outputs from the model; 3) to inform the student whether he will be required to submit an operations memorandum during each simulation session; and 4) to inform the student of the store and in-transit inventory levels which will exist when he conducts his first "recorded" simulation session.

The second session printout represents the first recorded simulation session for the student. The results of these decisions form the basis for the beginning conditions for the second quarter of operation.

The NOTE phrase at the bottom of each printout describes the purpose and audience of the material presented above it.
exec phoenix

PLEASE TYPE YOUR NAME (FIRST NAME, 1 SPACE, LAST NAME)

William S. Sargent

PLEASE TYPE YOUR STUDENT I.D. CODE (1 LETTER AND 5 NUMBERS)

b40839

WELCOME TO THE PHOENIX INDUSTRIES, LTD., COMPUTER-ASSISTED CASE STUDY. PLEASE REVIEW YOUR CASE WRITE-UP INSTRUCTIONS BEFORE RUNNING THE MODEL. WHEN THE PROGRAM TYPES NEW PAGE, PLEASE, ROLL THE PAPER TO THE TOP OF THE NEXT PAGE. THEN, TYPE 'TOP', AND DEPRESS THE RETURN KEY. DO NOT USE THE KEY MARKED 'ATTN' AT ANY TIME. IF YOU ACCIDENTLY DEPRESS IT, THE PROGRAM WILL STOP EXECUTING AND TYPE 'READY'. DEPRESS THE RETURN KEY TO RESUME EXECUTION OF THE PROGRAM. GOOD LUCK. ##

RUN AUTHORIZED FOR QUARTER 1: MANAGER: WILLIAM S. SARGENT

***** PRACTICE RUN *****

DO NOT USE THE RESULTS OF THIS RUN TO EVALUATE YOUR INITIAL INVENTORY STRATEGY
NOTE: This message is printed only for students required to submit written assignments.

THE EXECUTIVE COMMITTEE HAS DECIDED TO REQUIRE THE SUBMISSION OF AN OPERATIONS MEMO AT THE BEGINNING OF EACH QUARTER. CONSULT YOUR CASE WRITE-UP FOR FORMAT AND CONTENT DETAILS. REMEMBER, THE PURPOSE OF THE MEMO IS TO COMMUNICATE YOUR ANALYSIS TO MANAGEMENT, AND TO OUTLINE YOUR STRATEGY FOR SOLVING THE INVENTORY PROBLEMS OF THE STORE.

MINOR TYPING AND GRAMMATICAL ERRORS IN THE MEMO ARE ACCEPTABLE. TO CORRECT A TYPING ERROR, USE THE BACKSPACE KEY TO MOVE THE TYPING ELEMENT BACK TO THE ERROR. THEN, RETYPE THE LINE CORRECTLY. FOR MAJOR ERRORS, TYPE Q00, PRESS RETURN AND THE PROGRAM WILL DELETE THE LINE. THEN REENTER IT CORRECTLY.

THE ANALYSIS AND STRATEGY SECTIONS OF THE OPERATIONS MEMO MAY CONTAIN A TOTAL OF 36, 105-CHARACTER LINES. USE THE RETURN KEY TO ENTER EACH LINE, AND USE THE SPACE BAR TO INDENT PARAGRAPHS. TYPE THE SECTION TERMINATOR ** IMMEDIATELY AFTER THE LAST SENTENCE IN EACH SECTION. DO NOT USE ** TO TERMINATE INDIVIDUAL PARAGRAPHS WITHIN A SECTION. REMEMBER, USE THE BACKSPACE KEY TO ERASE 1 OR MORE CHARACTERS, AND USE THE LINE DELETION SYMBOL Q00 TO DELETE A LINE.

****DO NOT USE THE ATTENTION KEY AT ANY TIME****

NEW PAGE, PLEASE
NOTE: The memorandum format—shown with sample student reply—is used for the written assignment requirement.

TO: JAMES B. SMITH
FROM: WILLIAM S. SARGENT
SUBJECT: OPERATIONS MEMO FOR QUARTER 1

SECTION I: ANALYSIS OF PREVIOUS PERIOD(S)

In this section of the operations memo, the student would type in his analysis of the previous periods' results, focusing on the impact of his decision strategy on the financial and operating results of the store. In addition, he would analyze his stated objectives from the last period in terms of results actually achieved. He would then terminate this section of the memo like this:

SECTION II: STRATEGY AND FORECAST FOR QUARTER 1: THERE ARE 32 LINES LEFT.

The objective of this section of the memo is to make the student commit himself to some set of objectives which he feels can be reached with the decision strategy he is about to define for the model. In addition, he should present reasons for major changes from last periods' strategy and forecast the impact of the changes on operating results.

END OF OPERATIONS MEMO.
NEW PAGE, PLEASE

DEVELOPMENT VALUES FOR THIS QUARTER
NOTE: The decision variable value definition routine is used for all students.

INDICATE WHETHER YOU WILL USE A CONSTANT ORDER SIZE (OPTION 1) OR USE THE ORDER FORMULA (OPTION 2).
TYPE 1 OR 2

FORMULA X FACTOR (ENTER AS X.XX) : LIMITS ARE: 0.60 AND 1.50
VARIABLE VALUE IS 1.10

FORMULA ** FACTOR (±X.XX OR ±X.XX) : LIMITS ARE: -999 AND 999
VARIABLE VALUE IS 0

MINIMUM ORDER SIZE (IN UNITS) : LIMITS ARE: 0 AND 2500
VARIABLE VALUE IS 500

DAYS IN DEMAND AVERAGE (DAYS) : LIMITS ARE: 1 AND 15
VARIABLE VALUE IS 12

REVIEW INVENTORY EVERY X DAYS : LIMITS ARE: 2 AND 30
VARIABLE VALUE IS 11

LOW STOCK POINT (IN UNITS) : LIMITS ARE: 0 AND 2000
VARIABLE VALUE IS 1000

CANCEL IF NEXT ORDER DUE IN X DAYS : LIMITS ARE: 0 AND 30
VARIABLE VALUE IS 3

SHIPMENT MODE (ENTER AS 1, 2, OR 3) : LIMITS ARE: 1 AND 3
VARIABLE VALUE IS 1

COMMUNICATIONS METHOD (1, 2, OR 3) : LIMITS ARE: 1 AND 3
VARIABLE VALUE IS 1

PLEASE EXAMINE YOUR DECISION VALUES. IF THERE IS AN ERROR, TYPE ERROR. OTHERWISE, NEW PAGE, PLEASE
### Weekly Operations Report

**QUARTER: 1  FIRST DAY: 1  LAST DAY: 30**

**MANAGER: WILLIAM S. SARGENT**

<table>
<thead>
<tr>
<th>DAY</th>
<th>PERIOD TO DATE DEMAND</th>
<th>12-DAY DEMAND</th>
<th>STORE INVENTORY ON ORDER</th>
<th>NEXT ORDER DUE</th>
<th>DAY</th>
<th>SIZE</th>
<th>DUE</th>
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<tbody>
<tr>
<td>1</td>
<td>178</td>
<td>1278</td>
<td>1272</td>
<td>0</td>
<td>1200 TRUCK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>348</td>
<td>1348</td>
<td>1102</td>
<td>0</td>
<td>1200 TRUCK</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>518</td>
<td>1418</td>
<td>932</td>
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<td>1200 TRUCK</td>
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<td></td>
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<tr>
<td>4</td>
<td>679</td>
<td>1479</td>
<td>771</td>
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<td>1200 TRUCK</td>
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<td></td>
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<tr>
<td>5</td>
<td>840</td>
<td>1540</td>
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<td></td>
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<tr>
<td>6</td>
<td>1010</td>
<td>1610</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1180</td>
<td>1680</td>
<td>1470</td>
<td>0</td>
<td>700 AIR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1316</td>
<td>1716</td>
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<td>1794</td>
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<td>700 AIR</td>
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<td></td>
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<tr>
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<td>1830</td>
<td>1720</td>
<td>0</td>
<td>0 -</td>
<td></td>
<td></td>
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<tr>
<td>11</td>
<td>1808</td>
<td>1908</td>
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<td>0 -</td>
<td></td>
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<td>1936</td>
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<td>1960</td>
<td>1042</td>
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<tr>
<td>15</td>
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<td>1985</td>
<td>847</td>
<td>0</td>
<td>2160 AIR</td>
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</tr>
</tbody>
</table>

**NOTE: ALL PRODUCT FIGURES ARE IN UNITS**

---

*The practice session Weekly Operations Report is printed for all students.*

---
<table>
<thead>
<tr>
<th>Date</th>
<th>Weekly Operations Report (continued)</th>
</tr>
</thead>
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<tr>
<td>16</td>
<td>2673 2673 1994 677 0 2160 21 160 AIR</td>
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<tr>
<td>17</td>
<td>2868 2868 2028 482 0 2160 21 160 AIR</td>
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<td>18</td>
<td>3029 3029 2019 321 0 2160 21 160 AIR</td>
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<tr>
<td>19</td>
<td>3199 3199 2019 151 0 2160 21 160 AIR</td>
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<tr>
<td>20</td>
<td>3377 3350 2061 160 0 2000 21 2000 AIR</td>
</tr>
<tr>
<td>21</td>
<td>3538 3510 2044 0 0 4290 21 2000 AIR</td>
</tr>
<tr>
<td>22</td>
<td>3632 3510 2052 1800 200 2290 34 290 TRUCK</td>
</tr>
<tr>
<td>23</td>
<td>3835 3663 2027 1797 50 2290 34 290 TRUCK</td>
</tr>
<tr>
<td>24</td>
<td>4030 3458 2044 1652 0 2290 34 290 TRUCK</td>
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<tr>
<td>25</td>
<td>4208 4036 2044 1474 0 2290 34 290 TRUCK</td>
</tr>
<tr>
<td>26</td>
<td>4420 4248 2112 1262 0 2290 34 290 TRUCK</td>
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<td>27</td>
<td>4581 4409 2078 1101 0 2290 34 290 TRUCK</td>
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<td>28</td>
<td>4751 4579 2078 931 0 2290 34 290 TRUCK</td>
</tr>
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<td>29</td>
<td>4921 4749 2053 761 0 2290 34 290 TRUCK</td>
</tr>
<tr>
<td>30</td>
<td>5116 4944 2087 566 0 2290 34 290 TRUCK</td>
</tr>
</tbody>
</table>

**** END OF QUARTER 1

NEW PAGE, PLEASE
**QUARTERLY FINANCIAL STATEMENT**

MANAGER: WILLIAM S. SARGENT  QUARTER: 1  

**NOTE:** CALCULATIONS BASED ON SALES REVENUE

<table>
<thead>
<tr>
<th></th>
<th>CURRENT QUARTER</th>
<th>Year-To-Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SALES REVENUE (NET)</strong></td>
<td>$29,664 100.0%</td>
<td>$29,664 100.0%</td>
</tr>
<tr>
<td><strong>LESS: COST OF GOODS SOLD</strong></td>
<td>$19,776 66.7%</td>
<td>$19,776 66.7%</td>
</tr>
<tr>
<td><strong>GROSS MARGIN</strong></td>
<td>$9,888 33.3%</td>
<td>$9,888 33.3%</td>
</tr>
</tbody>
</table>

**VARIABLE EXPENSES:**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TRANSPORTATION COST</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRUCK</td>
<td>$1,232</td>
<td>$1,232</td>
</tr>
<tr>
<td>AIR</td>
<td>$3,620 $4,582</td>
<td>$3,620 $4,582</td>
</tr>
<tr>
<td><strong>ORDERING COST</strong></td>
<td>$290 1.0%</td>
<td>$290 1.0%</td>
</tr>
<tr>
<td><strong>INVENTORY CHARGES</strong></td>
<td>$130 0.4%</td>
<td>$130 0.4%</td>
</tr>
<tr>
<td><strong>WAREHOUSING COST</strong></td>
<td>$55 0.2%</td>
<td>$55 0.2%</td>
</tr>
<tr>
<td><strong>TOTAL VARIABLE EXPENSES</strong></td>
<td>$5,327 18.0%</td>
<td>$5,327 18.0%</td>
</tr>
</tbody>
</table>

|$ CONTRIBUTION BEFORE FIXED EXPENSES AND TAXES $4,561 15.4% $4,561 15.4%

**FIXED EXPENSES:**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CORPORATE SERVICE ALLOCATION</strong></td>
<td>$3,000 10.1%</td>
<td>$3,000 10.1%</td>
</tr>
<tr>
<td><strong>RENT, UTILITIES, SALARY, MISCELLANEOUS</strong></td>
<td>$4,000 $7,000 23.6%</td>
<td>$4,000 $7,000 23.6%</td>
</tr>
</tbody>
</table>

**NET $ CONTRIBUTION BEFORE TAXES** $-2,439 -8.2% $-2,439 -8.2%
**QUARTERLY OPERATING REPORT**

**MANAGER:** WILLIAM S. SARGENT  \quad **QUARTER:** 1

<table>
<thead>
<tr>
<th></th>
<th>CURRENT QUARTER</th>
<th>YEAR-TO-DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SALES STATISTICS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIMES STOCKED OUT</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>LOST SALES (UNITS)</td>
<td>172</td>
<td>172</td>
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<tr>
<td><strong>INVENTORY STATISTICS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STORE AVERAGE (UNITS)</td>
<td>431</td>
<td>431</td>
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<tr>
<td>WISE AVERAGE (UNITS/STORAGE DAY)</td>
<td>83</td>
<td>83</td>
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<tr>
<td>PUBLIC WISE USED (DAYS)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>NORMAL STOCK REVIEWS (#)</td>
<td>2</td>
<td>2</td>
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<tr>
<td>EMERGENCY STOCK REVIEWS (#)</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><strong>ORDER STATISTICS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NORMAL ORDERS PLACED</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>EMERGENCY ORDERS PLACED</td>
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<td>2</td>
</tr>
<tr>
<td>ORDERS CANCELLED</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>UNITS CANCELLED</td>
<td>640</td>
<td>640</td>
</tr>
</tbody>
</table>
Quarterly Operations Report (continued). Inventory level and on-order values for first recorded quarter are printed for all students.

NOTE: Quarterly Operations Report (continued). Inventory level and on-order values for first recorded quarter are printed for all students.

<table>
<thead>
<tr>
<th>SHIPMENT SIZE (UP TO)</th>
<th>TRUCK SHIPPED</th>
<th>AIR SHIPPED</th>
<th>TRUCK COST</th>
<th>AIR COST</th>
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</thead>
<tbody>
<tr>
<td>25</td>
<td>0</td>
<td>1</td>
<td>$ 0</td>
<td>$ 240</td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>0</td>
<td>$ 232</td>
<td>$ 0</td>
</tr>
<tr>
<td>75</td>
<td>0</td>
<td>1</td>
<td>$ 0</td>
<td>$ 980</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
<td>0</td>
<td>$ 0</td>
<td>$ 0</td>
</tr>
<tr>
<td>150</td>
<td>0</td>
<td>0</td>
<td>$ 0</td>
<td>$ 0</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
<td>1</td>
<td>$ 1000</td>
<td>$ 2400</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>2</strong></td>
<td><strong>3</strong></td>
<td><strong>$ 1232</strong></td>
<td><strong>$ 3620</strong></td>
</tr>
</tbody>
</table>

**** END OF PRACTICE RUN ****

USE THE FOLLOWING VALUES AS THE BASIS FOR YOUR INITIAL INVENTORY STRATEGY

THERE ARE 1450 UNITS OF INVENTORY ON HAND IN THE STORE

THERE ARE 0 UNITS IN THE WAREHOUSE

THERE ARE 1200 UNITS ON ORDER AND IN TRANSIT

EXPECTED SIZE(UNITS) MODE

DAY 10 1200 TRUCK

THE NEXT SESSION WILL BE FOR THE RECORD. GOOD LUCK.

REMEMBER TO PREPARE YOUR ANALYSIS FOR THE OPERATIONS MEMO
PLEASE TYPE YOUR NAME (FIRST NAME, 1 SPACE, LAST NAME)

William S. Sargent

PLEASE TYPE YOUR STUDENT I.D. CODE (1 LETTER AND 5 NUMBERS)

b40839

WELCOME TO THE PHOENIX INDUSTRIES, LTD., COMPUTER-ASSISTED CASE STUDY. PLEASE REVIEW YOUR CASE WRITE-UP INSTRUCTIONS BEFORE RUNNING THE MODEL. WHEN THE PROGRAM TYPES NEW PAGE, PLEASE ROLL THE PAPER TO THE TOP OF THE NEXT PAGE. THEN, TYPE TOP, AND DEPRESS THE RETURN KEY. DO NOT USE THE KEY MARKED ATTN AT ANY TIME. IF YOU ACCIDENTLY DEPRESS IT, THE PROGRAM WILL STOP EXECUTING AND TYPE READY. DEPRESS THE RETURN KEY TO RESUME EXECUTION OF THE PROGRAM. GOOD LUCK. ##

RUN AUTHORIZED FOR QUARTER 1: MANAGER: WILLIAM S. SARGENT

THE ANALYSIS AND STRATEGY SECTIONS OF THE OPERATIONS MEMO MAY CONTAIN A TOTAL OF 36, 105-CHARACTER LINES. USE THE RETURN KEY TO ENTER EACH LINE, AND USE THE SPACE BAR TO INDENT PARAGRAPHS. TYPE THE SECTION TERMINATOR ## IMMEDIATELY AFTER THE LAST SENTENCE IN EACH SECTION. DO NOT USE ## TO TERMINATE INDIVIDUAL PARAGRAPHS WITHIN A SECTION. REMEMBER, USE THE BACKSPACE KEY TO ERASE 1 OR MORE CHARACTERS, AND USE THE LINE DELETION SYMBOL ## TO DELETE A LINE.

****DO NOT USE THE ATTENTION KEY AT ANY TIME****

NEW PAGE, PLEASE
TO: JAMES B. SMITH
FROM: WILLIAM S. SARGENT
SUBJECT: OPERATIONS MEMO FOR QUARTER 1

SECTION 1: ANALYSIS OF PREVIOUS PERIOD(S)

the objective of section 1 of the memo is to provide the student with additional incentive to closely examine the results of the previous quarter's decision strategy as an aid to formulating a revised strategy for the next period. In addition, it provides him with an incentive to recognize the shortcomings, if any, of his previous decision strategy with respect to his objectives. He then ends the first section of the operations memo like this 

SECTION II: STRATEGY AND FORECAST FOR QUARTER 1: THERE ARE 31 LINES LEFT.

the objective of section II of the memo is to provide the student with additional incentive to more clearly set forth his rationale for his decision strategy. In addition, he should include here his reasoning for making major changes in his previous decision strategy for the coming quarter. After completing this section, he terminates the memo like this 

END OF OPERATIONS MEMO.
NEW PAGE, PLEASE

DECISION VALUES FOR THIS QUARTER
The decision variables value definition routine is used for all students.

NOTE: The decision variables value definition routine is used for all students.

1. If you will use a constant order size (Option 1) or use the order formula (Option 2),
   type 1 or 2.

2. Formula X Factor (Enter as X.XX): Limits are: 0.00 and 2.50
   Variable value is 1.00

3. Formula ++ Factor (+XXX or -XXX): Limits are: -999 and 999
   Variable value is 100

4. Minimum order size (in units): Limits are: 0 and 2500
   Variable value is 500

5. Days in demand average (days): Limits are: 1 and 15
   Variable value is 10

6. Review inventory every X days: Limits are: 2 and 30
   Variable value is 10

7. Low stock point (in units): Limits are: 0 and 2000
   Variable value is 600

8. Cancel if next order due in X days: Limits are: 0 and 30
   Variable value is 3

9. Shipment mode (enter as 1, 2, or 3): Limits are: 1 and 3
   Variable value is 1

10. Communications method (1, 2, or 3): Limits are: 1 and 3
    Variable value is 1

Please examine your decision values. If there is an error, type ERROR. Otherwise, new page, please.
### Operations Report

**Quarter:** 1  
**First Day:** 1  
**Last Day:** 60  
**Note:** All product figures are in units

**Manager:** William S. Sargent

<table>
<thead>
<tr>
<th>Day</th>
<th>Period Demand</th>
<th>To Date Demand</th>
<th>10-Day Demand</th>
<th>10-Day Store Wise On Order</th>
<th>10-Day Next Order Due</th>
<th>Size</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>105</td>
<td>105</td>
<td>1005</td>
<td>1345</td>
<td>0</td>
<td>10</td>
<td>1200 Truck</td>
</tr>
<tr>
<td>6</td>
<td>595</td>
<td>595</td>
<td>995</td>
<td>855</td>
<td>0</td>
<td>10</td>
<td>1200 Truck</td>
</tr>
<tr>
<td>11</td>
<td>1065</td>
<td>1065</td>
<td>960</td>
<td>1585</td>
<td>0</td>
<td>23</td>
<td>620 Truck</td>
</tr>
<tr>
<td>16</td>
<td>1575</td>
<td>1575</td>
<td>980</td>
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<td>0</td>
<td>23</td>
<td>620 Truck</td>
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<td>21</td>
<td>2085</td>
<td>2085</td>
<td>1020</td>
<td>1185</td>
<td>0</td>
<td>33</td>
<td>1190 Truck</td>
</tr>
<tr>
<td>26</td>
<td>2605</td>
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<td>1190 Truck</td>
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<tr>
<td>31</td>
<td>3110</td>
<td>3110</td>
<td>1025</td>
<td>160</td>
<td>0</td>
<td>33</td>
<td>1190 Truck</td>
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<tr>
<td>36</td>
<td>3545</td>
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<td>1040</td>
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<td>0</td>
<td>33</td>
<td>1190 Truck</td>
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<td>4185</td>
<td>3585</td>
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<td>46</td>
<td>1350 Truck</td>
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<td>4700</td>
<td>4100</td>
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<td>1710</td>
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<td>0</td>
<td>0 -</td>
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<td>4590</td>
<td>1005</td>
<td>1220</td>
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<tr>
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<td>5670</td>
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<td>970</td>
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<td>60</td>
<td>6045</td>
<td>5445</td>
<td>945</td>
<td>365</td>
<td>0</td>
<td>61</td>
<td>960 Truck</td>
</tr>
</tbody>
</table>

**** End of Quarter 1

New page, please
NOTE: The Quarterly Financial Statement is printed for all students.

QUARTERLY FINANCIAL STATEMENT

MANAGER: WILLIAM S. SARGENT  QUARTER: 1  NOTE: % CALCULATIONS BASED ON SALES REVENUE

<table>
<thead>
<tr>
<th></th>
<th>CURRENT QUARTER</th>
<th>YEAR-TO-DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SALES REVENUE (NET)</td>
<td>$ 32670 100.0 %</td>
<td>$ 32670 100.0 %</td>
</tr>
<tr>
<td>LESS: COST OF GOODS SOLD</td>
<td>$ 21780 66.7 %</td>
<td>$ 21780 66.7 %</td>
</tr>
<tr>
<td>GROSS MARGIN</td>
<td>$ 10890 33.3 %</td>
<td>$ 10890 33.3 %</td>
</tr>
</tbody>
</table>

VARIABLE EXPENSES:

**TRANSPORTATION COST**

<table>
<thead>
<tr>
<th></th>
<th>CURRENT QUARTER</th>
<th></th>
<th>YEAR-TO-DATE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TRUCK</td>
<td>$ 3190</td>
<td></td>
<td>$ 3190</td>
<td></td>
</tr>
<tr>
<td>AIR</td>
<td>$ 0 $ 3190</td>
<td>9.8 %</td>
<td>$ 0 $ 3190</td>
<td>9.8 %</td>
</tr>
</tbody>
</table>

**ORDERING COST**

<table>
<thead>
<tr>
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<th></th>
<th>YEAR-TO-DATE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>INVENTORY CHARGES</td>
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<td>1.1 %</td>
<td>$ 350</td>
<td>1.1 %</td>
</tr>
<tr>
<td>WAREHOUSING COST</td>
<td>$ 254</td>
<td>0.8 %</td>
<td>$ 254</td>
<td>0.8 %</td>
</tr>
</tbody>
</table>

**TOTAL VARIABLE EXPENSES**

<table>
<thead>
<tr>
<th></th>
<th>CURRENT QUARTER</th>
<th></th>
<th>YEAR-TO-DATE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ 3849 11.8 %</td>
<td></td>
<td>$ 3849</td>
<td>11.8 %</td>
</tr>
</tbody>
</table>

$ CONTRIBUTION BEFORE FIXED EXPENSES AND TAXES

<table>
<thead>
<tr>
<th></th>
<th>CURRENT QUARTER</th>
<th></th>
<th>YEAR-TO-DATE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ 7041 21.6 %</td>
<td></td>
<td>$ 7041</td>
<td>21.6 %</td>
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</table>

FIXED EXPENSES:

<table>
<thead>
<tr>
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<th></th>
<th>YEAR-TO-DATE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CORPORATE SERVICE ALLOCATION</td>
<td>$ 3000</td>
<td>9.2 %</td>
<td>$ 3000</td>
<td>9.2 %</td>
</tr>
<tr>
<td>RENT, UTILITIES, SALARY, MISC</td>
<td>$ 4000 $ 7000</td>
<td>21.4 %</td>
<td>$ 4000 $ 7000</td>
<td>21.4 %</td>
</tr>
</tbody>
</table>

**NET $ CONTRIBUTION BEFORE TAXES**

<table>
<thead>
<tr>
<th></th>
<th>CURRENT QUARTER</th>
<th></th>
<th>YEAR-TO-DATE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ 41 0.1 %</td>
<td></td>
<td>$ 41</td>
<td>0.1 %</td>
</tr>
</tbody>
</table>

NEW PAGE, PLEASE
The Quarterly Operations Report is printed only for students receiving full information.

**QUARTERLY OPERATING REPORT**

**MANAGER: WILLIAM S. SARGENT QUARTER: 1**

<table>
<thead>
<tr>
<th></th>
<th>CURRENT QUARTER</th>
<th>YEAR-TO-DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SALES STATISTICS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Times Stocked Out</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Lost Sales (Units)</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td><strong>INVENTORY STATISTICS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store Average (Units)</td>
<td>846</td>
<td>846</td>
</tr>
<tr>
<td>Wise Average (Units/Storage Day)</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Public Wise Used (Days)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Normal Stock Reviews (#)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Emergency Stock Reviews (#)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>ORDER STATISTICS</strong></td>
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<td></td>
</tr>
<tr>
<td>Normal Orders Placed</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Emergency Orders Placed</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Orders Cancelled</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Units Cancelled</td>
<td>260</td>
<td>260</td>
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</table>
### SHIPMENT ANALYSIS (ALL FIGURES IN CARTONS)

<table>
<thead>
<tr>
<th>SHIPMENT SIZE (UP TO)</th>
<th>TRUCK SHIPPED</th>
<th>AIR SHIPPED</th>
<th>TRUCK COST</th>
<th>AIR COST</th>
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</thead>
<tbody>
<tr>
<td>25</td>
<td>0</td>
<td>0</td>
<td>$ 0</td>
<td>$ 0</td>
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<tr>
<td>50</td>
<td>0</td>
<td>0</td>
<td>$ 0</td>
<td>$ 0</td>
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<tr>
<td>75</td>
<td>1</td>
<td>0</td>
<td>$ 434</td>
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<tr>
<td>100</td>
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<td>0</td>
<td>$ 1232</td>
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<td>150</td>
<td>2</td>
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<td>$ 1524</td>
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<tr>
<td>200</td>
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<td>0</td>
<td>$ 0</td>
<td>$ 0</td>
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<tr>
<td><strong>TOTALS</strong></td>
<td><strong>5</strong></td>
<td><strong>0</strong></td>
<td><strong>$ 3190</strong></td>
<td><strong>$ 0</strong></td>
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</tbody>
</table>

**SIMULATION COMPLETED.**
**READY**
TABLE 9.—Detailed analysis of student performance on the case study assignment, by section and by learning environment.

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Section A</th>
<th></th>
<th></th>
<th></th>
<th>Section B</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X1</td>
<td>X2</td>
<td>X3</td>
<td>X4</td>
<td>X1</td>
<td>X2</td>
<td>X3</td>
<td>X4</td>
</tr>
<tr>
<td>Annual Revenue ($)</td>
<td>127,635</td>
<td>130,226</td>
<td>135,203</td>
<td>137,350</td>
<td>136,150</td>
<td>136,453</td>
<td>128,725</td>
<td>136,465</td>
</tr>
<tr>
<td>High</td>
<td>142,440</td>
<td>144,300</td>
<td>144,300</td>
<td>144,300</td>
<td>144,300</td>
<td>144,300</td>
<td>143,880</td>
<td>144,030</td>
</tr>
<tr>
<td>Low</td>
<td>101,430</td>
<td>133,810</td>
<td>116,340</td>
<td>128,470</td>
<td>108,720</td>
<td>122,100</td>
<td>105,300</td>
<td>132,030</td>
</tr>
<tr>
<td>Median</td>
<td>130,970</td>
<td>136,230</td>
<td>136,110</td>
<td>139,650</td>
<td>139,500</td>
<td>135,720</td>
<td>138,085</td>
<td>139,095</td>
</tr>
<tr>
<td>Annual Profit (%)</td>
<td>(2.27)%</td>
<td>1.45%</td>
<td>(1.74)%</td>
<td>(9.68)%</td>
<td>(1.95)%</td>
<td>(5.43)%</td>
<td>(1.05)%</td>
<td>(3.15)%</td>
</tr>
<tr>
<td>High</td>
<td>3,321</td>
<td>4,545</td>
<td>5,675</td>
<td>4,260</td>
<td>4,090</td>
<td>2,945</td>
<td>2,334</td>
<td>1,878</td>
</tr>
<tr>
<td>Low</td>
<td>(7,342)</td>
<td>(2,705)</td>
<td>(10,189)</td>
<td>(53,426)</td>
<td>(34,226)</td>
<td>(17,195)</td>
<td>(8,919)</td>
<td>(11,694)</td>
</tr>
<tr>
<td>Median</td>
<td>(3,226)</td>
<td>1,442</td>
<td>(900)</td>
<td>(3,273)</td>
<td>1,924</td>
<td>(3,467)</td>
<td>116</td>
<td>(1,910)</td>
</tr>
<tr>
<td>Profit as a Per Cent of Annual Revenue (%)</td>
<td>(2.0)%</td>
<td>1.1%</td>
<td>(1.3)%</td>
<td>(7.8)%</td>
<td>(1.2)%</td>
<td>(3.9)%</td>
<td>(5.7)%</td>
<td>(2.3)%</td>
</tr>
<tr>
<td>High</td>
<td>2.4</td>
<td>3.2</td>
<td>4.0</td>
<td>3.1</td>
<td>3.0</td>
<td>2.0</td>
<td>2.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Low</td>
<td>(6.6)</td>
<td>(2.0)</td>
<td>(7.1)</td>
<td>(37.0)</td>
<td>(23.9)</td>
<td>(11.9)</td>
<td>(8.0)</td>
<td>(8.2)</td>
</tr>
<tr>
<td>Median</td>
<td>(2.6)</td>
<td>1.1</td>
<td>(0.7)</td>
<td>(1.7)</td>
<td>1.4</td>
<td>(2.6)</td>
<td>0.1</td>
<td>(1.4)</td>
</tr>
</tbody>
</table>

a( ) denote negative values.
TABLE 10.—Detailed results of tests of the null hypothesis that there were no significant differences in median performance scores among the learning environments—by data group, by performance criterion.

<table>
<thead>
<tr>
<th>Combined Sections b</th>
<th>Section A b</th>
<th>Section B b</th>
</tr>
</thead>
<tbody>
<tr>
<td>X2 X1</td>
<td>128.5</td>
<td>.080</td>
</tr>
<tr>
<td>X3 X1</td>
<td>216.5</td>
<td>.275</td>
</tr>
<tr>
<td>X4 X1</td>
<td>101.5</td>
<td>.044</td>
</tr>
<tr>
<td>X2 X3</td>
<td>147.5</td>
<td>.199</td>
</tr>
<tr>
<td>X4 X2</td>
<td>107.5</td>
<td>.426</td>
</tr>
<tr>
<td>X3 X3</td>
<td>121.0</td>
<td>.142</td>
</tr>
</tbody>
</table>

**Annual Revenue ($)**

| X1 X2 | 167.0 | .395 | NS | X2 X1 | 19.0 | .018 | VS | X1 X2 | 16.0 | .009 | VS |
| X1 X3 | 209.0 | .219 | NS | X3 X1 | 55.0 | .347 | NS | X1 X3 | 15.0 | .091 | S |
| X1 X4 | 120.0 | .135 | NS | X4 X1 | 38.0 | .465 | NS | X1 X4 | 15.0 | .018 | VS |
| X3 X2 | 172.0 | .453 | NS | X2 X3 | 30.0 | .041 | NS | X3 X2 | 14.0 | .072 | S |
| X4 X2 | 97.0 | .266 | NS | X2 X4 | 12.0 | .117 | NS | X4 X2 | 29.0 | .250 | NS |
| X3 X4 | 139.0 | .313 | NS | X3 X4 | 47.0 | .471 | NS | X3 X4 | 18.0 | .245 | NS |

**Annual Profit ($)**

| X1 X2 | 173.5 | .470 | NS | X2 X1 | 19.0 | .018 | VS | X1 X2 | 14.0 | .010 | VS |
| X1 X3 | 181.0 | .321 | NS | X3 X1 | 94.5 | .338 | NS | X1 X3 | 15.5 | .088 | S |
| X1 X4 | 129.0 | .201 | NS | X4 X1 | 35.5 | .463 | NS | X1 X4 | 13.5 | .028 | VS |
| X3 X2 | 143.5 | .493 | NS | X2 X3 | 28.5 | .033 | NS | X3 X2 | 13.0 | .049 | VS |
| X2 X4 | 96.0 | .252 | NS | X2 X4 | 12.0 | .117 | NS | X2 X4 | 27.0 | .317 | NS |
| X3 X4 | 118.0 | .323 | NS | X3 X4 | 46.0 | .441 | NS | X3 X4 | 15.0 | .227 | NS |

**Profit as a Per Cent of Revenue (%)**

| X1 X2 | 173.5 | .470 | NS | X2 X1 | 19.0 | .018 | VS | X1 X2 | 14.0 | .010 | VS |
| X1 X3 | 181.0 | .321 | NS | X3 X1 | 94.5 | .338 | NS | X1 X3 | 15.5 | .088 | S |
| X1 X4 | 129.0 | .201 | NS | X4 X1 | 35.5 | .463 | NS | X1 X4 | 13.5 | .028 | VS |
| X3 X2 | 143.5 | .493 | NS | X2 X3 | 28.5 | .033 | NS | X3 X2 | 13.0 | .049 | VS |
| X2 X4 | 96.0 | .252 | NS | X2 X4 | 12.0 | .117 | NS | X2 X4 | 27.0 | .317 | NS |
| X3 X4 | 118.0 | .323 | NS | X3 X4 | 46.0 | .441 | NS | X3 X4 | 15.0 | .227 | NS |

---

**Note:** See Appendix G for a discussion of the Mann-Whitney U test.

**Notes:**
- Higher and Lower indicate the relative median performance ranks of the two groups.
- U is the value of the Mann-Whitney U statistic. See Appendix G.
- P is the probability of rejecting the null hypothesis when it is actually true.
- Eval. is the level of significance of the test result: NS is not significant; S is significant—P < .10, one-tail; VS is very significant—P < .05, one-tail.
TABLE 11.—Detailed results of tests of the null hypothesis that one variable was not dominant with respect to its effect on performance—by data group, by performance criterion.

<table>
<thead>
<tr>
<th>COMBINED SECTIONS</th>
<th>SECTION A</th>
<th>SECTION B</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGHER</td>
<td>LOWER</td>
<td>U</td>
</tr>
<tr>
<td>Full Information (X1,X3) vs. Limited Information (X2,X4)—Annual Revenue ($)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X2,X4) (X1,X3) 598.5 .0376 VS (X2,X4) (X1,X3) 121.5 .0376 VS (X2,X4) (X1,X3) 115.0 .318 VS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Information (X1,X3) vs. Limited Information (X2,X4)—Annual Profit ($)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X1,X3) (X2,X4) 598.0 .247 VS (X2,X4) (X1,X3) 138.0 .085 S (X1,X3) (X2,X4) 60.0 .005 VS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Information (X1,X3) vs. Limited Information (X2,X4)—Profit as a Per Cent of Annual Revenue (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X1,X3) (X2,X4) 561.0 .321 VS (X2,X4) (X1,X3) 136.0 .076 S (X1,X3) (X2,X4) 55.5 .005 VS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Written Assignment (X1,X2) vs. No Written Assignment (X3,X4)—Annual Revenue ($)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X3,X4) (X1,X2) 620.0 .279 VS (X3,X4) (X1,X2) 172.5 .116 NS (X1,X2) (X3,X4) 117.0 .366 NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Written Assignment (X1,X2) vs. No Written Assignment (X3,X4)—Annual Profit ($)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X1,X2) (X3,X4) 606.0 .199 VS (X1,X2) (X3,X4) 193.0 .298 NS (X1,X2) (X3,X4) 112.0 .297 NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Written Assignment (X1,X2) vs. No Written Assignment (X3,X4)—Profit as a Per Cent of Annual Revenue (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(X1,X2) (X3,X4) 549.5 .244 VS (X1,X2) (X3,X4) 193.5 .252 NS (X1,X2) (X3,X4) 106.0 .323 NS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aSee Appendix G for a discussion of the Mann-Whitney U test.

bHIGHER and LOWER indicate the relative median performance ranks of the two groups. U is the value of the Mann-Whitney U statistic. See Appendix C. P is the probability of rejecting the null hypothesis when it is actually true. EVAL is the level of significance of the test result; NS is not significant; S is significant—P < .10, one-tail; VS is very significant—P < .05, one-tail.
TABLE 12.—Detailed results of tests of the null hypothesis that there were no significant differences in median performance scores attributable to level of information feedback, given a common level of written assignment requirements—by data group, by performance criterion

<table>
<thead>
<tr>
<th>COMBINED SECTIONS</th>
<th>SECTION A</th>
<th>SECTION B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HIGHER</td>
<td>LOWER</td>
</tr>
<tr>
<td>Full Info.—Written Assignment (X1) vs. Limited Info.—Written Assignment (X2)—Annual Revenue ($)</td>
<td>X2 X1 128.5 .080 S</td>
<td>X2 X1 11.0 .026 VS</td>
</tr>
<tr>
<td>Full Info.—Written Assignment (X1) vs. Limited Info.—Written Assignment (X2)—Annual Profit ($)</td>
<td>X1 X2 167.0 .345 NS</td>
<td>X2 X1 19.0 .018 VS</td>
</tr>
<tr>
<td>Full Info.—Written Assignment (X1) vs. Limited Info.—Written Assignment (X2)—Per Cent Profit (%)</td>
<td>X1 X2 172.5 .470 NS</td>
<td>X2 X1 19.0 .018 VS</td>
</tr>
<tr>
<td>Full Info.—No Written Assignment (X3) vs. Limited Info.—No Written Assignment (X4)—Annual Revenue ($)</td>
<td>X4 X3 121.0 .142 NS</td>
<td>X4 X3 38.0 .230 NS</td>
</tr>
<tr>
<td>Full Info.—No Written Assignment (X3) vs. Limited Info.—No Written Assignment (X4)—Annual Profit ($)</td>
<td>X3 X4 139.0 .313 NS</td>
<td>X4 X3 47.0 .471 NS</td>
</tr>
<tr>
<td>Full Info.—No Written Assignment (X3) vs. Limited Info.—No Written Assignment (X4)—Per Cent Profit (%)</td>
<td>X3 X4 114.0 .723 NS</td>
<td>X3 X4 46.0 .441 NS</td>
</tr>
</tbody>
</table>

aSee Appendix G for a discussion of the Mann-Whitney U test.

bHIGHER and LOWER indicate the relative median performance ranks of the two groups.
U is the value of the Mann-Whitney U statistic. See Appendix G.
P is the probability of rejecting the null hypothesis when it is actually true.
EVAL is the level of significance of the test result: NS is not significant; S is significant
--P < .10, one-tail; VS is very significant--P < .05, one-tail.
TABLE 13.--Detailed results of tests of the null hypothesis that there were no significant differences in median performance scores attributable to written assignment requirements, given a common level of information feedback--by data group, by performance criterion.

<table>
<thead>
<tr>
<th>COMBINED SECTIONS</th>
<th>SECTION A</th>
<th>SECTION B</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGHER</td>
<td>LOWER</td>
<td>U</td>
</tr>
<tr>
<td>Written Assignment—Full Info. (X1) vs. No Written Assignment—Full Info. (X3)—Annual Revenue ($)</td>
<td>X3</td>
<td>X1</td>
</tr>
<tr>
<td>Written Assignment—Full Info. (X1) vs. No Written Assignment—Full Info. (X3)—Annual Profit ($)</td>
<td>X1</td>
<td>X3</td>
</tr>
<tr>
<td>Written Assignment—Full Info. (X1) vs. No Written Assignment—Full Info. (X3)—Per Cent Profit (%)</td>
<td>X1</td>
<td>X3</td>
</tr>
<tr>
<td>Written Assignment—Limited Info. (X2) vs. No Written Assignment—Limited Info. (X4)—Annual Revenue ($)</td>
<td>X4</td>
<td>X2</td>
</tr>
<tr>
<td>Written Assignment—Limited Info. (X2) vs. No Written Assignment—Limited Info. (X4)—Annual Profit ($)</td>
<td>X2</td>
<td>X4</td>
</tr>
<tr>
<td>Written Assignment—Limited Info. (X2) vs. No Written Assignment—Limited Info. (X4)—Per Cent Profit (%)</td>
<td>X2</td>
<td>X4</td>
</tr>
</tbody>
</table>

See Appendix G for a discussion of the Mann-Whitney U test.

HIGHER and LOWER indicate the relative median performance ranks of the two groups. U is the value of the Mann-Whitney U statistic. See Appendix G. P is the probability of rejecting the null hypothesis when it is actually true. EVAL is the level of significance of the test result: NS is not significant; S is significant —P < .10, one-tail; VS is very significant—P < .05, one-tail.
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Section A</th>
<th>Section B</th>
<th>Total</th>
<th>Env. X1</th>
<th>Env. X2</th>
<th>Env. X3</th>
<th>Env. X4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Demographic Characteristics</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic class?</td>
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<td>42</td>
<td>100</td>
<td>32</td>
<td>100</td>
<td>74</td>
<td>100</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Full-time</td>
<td>42</td>
<td>100</td>
<td>32</td>
<td>100</td>
<td>74</td>
<td>100</td>
<td>22</td>
</tr>
<tr>
<td>Student status?</td>
<td></td>
<td>42</td>
<td>100</td>
<td>32</td>
<td>100</td>
<td>74</td>
<td>100</td>
<td>22</td>
</tr>
<tr>
<td>Field of study?</td>
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</table>

aPercentages rounded to nearest per cent and adjusted for nonresponse; totals may not add to 100 per cent due to rounding.

bThe full text of each question is presented in the questionnaire forms in Appendix A.

cResponse categories not receiving any response among the various tabulations have been eliminated.
TABLE 15.--Detailed summary of the statistical analysis of student demographic and experience characteristics using the Mann-Whitney U test, by section and learning environment

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<th>Learning Environment Comparisons</th>
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<th>P</th>
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### Learning Environment Comparison

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*a* See Appendix G for a discussion of the Mann-Whitney U test.

*b* The full text of each question is presented in the questionnaire forms in Appendix A.

*c* Higher and lower indicate the section or group reporting a higher or more positive response to the questions.

U is the value of the Mann-Whitney U statistic. See Appendix G.

P is the probability of rejecting the null hypothesis when it is actually true.

Eval. is the level of significance of the test result: NS is not significant; S is significant—P < .10, one-tail; VS is very significant—P < .05, one-tail.
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*See Appendix G for a discussion of the Kendall Rank Correlation Coefficient.
TABLE 16 (Continued)

bThe full text of the questions is presented in the questionnaire forms in Appendix A.

cTau is the value of the Kendall Rank Correlation Coefficient. See Appendix G.

dp is the probability that the correlation relationship observed is due to chance, i.e., the "true" correlation relationship is zero.

eDue to the method of coding the responses, positive correlation relationships indicate that higher performance was associated with "no" response to the question.

fDue to the method of coding the responses, positive correlation relationships indicate that higher performance was associated with lower agreement or higher disagreement on the question.
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**TABLE 17 (Continued)**

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*The full text of each question is listed in the post test questionnaire forms in Appendix A.*

*Percentages rounded to nearest per cent and adjusted for nonresponse; totals may not add to 100 per cent due to rounding.*

*Responses coded as follows:*

- **Positive**: strongly agree, agree
- **Neutral**: somewhat agree, somewhat disagree
- **Negative**: disagree, strongly disagree
TABLE 18.—Detailed summary of the statistical analysis of student attitudes toward the case study method using the Mann-Whitney U test, by section and learning environment.

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a See Appendix C for a discussion of the Mann-Whitney U test.
b The full text of each question is presented in the questionnaire forms in Appendix A.
c Higher and lower indicate the section or group reporting a higher or more positive response to the questions. U is the value of the Mann-Whitney U statistic. See Appendix C. P is the probability of rejecting the null hypothesis when it is actually true. Eval. is the level of significance of the test result. NS is not significant; S is significant—P < .10, one-tail; VS is very significant—P < .05, one-tail.
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aPercentages rounded to nearest percent and adjusted for nonresponse; totals may not add to 100 percent due to rounding.

bResponses coded as follows: Positive: strongly agree, agree
Neutral: somewhat agree, somewhat disagree
Negative: disagree, strongly disagree

cCalculated as follows: (change in number of responses)/
(number of pretest responses); - indicates decrease between pretest and post test.
TABLE 20.—Detailed summary of the statistical analysis of Section A pre-experiment differences in case study method attitudes, by learning environment

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*See appendix G for a discussion of the Mann-Whitney U test.

*The full text of each question is presented in the questionnaire forms in Appendix A.

*Higher and lower indicate the section or group reporting a higher or more positive response to the questions.

*U is the value of the Mann-Whitney U statistic. See Appendix G.

*P is the probability of rejecting the null hypothesis when it is actually true.

*Eval. is the level of significance of the test result: NS is not significant; S is significant--P < .10, one-tail; VS is very significant--P < .05, one-tail.
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TABLE 21.—Analysis of responses to questions concerning student attitudes toward the experiment case study, by section and by learning environment\textsuperscript{a,b} (continued)

<table>
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<th>Env. X2</th>
<th>Env. X3</th>
<th>Env. X4</th>
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<tbody>
<tr>
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<td>%</td>
<td>No.</td>
<td>%</td>
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<td>%</td>
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<td>Time-sharing terminal instructions O.K?</td>
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<td>7</td>
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<td>12</td>
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<tr>
<td>Would like formal demonstration of time-sharing terminal?</td>
<td>Positive</td>
<td>7</td>
<td>17</td>
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<td>56</td>
<td>25</td>
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<tr>
<td>Overall, case study was valuable contribution to course?</td>
<td>Positive</td>
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<td>24</td>
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\textsuperscript{a}The full text of each question is listed in the post test questionnaire forms in Appendix A.

\textsuperscript{b}Percentages rounded to nearest per cent and adjusted for nonresponse; totals may not add to 100 per cent due to rounding.

\textsuperscript{c}Responses coded as follows: Positive: strongly agree, agree
Neutral: somewhat agree, somewhat disagree
Negative: disagree, strongly disagree
TABLE 22.—Detailed summary of the statistical analysis of student attitudes toward the experiment case study using the Mann-Whitney U statistic, by section and learning environment.

<table>
<thead>
<tr>
<th>Question</th>
<th>Section Comparison</th>
<th>Learning Environment Comparisons</th>
</tr>
</thead>
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<td>Case materials answered most questions?</td>
<td>A</td>
<td>B</td>
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<tr>
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<tr>
<td>Information in case write-up sufficient for first decision?</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
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<tr>
<td>Information reported by model not sufficient to make strategy changes?</td>
<td>A</td>
<td>B</td>
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<td>Model reported more information than necessary?</td>
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<tr>
<td>Model should be more complex?</td>
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<td>Section Comparison</td>
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<td>----------------------------------</td>
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<td>Lower</td>
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<tr>
<td>Make model less complex?</td>
<td>A</td>
<td>B</td>
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<td>Prefer to work with team on this case?</td>
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<td>B</td>
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<td>Time-sharing terminal instructions O.K?</td>
<td>A</td>
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<tr>
<td>Would like formal demonstration of time-sharing terminal?</td>
<td>B</td>
<td>A</td>
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TABLE 22 (Continued)

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<th>Learning Environment Comparisons</th>
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aSee Appendix G for a discussion of the Mann-Whitney U test.
bThe full text of each question is presented in the questionnaire forms in Appendix A.
cHigher and lower indicate the section or group reporting a higher or more positive response to the question.

U is the value of the Mann-Whitney U statistic. See Appendix G.
P is the probability of rejecting the null hypothesis when it is actually true.
Eval. is the level of significance of the test result: NS is not significant; S is significant—P < .10, one-tail; VS is very significant—P < .05, one-tail.
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<th>Section B</th>
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<th>Env. X2</th>
<th>Env. X3</th>
<th>Env. X4</th>
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<td>No.</td>
<td>%</td>
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<td>9</td>
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<td>Number of decision variables?</td>
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<td>1</td>
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<td>Use time-sharing terminal again?</td>
<td>*Yes</td>
<td>37</td>
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<td>6 or more</td>
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<td>5</td>
<td>6</td>
<td>19</td>
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<td>11</td>
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</tbody>
</table>

a. Percentages rounded to nearest per cent and adjusted for nonresponse; totals may not add to 100 per cent due to rounding.

b. The full text of the questions is presented in the post test questionnaire forms in Appendix A.

c. Responses have been categorized to facilitate tabulation.

* denotes value used for case study during experiment.

d. Percentage less than 1.0.

e. Count contains one or more values of 40 days.
TABLE 24.—Detailed summary of the statistical analysis of student recommendations for the experiment using the Mann-Whitney U statistic, by section and learning environmentb

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<th>Section Comparisonc</th>
<th>Learning Environment Comparisonsc</th>
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<td>Number of decision periods?</td>
<td>B</td>
<td>A</td>
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<tr>
<td>Length of decision period (days)?</td>
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<td>Number of decision variables?</td>
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<tr>
<td>Use time-sharing terminal again?</td>
<td>B</td>
<td>A</td>
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</tbody>
</table>

aSee Appendix G for a discussion of the Mann-Whitney U test.
bThe full text of each question is presented in the questionnaire forms in Appendix A.

Higher and lower indicate the section or group reporting a higher or more positive response to the question.
U is the value of the Mann-Whitney U statistic. See Appendix G.
P is the probability of rejecting the null hypothesis when it is actually true.
Eval. is the level of significance of the test result; NS is not significant; S is significant—P < .10, one-tail; VS is very significant—P < .05, one-tail.
APPENDIX E

The Simulation Model
The simulation model was programmed in PL/I level F computer language. The model consists of five programs—called procedures in PL/I—which control various aspects of the simulation session. The five procedures are:

I. Phoenix Procedure
II. Setup Procedure
III. Store Procedure
IV. Report Procedure
V. Errorp Procedure

The Appendix is divided into seven sections. The first section presents a brief technical overview of the model. Sections two through six discuss the individual model procedures. Section seven contains the source listings of the five procedures.

Technical Summary

The size of the model when compiled as a single load module is approximately 96K characters, which exceeds the memory space available when operating in a Time Sharing Option environment on the Ohio State University IBM System 370 Model 165 computer system. Therefore, the model was designed to be compiled in overlay structure, i.e., only two procedures are in memory at any one time.
The Phoenix procedure is the master control procedure. It is always in memory, and it "calls" the other procedures into memory in the proper sequence to execute the simulation model.

Communications between procedures is handled in two ways: 1) One procedure can provide data for another procedure by storing the data in a specified location or matrix cell in the Student Data Record storage area, which is always in memory; and 2) the procedure can store the data in a variable which is known and common to all procedures—i.e., the variable is declared in each procedure and defined as external.

The primary source of control and inter-procedure communications data is the Student Data Record. The Data Record provides the means for maintaining quarter-to-quarter continuity of the model results for a given student. The Data Record contains the values of the previous simulation sessions results, provides information to indicate if and how the session is to be conducted, and is used to store the results of the current run for reference and control purposes in later simulation sessions. A complete discussion of the Student Data Record and of the program used to construct the Student Data Record file is presented in Appendix F.

The link between the model and the time-sharing system was implemented using a T.S.O. procedure. The student
logged into the time-sharing system, and then executed a T.S.O. procedure by typing "EXEC 'CEA571.XXXXXX.CLIST'," where XXXXXX represented the logon account number. The above statement caused a T.S.O. program to be executed which 1) set up the files and linkages necessary to execute the model, 2) called the model from disk storage into memory, and 3) passed control of the simulation session to the model. At the conclusion of the model program, the T.S.O. procedure resumed control and automatically terminated the session.

**Phoenix Procedure**

The Phoenix Procedure is the master control procedure for the model. It is the first procedure executed during the simulation session, controls the execution of the other procedures, and ends each simulation session.

The Phoenix procedure performs the following tasks:

- Defines the major data files and variables used for the simulation.
- Records the time of day the session was started.
- Prompts the student for his name.
- Prompts the student for and checks the accuracy of his student identification code.
- Locates and reads the student's Data Record into memory.
- Calls the other three procedures in sequence to conduct the simulation session.
- Determines if the student will be allowed to use the model again during the same terminal session.
- Terminates the simulation session at the completion of a simulation period.

Setup Procedure

The Setup Procedure takes control of the simulation session after the student's identification code has been checked and his Data Record has been read in by the Phoenix Procedure.

The Setup Procedure performs the following tasks:
- Defines the variables needed by the procedure.
- Transfers data values from the student's Data Record to the appropriate procedure variables.
- Reads in from the Header data file and prints out on the terminal the introductory "greeting."
- Performs the following simulation control checks:
  - Is this student authorized to simulate the next period of operation?
  - Has the minimum time between simulation sessions elapsed since the last session?
- Determines if this session is a practice session and, if it is, makes changes to the model demand and reporting parameters.
- Reads in the decision variable labels and numeric limits from the data file.
- Determines if this student is required to enter a management memorandum and, if so, prints out the memo format and records the text of the student's reply.
- Records the decision variables for the simulation run.
  - Prompts the student for the value of each relevant variable.
  - Checks the entered value against the appropriate numeric limits.
  - If the variable value is outside the limit, it reprompts the student to reenter the value.
- Prints the heading for the Weekly Operations Report.

**Store Procedure**

The Store Procedure takes control of the simulation session after the Setup Procedure has successfully secured the decision variable values from the student.

The Store Procedure performs the following tasks:
- Defines the variables needed by the procedure.
- Transfers data values from the Student's Data Record to the appropriate procedure variables.
- Calculates the values of the expected communication time delay and expected shipment time delay based on the student's decision strategy.
- Simulates the operation of the store on a day-by-day basis using the student's decision strategy to review and order inventory.
- Issues the one-line summary reports of selected model variables every five days.
- Updates the student's Data Record with the appropriate summary statistics at the end of the simulated period.

Report Procedure

The Report Procedure takes control of the simulation session after the Store Procedure has completed simulating store operations.

The Report Procedure performs the following tasks:
- Defines the variables needed by the procedure.
- Calculates the store's financial results and prints the Quarterly Financial Statement.
- If the student is to receive the Quarterly Operating Report, it calculates the required values and prints the report.
- If this session is a practice run, it resets the student's Data Record to indicate that the next run is an actual simulation run and prints out the initial conditions concerning the store and in-transit inventory positions for the first recorded simulation session.
- Records the end time of the simulation session.

**Errorp Procedure**

The Errorp Procedure is executed when an error occurs in one of the other model procedures.

The Errorp Procedure performs the following tasks:

- Prints the error message codes associated with the error and indicates the Procedure and approximate location within the Procedure where the error occurred.

- Returns control to the Procedure in which the error occurred.
Phoenix Procedure

DECLARE
  I1IPT CHAR(100) VARYING,
  SETUP ENTRY EXTERNAL,
  TEMPRY FILE SEQUENTIAL RECORD ENV(F(1330) CONSEQUENTIAL),
  VALUES FILE RECORD KEYED ENV(F(1320) NOWRITE INDEXED),
  HEADER FILE RECORD KEYED ENV(F(1320) NOWRITE NCP(2) GENKEY INDEXED),
  STORE ENTRY EXTERNAL,
  ERRORP ENTRY EXTERNAL,
  REPORT ENTRY EXTERNAL,
  MASTER(15,22) FIXED DECIMAL(6) EXTERNAL,
  TIMEIN FIXED DECIMAL(6) INIT(0) EXTERNAL,
  NAME CHAR(25) VARYING INIT('AA') EXTERNAL,
  NUMBER EXTERNAL PICTURE 'A99999',
  WHERE CHAR(20) INIT('AA') EXTERNAL,
  INPT_LENGTH FIXED BINARY 116),
  SYSPRINT FILE STREAM OUTPUT INTERNAL ENV(150) BUFFERS(1),
  SPACES FIXED DECIMAL(1) EXTERNAL, BLINE CHAR(1) INIT(' '),
  TERM IN FILE SEQUENTIAL RECORD UNBUF INPUT ENV(0) CONSECUTIVE),
  TERMOUT FILE SEQUENTIAL RECORD UNBUF OUTPUT ENV(U120) CONSECUTIVE),
  PRTLNE CHAR(115) VARYING EXTERNAL,
  LOOPER: MASTER = 0;
  ON ERROR CALL ERRORP;
  ON RECORD (TERMOUT);
  ON RECORD (TERMIN);
  ON CONDITION (SPACER) BEGIN;
  DO I = 1 TO SPACES;
  WRITE FILE (TERMOUT) FROM (BLINE);
  END;
  END;
  WHAT = 'INITIALIZE VARIABLES';
  WHERE = 'PHOENIX';
  NAME = TIME;
  TIMEIN = SUBSTR(NAME,1,6);
  IF TIMEIN > '213000' & TIMEIN < '223000' THEN DO;
  PUT STRING (PRTLNE) EDIT
  ('FILE MAINTENANCE PERIOD. GAME NOT AVAILABLE. TRY AFTER 10:30')
  (A);
  WRITE FILE (TERMOUT) FROM (PRTLNE);
  GO TO END_PHOENIX; END;
  ON CONVERSION BEGIN;
  PUT STRING (PRTLNE) EDIT('I.D. CODE DOES NOT CONTAIN 1 LETTER AND',
  ' 5 NUMBERS.' ) (A); WRITE FILE (TERMOUT) FROM (PRTLNE);
  GO TO NUMBER_GETTER; END;
  GET_NAME_AND_NUMBER:
  PRTLNE = 'PLEASE TYPE YOUR NAME (FIRST NAME, 1 SPACE, LAST NAME)';
  NAME = 1
  SPACES = 2;
  SIGNAL CONDITION (SPACER);
  WRITE FILE (TERMOUT) FROM (PRTLNE);
  READ FILE(TERMIN) INTO (NAME);
  NUMBER_GETTER:
PRTLNE = 'PLEASE TYPE YOUR STUDENT I.D. CODE (1 LETTER AND 5 NUMBERS)';
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
READ FILE (TERMOUT) INTO (PRTLNE);
INPUT_LENGTH = LENGTH (PRTLNE); IF INPUT_LENGTH == 5 THEN DO;
  PRTLNE = 'YOUR I.D. CODE IS TOO SHORT OR TOO LONG';
  SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
  GO TO NUMBER_GETTER; END;
NUMBER = SUBSTR (PRTLNE, 1, 5);
OPEN FILE (VALUES) DIRECT INPUT;
ON KEY (VALUES) BEGIN;
  IF I == 11 THEN DO;
    PUT STRING (PRTLNE) EDIT (NUMBER, ' NOT IN FILE. CONTACT CASE MONITOR. GAME TERMINATED') (A(6), A);
    WRITE FILE (TERMOUT) FROM (PRTLNE);
    GO TO ALLOVER;
  END;
  ELSE DO;
    PUT STRING (PRTLNE) EDIT (NUMBER, ' IS NOT AN AUTHORIZED CODE. PLEASE ENTER YOUR STUDENT CODE (1 LETTER AND 5 NUMBERS)') (A(6), A);
    SPACES = 2; SIGNAL CONDITION (SPACER);
    WRITE FILE (TERMOUT) FROM (PRTLNE);
    NUMBER = SUBSTR (PRTLNE, 1, 5);
    I = I + 1;
    GO TO GET_MASTER_ARRAY;
  END;
END;
GET_MASTER_ARRAY:
READ FILE (VALUES) INTO (MASTER) KEY (NUMBER);
CLOSE FILE (VALUES);
ON CONVERSION;
- CALL SETUP;
- SIMULATE: CALL STORE;
- CALL REPORT;
- IF MASTER[1:5] == 0 THEN GO TO ALLOVER;
- PUT STRING (PRTLNE) EDIT ('RUN AGAIN? YES OR NO') (X(5), A);
- WRITE FILE (TERMOUT) FROM (PRTLNE);
- READ FILE (TERMOUT) INTO (WHAT);
- I = LENGTH (WHAT);
  IF I > 10 THEN GO TO LOOP;
- ALLOVER: PRTLNE = 'SIMULATION COMPLETED'; SPACES = 2;
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
END PHOENIX: END PHOENIX;
Setup Procedure

-PROCESS ('S M -C 2,8 0,1 ) , O P T -2 , S T , N T , L C -6 0 , N O L , N S , F E ' );
-DECLARE
  ERORRP ENTRY EXTERNAL,
  TEMP RY FILE SEQUENTIAL RECORD ENV(F(1330) CONSECUTIVE),
  MASTER(15,22) FIXED DECIMAL(6,0) EXTERNAL,
  TIME IN FIXED DECIMAL(6,0) INIT(0) EXTERNAL,
  VALUES FILE RECORD KEYED ENV(F(1320) NO WRITE HCP(2) GEN KEY INDEXED),
  HEAD ER FILE RECORD KEYED ENV(F(1320) NO WRITE HCP(2) G E N KEY INDEXED),
  NAME CHAR(25) VARYING INIT('AA') EXTERNAL,
  NUMBER EXTERNAL PICTURE 'A99999',
  WHAT CHAR(40) VARYING INIT('AA') EXTERNAL,
  W HERE CHAR(20) INIT('AA') EXTERNAL,
  AB FIXED DECIMAL(3),
  IB FIXED BINARY (16),
  VALUE FIXED DECIMAL(6,2) EXTERNAL,
  (1, J , K , L) FIXED BINARY (16,0) INIT(0)
  CHRBUF2 CHAR(110),
  CHRibuf2 CHAR(1320),
  LABELS (15) CHAR(35),
  LIMITS (15,2) FIXED DECIMAL (6,0),
  PR TLINE CHAR(115) VARYING EXTERNAL,
  PR TLINE2 CHAR(110) EXTERNAL,
  DTE FIXED DECIMAL (6,0) INIT(0) EXTERNAL,
  DEBUG FIXED DECIMAL (6) EXTERNAL,
  SCALE FIXED DECIMAL (1,0) INIT(0),
  CODE CHAR(10) VARYING INIT('AA'),
  LIMITS_STRING (15,2) CHAR(6),
  SYSPRINT FILE STREAM OUTPUT INTERNAL ENV(V(120) B U F F E R S (1)),
  SPACES FIXED DECIMAL (1) EXTERNAL, B L I N E CHAR(1) INIT(' '), EXTERNAL,
  TERMIN FILE SEQUENTIAL RECORD UNBUF INPUT ENV(U(115) CONSECUTIVE),
  TERMIN FILE SEQUENTIAL RECORD UNBUF OUTPUT ENV(U(120) CONSECUTIVE),
  TEMPL CHAR(6),
  CHRBUF3 CHAR(1330),
  BACKTO LABEL (VALUE1,VALUE2),
-DECLARE
  (MIN_TIME_BETWEEN_RUNS, JUSTIFICATION_REQUIRED,D A T E _O F _S I M U L A T I O N ,
  PERIOD_OF_SIMULATION, LENGTH_OF_SIMULATION, LOGON_TIME,
  LOGOFF_TIME, F INAL _S IM U L A T I O N _D A T E , F INAL _S IM U L A T I O N _R U N ,
  TODAY, LAST_DAY) FIXED DECIMAL(6);
ON ERROR CALL ERRORP;
-DEFINE_VARIABLES;
WHAT = 'DEFINE VARIABLES';
DTE = DATE;
MIN_TIME_BETWEEN_RUNS = MASTER(11,2);
JUSTIFICATION_REQUIRED = MASTER(11,4);
DATE_OF_SIMULATION = MASTER(12,1);
PERIOD_OF_SIMULATION = MASTER(12,2);
LENGTH_OF_SIMULATION = MASTER(12,3);
FINAL_SIMULATION_DATE = MASTER(14,1);
FINAL_SIMULATION_RUN = MASTER(14,2);
TODAY = MASTER(15,1);
LAST_DAY = MASTER(15,2);
DEBUG = MASTER(12,5);
-OPEN_FILE (HEADER) INPUT BUF, FILE (TEMP RY) OUTPUT;
CODE = 'H E A D ';
SPACES = 4;
SIGNAL CONDITION (SPACER);
HEADER PRINT ROUTINE:
READ FILE (HEADER) INTO (CHRBUF2) KEY(CODE);
SPACES = 1;
NEXT_HEADER:
DO I = 1 TO 12;
CHRBUF(I) = SUBSTR(CHRBUF2,((I-1)*10) - 109),110);
PUT STRING(PRTLINE) EDIT (CHRBUF(I)) (A);
SIGNAL CONDITION (SPACER);
WRITE FILE (TERMOUT) FROM (PRTLINE);
K = INDEX(CHRBUF(I),"#");
IF K > 0 THEN GO TO ABORT_CHECK;
END;
READ FILE (HEADER) INTO (CHRBUF2);
GO TO NEXT_HEADER;
ABORT_CHECK:
WHAT = 'RUN NUMBER CHECK';
SPACES = 3;
SIGNAL CONDITION (SPACER);
DEBUG = MASTER(12,4);
IF FINAL SIMULATION_RUN # = 0 THEN GO TO TIME_CHECK_ROUTINE;
IF PERIOD # OF SIMULATION > FINAL SIMULATION RUN #
THEN GO TO ABORT;
TIME_CHECK_ROUTINE:
WHAT = 'TIME CHECK';
IF PERIOD # OF SIMULATION = 0 | MIN TIME BETWEEN RUNS = 0
THEN GO TO UPDATE_MASTER_ARRAY;
IF DTE < MASTER(12,1) + MIN TIME BETWEEN RUNS
THEN GO TO ABORT;
IF FINAL SIMULATION DATE <= 0 THEN GO TO UPDATE_MASTER_ARRAY;
IF FINAL SIMULATION_DATE < DTE THEN GO TO ABORT;
UPDATE_MASTER_ARRAY:
WHAT = 'UPDATE MASTER ARRAY';
DATE OF SIMULATION, MASTER(12,1) = DTE;
PERIOD # OF SIMULATION, MASTER(12,2) = PERIOD # OF SIMULATION + 1;
LOGON TIME, MASTER(13,1) = TIMEIN;
LAST_DAY, MASTER(15,2) = TODAY + LENGTH OF SIMULATION;
PUT STRING(PRTLINE) EDIT (RUN AUTHORIZED FOR QUARTER, MASTER(12,2), MANAGER: NAME)
(A,F(2),A,X(4),A); SIGNAL CONDITION (SPACER);
WRITE FILE (TERMOUT) FROM (PRTLINE);
IF MASTER(14,5) = 0 THEN DO; SIGNAL CONDITION (SPACER);
PUT STRING(PRTLINE) EDIT (**** PRACTICE RUN ****) (X(10),A);
WRITE FILE (TERMOUT) FROM (PRTLINE); SPACES = 1;
SIGNAL CONDITION (SPACER); PUT STRING(PRTLINE) EDIT (DO NOT USE THE RESULTS OF THIS RUN TO EVALUATE YOUR INITIAL
' INVENTORY STRATEGY') (A,A); WRITE FILE (TERMOUT) FROM (PRTLINE);
MASTER(14,4) = 170; MASTER(13,3) = 1; MASTER(15,2), LAST DAY = 30;
END; SPACES = 2; SIGNAL CONDITION (SPACER); SPACES = 1;
GO TO READ LABELS AND LIMITS;
ABORT:
PUT STRING(PRTLINE) EDIT ('UNAUTHORIZED RUN: (INIT/TODAY/FINAL)', (MASTER
(12,1) + MASTER(11,2)), DTE, MASTER(14,1)) (X(2),A,3 (X(2),F(8))); WRITE FILE (TERMOUT) FROM (PRTLINE);
PUT STRING(PRTLINE) EDIT ('RUN PERIOD: (LAST,FINAL)', MASTER(12,2),
MASTER(14,4), (X(4),A,2 (X(3),F(3)));
WRITE FILE (TERMOUT) FROM (PRTLINE);
PUT STRING(PRTLINE) EDIT ('CONTACT CASE MONITOR PLEASE. THIS RUN IS NOT AUTHORIZED')
(A);
SIGNAL CONDITION (SPACER);
WRITE FILE (TERMOUT) FROM (PRTLNE);
STOP;
-READ_LABELS AND LIMITS:
  WHAT = 'READ LABELS AND LIMITS';
  READ HEADER INTO (CHRBUF2);
  DO I = 1 TO 15;
    LABELS(I) = SUBSTR(CHRBUF2,((I*35) - 34),35);
  END;
  DO I = 1 TO 15;
    LIMITS(I,1) = DEC(TEMP1,6,0);
    LIMITS(I,2) = DEC(TEMP1,6,0);
END;
-IF JUSTIFICATION_REQUIRED = 0 THEN GO TO ZERO_MASTER_ARRAY;
  IF MASTER(14,5) = 0 THEN DO;
    PUT STRING(PRTLNE) EDIT('THE EXECUTIVE COMMITTEE HAS DECIDED TO REQUIRE THE
      SUBMISSION OF AN OPERATIONS MEMO AT THE BEGINNING') (A,X(1),A);
    WRITE FILE (TERMOUT) FROM (PRTLNE); SIGNAL CONDITION (SPACER);
    PUT STRING(PRTLNE) EDIT('OF EACH QUARTER. CONSULT YOUR CASE WRITE-UP FOR
      FORMAT AND CONTENT DETAILS. REMEMBER, THE PURPOSE OF THE MEMO')
      (A,X(1),A);
    WRITE FILE (TERMOUT) FROM (PRTLNE); SIGNAL CONDITION (SPACER);
    PUT STRING(PRTLNE) EDIT('THE ANALYSIS AND STRATEGY SECTIONS OF THE OPERATIONS MEMO MAY CONTAIN A
      TOTAL OF 36, 105-CHARACTER LINES.') (A,A);
    WRITE FILE (TERMOUT) FROM (PRTLNE); SIGNAL CONDITION (SPACER);
    PUT STRING(PRTLNE) EDIT('USE THE RETURN KEY TO ENTER EACH LINE, AND USE THE SPACE BAR TO INDENT P
      PARAGRAPHS. TYPE THE SECTION') (A,A);
    WRITE FILE (TERMOUT) FROM (PRTLNE); SIGNAL CONDITION (SPACER);
    PUT STRING(PRTLNE) EDIT('TERMINATOR ** IMMEDIATELY AFTER THE LAST SENTENCE IN EACH SECTION. DO NOT
      USE # TO TERMINATE INDIVIDUAL') (A,A);
    WRITE FILE (TERMOUT) FROM (PRTLNE); SIGNAL CONDITION (SPACER);
    PUT STRING(PRTLNE) EDIT('THE LINE DELETION SYMBOL @@ TO DELETE A LINE.') (A);
    WRITE FILE (TERMOUT) FROM (PRTLNE); SIGNAL CONDITION (SPACER);
PUT STRING(PRTLNE) EDIT ('***DO NOT USE THE ATTENTION KEY AT ANY TIME***') (X(10),A);
WRITE FILE (TERMOUT) FROM (PRTLNE); SIGNAL CONDITION (SPACER);
SPACES - 2;
SIGNAL CONDITION (SPACER);
PRTLNE - 'NEW PAGE, PLEASE';
WRITE FILE (TERMOUT) FROM (PRTLNE);
READ FILE (TERMOUT) INTO (PRTLNE);
WHAT = 'PRINT MEMO HEADER';
SPACES - 3;
SIGNAL CONDITION (SPACER);
PRTLNE - 'H E W  PACE, PLEASE';
WRITE FILE (TERMOUT) FROM (PRTLNE);
READ FILE (TERMOUT) INTO (PRTLNE);
WHAT = 'PRINT MEMO HEADER';
SPACES - 3;
SIGNAL CONDITION (SPACER);
PRTLNE - 'FROM: NAME) (A (13),A);
SPACES - 1; SIGNAL CONDITION (SPACER);
WRITE FILE (TERMOUT) FROM (PRTLNE);
SIGNAL CONDITION (SPACER);
PRTLNE - 'SUBJECT: OPERATIONS MEMO FOR QUARTER',
MASTER(12,2) (A,F(3));
WRITE FILE (TERMOUT) FROM (PRTLNE);
PRTLNE - 'SECTION I: ANALYSIS OF PREVIOUS PERIOD(S)'
(4); (A);
SIGNAL CONDITION (SPACER);
WRITE FILE (TERMOUT) FROM (PRTLNE);
SIGNAL CONDITION (SPACER);
CODE - ' * '; PRTLNE - REPEAT(CODE,105); WRITE FILE (TERMOUT) FROM (PRTLNE);
SIGNAL CONDITION (SPACER);
WHAT = 'GET TEXT OF MEMO';
L = 18; IJ - 1; CHRBUF = ' * '; CHRBUF3 = ' * ';
SPACES - 1;
MEMO: DO J = 1 TO 36;
SIGNAL CONDITION (SPACER);
BADLINE: PRTLNE = ' * ';
READ FILE (TERMOUT) INTO (PRTLNE);
K = LENGTH(PRTLNE);
IF K = 1 THEN GO TO BADLINE;
IF K > 105 THEN DO;
PUT STRING (PRTLNE) EDIT ('YOUR LAST LINE WAS ', (K - 105), ' CHARACTERS TOO LONG."
'RESET RIGHT MARGIN AND REENTER THE LINE.') (A,F(2),A,X(2),A);
WRITE FILE (TERMOUT) FROM (PRTLNE);
GO TO BADLINE; END;
K = INDEX(PRTLNE,'@0');
IF K > 0 THEN DO;
PUT STRING (PRTLNE) EDIT ('LINE DELETED,') (A);
WRITE FILE (TERMOUT) FROM (PRTLNE);
J = J - 1; GO TO END_MEMO; END;
CHRBUF(IJ), PRTLNE2 = PRTLNE; (J = IJ + 1);
IF IJ > 12 THEN DO;
SUBSTRCHRBUF3,1,10) = NUMBER('TEXT');
SUBSTRCHRBUF3,11,1320) = STRING(CHRBUF); WRITE FILE (TERMOUT) FROM (CHRBUF3);
CHRBUF3 = ' * '; CHRBUF(*) = ' * ';
IJ - 1;
END;
K = INDEX(PRTLNE2,'#');
IF K = 0 & J < 36 THEN GO TO END_MEMO;
IF K > 0 & L = 1 & J < 36 THEN DO;
SPACES = 3; SIGNAL CONDITION (SPACER); L = 10;
PUT STRING (PRTLNE) EDIT ('SECTION II: STRATEGY AND FORECAST FOR QUARTER
MASTER(12,2),'; THERE ARE ',(36 - J), ' LINES LEFT.'),(A,2 (F(2),A));
WRITE FILE(TERMOUT) FROM (PRTLNE);
SPACES = 1; GO TO END_MEMO; END;
ELSE DO;
SPACES = 3; SIGNAL CONDITION (SPACER);
PUT STRING(PRTLNE) EDIT('END OF OPERATIONS MEMO.'),(A);
WRITE FILE(TERMOUT) FROM (PRTLNE);
IF [J = 1 THEN GO TO ZERO_MASTER_ARRAY;
SUBSTR(CHRBUF5,1,10) = NUMBER I 'TEXT';
SUBSTR(CHRBUF5,11,1320) = STRING(CHRBUF);
WRITE FILE (TEMPO) FROM (CHRBUF5);
GO TO ZERO_MASTER_ARRAY;
END;
END_MEMO; END MEMO;
-ZERO_MASTER_ARRAY:
WHAT = 'ZERO MASTER ARRAY'; DO I = 1 TO 15;
MASTER (I,9) = 0;
MASTER(I,11) = 0;
MASTER(I,22) = 0;
IF MASTER (I,20) = 0 THEN MASTER (I,20) = 100;
END;
DO I = 1 TO 6;
MASTER(I,10) = 0;
MASTER(I,12) = 0;
MASTER(I,13) = 0;
END;
-DECISION_ROUTINE:
WHAT = 'GET DECISION VALUES';
PUT STRING(PRTLNE) EDIT('NEW PAGE, PLEASE') (A);
WRITE FILE (TERMOUT) FROM (PRTLNE);
READ FILE (TERMIN) INTO (PRTLNE);
PUT STRING(PRTLNE) EDIT
('DECISION VALUES FOR THIS QUARTER') (A);
SPACES = 3;
SIGNAL CONDITION (SPACER);
WRITE FILE (TERMOUT) FROM (PRTLNE);
SIGNAL CONDITION (SPACER);
ON CONVERSION BEGIN; PRTLNE = 'INPUT VALUE CONTAINS SPACES OR LETTERS';
WRITE FILE (TERMOUT) FROM (PRTLNE); GO TO BACKTO; END;
ON ERROR BEGIN;
IF ONCODE = 100 THEN DO;
PRTLNE = 'BLANK LINE NOT ACCEPTABLE. TRY AGAIN.';
WRITE FILE (TERMOUT) FROM (PRTLNE); GO TO BACKTO; END;
ELSE CALL ERRORP; END;
-DEFINE_ORDER_OPTION: BACKTO = VALUE1;
VALUE1: IF MASTER(1,21) = 0 & MASTER (2,21) = 0 THEN DO;
PUT STRING(PRTLNE) EDIT
('INDICATE WHETHER YOU WILL USE A CONSTANT ORDER SIZE (OPTION 1) OR USE
' THE ORDER FORMULA (OPTION 2).') (A,A);
WRITE FILE (TERMOUT) FROM (PRTLNE);
 PRTLNE = 'TYPE 1 OR 2'; WRITE FILE (TERMOUT) FROM (PRTLNE);
END;
ELSE GO TO DECISION_VALUES;
-ORDER_OPTION_VALUE:
READ FILE (TERMIN) INTO (PRTLNE); IL = LENGTH(PRTLNE);
IF IL > 2 THEN GO TO DEFINE_ORDER_OPTION;
GET STRING (PRTLNE) LIST(VALUE);
IF VALUE " = 1. THEN IF VALUE " = 2. THEN DO;
PUT STRING(PRTLNE) EDIT('TRY AGAIN. ORDER OPTION =') (A);
WRITE FILE (TERMOUT) FROM (PRTLNE);
GO TO ORDER_OPTION_VALUE;
END;
IF VALUE = 1 THEN DO;
J = 1; K = 5; END;
ELSE DO;
J = 2; K = 3; END;
SPACES = 2;
-DECISION_VALUES:
DO I = J TO J,K TO 15;
IF MASTER(1,21) < -9999 THEN MASTER(1,21) > 9999 THEN DO;
IF MASTER(1,22) = -9999 THEN DO; IB = 2; SCALE = -2; END;
IF MASTER(1,21) > 0 THEN DO;
PUT STRING(PRTLNE) EDIT (LABELS(I), 'VALUE IS: MASTER(1,21))
(A, F(G,1B,SCALE));
WRITE FILE (TERMOUT) FROM (PRTLNE);
MASTER(1,22) = MASTER(1,21); GO TO NEXT;
END;
IB,SCALE = 0; Ic I = 2 THEN DO; IB = 2; SCALE = -2; END;
IF MASTER(1,21) > 0 THEN DO;
PUT STRING(PRTLNE) EDIT (LABELS(I), 'VALUE IS: MASTER(1,21))
(A, F(G,1B,SCALE));
WRITE FILE (TERMOUT) FROM (PRTLNE);
GO TO PRINT_LABELS_AND_LIMITS;
-PRINT_LABELS_AND_LIMITS: BACKTO = VALUE2;
VALUE2: PUT STRING(PRTLNE) EDIT (LABELS(I), 'LIMITS ARE: LIMITS(1,1), LIMITS(1,2))
(A, A, F(G,1B,SCALE));
WRITE FILE (TERMOUT) FROM (PRTLNE);
READ FILE (TERMOUT) INTO (PRTLNE); L = LENGTH(PRTLNE);
IF L > 5 THEN DO; PRTLNE = 'LINE BLANK OR TOO LONG.';
WRITE FILE (TERMOUT) FROM (PRTLNE);
GO TO PRINT_LABELS_AND_LIMITS;
END;
GET STRING(PRTLNE) LIST(VALUE);
IF I = 2 THEN VALUE = VALUE*100;
IF AB > 0 THEN DO;
PRTLNE = 'DECIMAL VALUE TOO LARGE OR INTEGER VALUE REQUIRED.';
WRITE FILE (TERMOUT) FROM (PRTLNE);
GO TO PRINT_LABELS_AND_LIMITS;
END;
IF VALUE >= LIMITS(1,1) AND VALUE <= LIMITS(1,2) THEN DO;
MASTER(1,22) = VALUE;
WRITE FILE (TERMOUT) FROM (PRTLNE);
READ FILE (TERMOUT) INTO (PRTLNE);
HEAD FILE (TERMOUT) INTO (PRTLNE);
I = LENGTH(PRTLNE);
IF I > 3 THEN DO;
MASTER(1,22) = 0;
WRITE FILE (TERMOUT) FROM (PRTLNE);
GO TO PRINT_LABELS_AND_LIMITS;
END;
NEXT: END DECISION_VALUES;
SPACES = 4;
-PRINT_REPORT_HEADER:
PUT STRING(PRTLNE) EDIT ('PLEASE EXAMINE YOUR DECISION VALUES, IF THERE IS AN ERROR, TYPE ERROR')
(A);
WRITE FILE (TERMOUT) FROM (PRTLNE);
PRTLNE = 'OTHERWISE, NEW PAGE, PLEASE.';
WRITE FILE (TERMOUT) FROM (PRTLNE);
HEAD FILE (TERMOUT) INTO (PRTLNE);
I = LENGTH(PRTLNE);
IF I > 3 THEN DO;
MASTER(1,22) = 0;
WRITE FILE (TERMOUT) FROM (PRTLNE);
GO TO DEFINE_ORDER_OPTION;
END;
SPACES = 3;
WRITE FILE(TERMOUT) FROM (PRTLNE);
SPACES = 2; SIGNAL CONDITION (SPACER);
PUT STRING(PRNLNE) EDIT
('QUARTER: ', MASTER(12, 2), 'FIRST DAY: ' , MASTER(15, 1) + 1, 'LAST DAY: ', MASTER(15, 2), 'NOTE: ALL PRODUCT FIGURES ARE IN UNITS');
(A, F(2), 2 (X(5), A, F(3)), X(13), A);
WRITE FILE(TERMOUT) FROM (PRNLNE);
SIGNAL CONDITION (SPACER);
PUT STRING(PRNLNE) EDIT
('MANAGER: ', NAME); (A, A);
WRITE FILE(TERMOUT) FROM (PRNLNE);
PUT STRING(PRNLNE) EDIT
('PERIOD TO DATE', MASTER(5, 22), 'DAY', '<----- INVENTORY ----->', 'NEXT ORDER DUE') (X(10), A, X(4), F(2), A, X(4), A, X(8), A);
SPACES = 3; SIGNAL CONDITION (SPACER);
WRITE FILE(TERMOUT) FROM (PRNLNE);
PUT STRING(PRNLNE) EDIT
('DAY', 'DEMAND', 'SALES', 'DEMAND', 'STORE', 'RAISE', 'ON ORDER', 'DAY', 'SIZE', 'NOTE');
WRITE FILE(TERMOUT) FROM (PRNLNE);
END SETUP;
Store Procedure

-PROCESS ('SM=(2,80,1),OPT=2,ST,HT,LC=60,NO,H,S,FE');
-STORE: PROCEDURE;
-DECLARE /* DCL'S FOR FILES AND PROCEDURES */
  ERRORP ENTRY EXTERNAL,
  TERMIN FILE SEQUENTIAL RECORD ENV(U(1330) CONSECUTIVE),
  TERMIN FILE SEQUENTIAL RECORD UNBUF INPUT ENV(U(115) CONSECUTIVE),
  TERMIN FILE SEQUENTIAL RECORD UNBUF OUTPUT ENV(U(120) CONSECUTIVE),
  SYSPRINT FILE STREAM OUTPUT INTERNAL ENV(V(120) BUFFERS(1)),
  MASTER (15,22) FIXED DECIMAL(6) EXTERNAL,
  WHAT CHAR(40) VARYING EXTERNAL INIT('AA'),
  WHERE CHAR(20) EXTERNAL INIT('AA'),
  DEBUG FIXED DECIMAL(6) EXTERNAL,
  RANK(10) FIXED DECIMAL(6),
  REPORT_PERIOD FIXED DECIMAL(6),
  ROUTING ENTRY (UPDATE_DEMAND,ORDER_PROCESSING_DELAY,
  SHIPMENT_TRANSIT_TIME),
  PROBABILITY FIXED DECIMAL(6),
  MASTER_DEMAND_FACTOR, STORAGE_CHARGE, WHSE_CARTON_CHARGE, MIN_STORAGE_CHARGE,
  WHSE_STORAGE_COST, ORDER_MULTIPLY_FACTOR) FIXED DECIMAL(6,2),
  SHIPMENT_MODE FIXED DECIMAL(6),
  SPACES FIXED DECIMAL(1) EXTERNAL, BLINE CHAR(1) INIT(' '),
  MODE CHAR(18),
-DECLARE (I,J,K,L,I,J) FIXED BINARY (25);
-DECLARE
  TODAY, EMERGENCY_ORDER, DEMAND_SUM, WHSE_STORED_CARTONS,
  UNIT_DEMAND, DEMAND_ARRAY_LENGTH, UNITS_ONHAND, UNIT_STOCKOUT_COUNT,
  UNITS_STOCKOUT_TOTAL, UNIT_SALES, STOCK_REVIEW_DAY, CUM_UNITS_ONHAND,
  STORE_UNIT_CAPACITY, UNITS_PER_CARTON, SLOT_1, SLOT_2, EXCESS_CARTONS,
  CARTONS_ACCEPTED, CARTON_ORDER_SIZE, STORE_CARTON_CAPACITY, COLUMN,
  WHSE_STORAGE_DAYS) FIXED DECIMAL(6);
-DECLARE
  CUM_WHSE_STORED_CARTONS, WHSE_TRANSIT_TIME, WHSE_STORED_CARTONS_HI,
  WHSE_STORED_CARTONS_LOW, LOW_STOCK_POINT, ORDER_DUE_IN_X_DAYS,
  NORMAL_REVIEIV_COUNT, PROHIBIT, CONSUME, UNIT_STOCKOUT_TOTAL, UNIT_SALES,
  WHSE_STOCKOUT_TOTAL, EXCESS_CARTONS, CARTONS_ACCEPTED, CARTON.Order_SIZE,
  STORE_UNIT_CAPACITY, COLUMN, WHSE_STORAGE_DAYS) FIXED DECIMAL(6);
-DECLARE
  CUM_WHSE_STORED_CARTONS, WHSE_TRANSIT_TIME, WHSE_STORED_CARTONS_HI,
  WHERE STORED_CARTONS_LOW, LOW_STOCK_POINT, ORDER_DUE_IN_X_DAYS,
  NORMAL_REVIEIV_COUNT, PROHIBIT, CONSUME, UNIT_STOCKOUT_TOTAL, UNIT_SALES,
  WHSE_STOCKOUT_TOTAL, EXCESS_CARTONS, CARTONS_ACCEPTED, CARTON.Order_SIZE,
  STORE_UNIT_CAPACITY, COLUMN, WHSE_STORAGE_DAYS) FIXED DECIMAL(6);
-DECLARE
  CUM_WHSE_STORED_CARTONS, WHSE_TRANSIT_TIME, WHSE_STORED_CARTONS_HI,
  WHERE STORED_CARTONS_LOW, LOW_STOCK_POINT, ORDER_DUE_IN_X_DAYS,
  NORMAL_REVIEIV_COUNT, PROHIBIT, CONSUME, UNIT_STOCKOUT_TOTAL, UNIT_SALES,
  WHSE_STOCKOUT_TOTAL, EXCESS_CARTONS, CARTONS_ACCEPTED, CARTON.Order_SIZE,
  STORE_UNIT_CAPACITY, COLUMN, WHSE_STORAGE_DAYS) FIXED DECIMAL(6);
-DECLARE (MIN_ORDER_SIZE, ORDERS_CANCELLED, CARTONS_CANCELLED, TEMP_ORDER_VARIABLE,
  COMMUNICATIONS_FACTOR, TRUCKLD_SIZE_FACTOR, SHIPMENT_SPEED_FACTOR,
  FIRST_DAY,CUM_UNIT_DEMAND) FIXED DECIMAL(6);
-DECLARE (TODAY,UNIT_DEMAND,UNIT_SALES,TELEPHONE_COUNT,CARTONS_ORDERED = 0;
MAIL_COUNT, CUM_UNIT_DEMAND = 0; WHSE_STORED_CARTONS_LBH = 99999;
MASTER_DEMAND_FACTOR, STOCK_REVIEW_DAY = 0;
WHAT = 'INITIALIZE VARIABLES' ;
A1 = 1B; A2 = 10B; A3 = 11B; A4 = 100B; A5 = 101B; A6 = 110B;
A7 = 111B; A8 = 1000B; A9 = 1010B; A10 = 1010B; A11 = 1011B; A12 = 1100B;
A13 = 1110B; A14 = 1111B; A15 = 1111B; A16 = 10000B; A17 = 10001B;
A18 = 10010B; A19 = 10011B; A20 = 10100B; A21 = 10101B; A22 = 10110B;
TODAY = MASTER(A15,A11);
REPORT_PERIOD = MASTER(A15,A3);
STORE_UNIT_CAPACITY = MASTER(A8,A6);
UNITS_ONHAND = MASTER(A13,A16);
UNITS_PER_CARTON = MASTER(A7,A6); SLOT_1 = MASTER(A14,A15);
SLOT_2 = MASTER(A15,A15); WHSE_STORED_CARTONS = MASTER(A14,A16);
LOW_STOCK_POINT = MASTER(A7,A22);
ORDER_DUE_DAYS = MASTER(A8,A22); STOCK_REVIEW_PERIOD = MASTER(A6,A22);
CONSTANT_ORDER_SIZE = MASTER(A1,A22);
ORDER_ADDITIVE_FACTOR = MASTER(A3,A22); UNITS_ON_ORDER = MASTER(A12,A16);
UNIT_ORDER_SIZE = MASTER(A9,A7); SHIPMENT_SPEED_FACTOR = MASTER(A10,A7);
TRUCKLD_SIZE_FACTOR = MASTER(A9,A7);
TRUCKLD_SIZE = MASTER(A6,A6);
STOCK_REVIEW_DAY,Mастер(15,4) = TODAY + STOCK_REVIEW_PERIOD;
EMERGENCY_ORDER, PROBABILITY, UNIT_DEMAND, UNIT_STOCKOUT_COUNT = 0;
UNITS_STOCKOUT_TOTAL, UNIT_SALES, EXCESS_CARTONS, CARTONS_ACCEPTED = 0;
CARTON_ORDER_SIZE, STORE_CARTON_CAPACITY, STORAGE_CHARGE = 0;
COLUMN, WHSE_STORAGE_COST, WHSE_STORAGE_DAYS, WHSE_TRANSPORT_TIME = 0;
WHSE_STORED_CARTONS_HI, WHSE_STORED_CARTONS_LO, NORMAL_REVIEW_COUNT = 0;
EMERGENCY_REVIEW_COUNT, AVERAGE_DAILY_DEMAND, EXPECTED_CYCLE_TIME = 0;
EXPECTED_EMERGENCY_CYCLE_TIME, EXPECTED_NORMAL_CYCLE_TIME = 0;
UNIT_ORDER_SIZE, ORDERS_CANCELED, CARTONS_CANCELED, TEMP_ORDER_VARIABLE = 0;
EMERGENCY_ORDER_COUNT, NORMAL_ORDER_COUNT = 0;
I, J, K, L = 0;
WHAT = 'PERFORM PRE_LOOP ACTIVITIES';
REPORT_DAY = MASTER(A15,A3);
LAST_DAY = MASTER(A15,A2);
POINTER = 1;
STORE_CARTON_CAPACITY = TRUNC(MASTER(A8,A6)/MASTER(A7,A6) + 1));
DEMAND_ARRAY_LENGTH = MASTER(A5,A22);
IF MASTER(A12,A2) = 1 THEN BEGIN; DEMAND_SUM = DEMAND_ARRAY_LENGTH = 100;
ELSE BEGIN; DEMAND_SUM = 0; DO L = 1 TO DEMAND_ARRAY_LENGTH;
DEMAND_SUM = DEMAND_SUM + MASTER(L,20); END; END;
COMUNICATIONS_MODE = MASTER(A10,A22);
COMUNICATIONS_FACTOR = MASTER(A13,A7);
COMM_FACTOR = 0;
IF COMMUNICATIONS_MODE > 1 THEN IF COMMUNICATIONS_MODE = 2 THEN DO;
TIME1, TIME3 = MASTER(A9,A8);
GO TO BR1;
END;
ELSE DO;
TIME1, TIME3 = MASTER(A9,A8) - COMMUNICATIONS_FACTOR;
COMM_FACTOR = COMMUNICATIONS_FACTOR;
GO TO BR1;
END;
TIME1 = MASTER(A9,A8);
TIME3 = MASTER(A9,A8) - COMMUNICATIONS_FACTOR;
BR1:
SHIPMENT_MODE = MASTER(A9,A22);
SHIP_MODE = 0;
IF SHIPMENT_MODE > 1 THEN IF SHIPMENT_MODE = 2 THEN DO;
TIME2, TIME4 = MASTER(A8, A7);
GO TO BR2;
END;
ELSE DO;
TIME2, TIME4 = MASTER(A8, A8);
GO TO BR2;
END;
TIME2 = MASTER(A8, A7);
TIME4 = MASTER(A8, A8);
BR2:
EXPECTED_NORMAL_CYCLE_TIME = TIME1 + TIME2;
EXPECTED_EMERGENCY_CYCLE_TIME = TIME3 + TIME4;
Y = MASTER(A11, A15);
Z = MASTER(A12, A13);
D = 65539;
SPACES = 1;
IJ = TODAY + 1;
IF MASTER(14, 4) > 0 THEN MASTER_DEMAND_FACTOR = MASTER(14, 4)/100;
WHSE_CARTON_CHARGE = MASTER(A13, A6)/100;
MIN_STORAGE_CHARGE = MASTER(14, 6);
ORDER_MULTIPLY_FACTOR = MASTER(2, 22)/100;
FIRST_DAY = TODAY + 1;
START:
DO TODAY = IJ TO LAST_DAY;
EMERGENCY_ORDER = 0;
ROUTINE = UPDATE_DEMAND;
-RANDOM_GENERATOR_1:
Y = MOD(Y + D, 100000);
PROBABILITY = TRUNC (100*(Y/100000));
GO TO CHECK_NUMBER_RANGE;
-RANDOM_GENERATOR_2:
Z = MOD(Z + D, 100000);
PROBABILITY = TRUNC (100*(Z/100000));
-CHECK_NUMBER_RANGE:
IF PROBABILITY < 0 THEN PROBABILITY = 1;
IF PROBABILITY > 100 THEN PROBABILITY = 99;
-SEARCH:
DO I = A1 TO A10;
IF PROBABILITY < MASTER(I, A1) THEN GO TO ROUTINE;
END;
PUT STRING(PRTLNE) EDIT ('RANDOM NUMBER ERROR. PROBABILITY = , PROBABILITY, WHAT) (A, F(10), A(40));
WRITE FILE(TERMOUT) FROM (PRTLNE) ;
I = 18;
GO TO ROUTINE;
-UPDATE_DEMAND:
IF MASTER_DEMAND_FACTOR > 0 THEN UNIT_DEMAND = MASTER(I, A2) * MASTER_DEMAND_FACTOR;
ELSE UNIT_DEMAND = MASTER(I, A2);
CUM_UNIT_DEMAND = CUM_UNIT_DEMAND + UNIT_DEMAND;
DEMAND_SUM = DEMAND_SUM + MASTER(PINTER, A20) * UNIT_DEMAND;
IF POINTER < DEMAND_ARRAY_LENGTH THEN POINTER = POINTER + 1;
ELSE POINTER = 1;
IF UNIT_DEMAND <= UNITS_ONHAND THEN GO TO SELLIT;
-STOCKOUT_ROUTINE:
UNIT_STOCKOUT_COUNT = UNIT_STOCKOUT_COUNT + 1;
UNITS_STOCKOUT_TOTAL = UNITS_STOCKOUT_TOTAL + (UNIT_DEMAND - UNITS_ONHAND);
UNIT_SALES = UNIT_SALES + UNITS_ONHAND;
UNIT_ORDER = 0;
IF UNIT_ORDER = 0 THEN STOCK_REVIEW_DAY = TODAY;
GO TO CHECK_ORDER_ARRIVAL;
SELLIT:
UNIT_SALES = UNIT_SALES + UNIT_DEMAND;
UNITS_ONHAND = UNITS_ONHAND - UNIT_DEMAND;
CUM_UNITS_ONHAND = CUM_UNITS_ONHAND + UNITS_ONHAND;
CHECK_ORDER_ARRIVAL:
DO J = A1 TO A10;
IF TODAY = MASTER(J,A16) THEN GO TO AGAIN;
UNIT_ORDER = 0;
UNITS_ON_ORDER = UNITS_ON_ORDER - (MASTER(J,A17) * UNITS_PER_CARTON);
IF STORE_UNIT_CAPACITY << UNITS_ONHAND + MASTER(J,A17) * UNITS_PER_CARTON;
THEN GO TO ACCEPT_TO_CAPACITY;
UNITS_ONHAND = UNITS_ONHAND + MASTER(J,A17) * UNITS_PER_CARTON;
DO IB = 1 TO 5; MASTER(J,14 + IB) = 0; END;
IF SLOT_1 > 0 THEN SLOT_2 = J;
ELSE SLOT_1 = J;
GO TO AGAIN;
ACCEPT_TO_CAPACITY:
IF EXCESS_CARTONS > 0 THEN GO TO SHIP_TO_WHSE;
CARTONS_ACCEPTED = 0;
CARTON_ORDER_SIZE = MASTER(J,A17);
DO L = A1 TO STORE_CARTON_CAPACITY;
IF CARTON_ORDER_SIZE = CARTONS_ACCEPTED = 0 THEN GO TO ERROR1;
IF STORE_UNIT_CAPACITY == UNITS_ONHAND + L * UNITS_PER_CARTON;
THEN CARTONS_ACCEPTED = CARTONS_ACCEPTED + 1;
ELSE GO TO ACCEPT;
END;
ERROR1:
PUT STRING(PRTLNE)
EDIT ('ACCEPT TO CAPACITY ERROR. ACCEPTED ALL CARTONS.')(X(5), A);
WRITE FILE (TERMOUT) FROM (PRTLNE);
PUT STRING(PRTLNE)
EDIT ('UNITS_ONHAND', 'STORE_UNIT_CAPACITY', 'CARTONS_ACCEPTED')(3(X(5), A));
WRITE FILE (TERMOUT) FROM (PRTLNE);
PUT STRING(PRTLNE)
EDIT (UNITS_ONHAND, STORE_UNIT_CAPACITY, CARTONS_ACCEPTED)
(X(8), F(7), X(13), F(7), X(10), F(7));
WRITE FILE (TERMOUT) FROM (PRTLNE);
ACCEPT:
UNITS_ONHAND = UNITS_ONHAND + CARTONS_ACCEPTED * UNITS_PER_CARTON;
EXCESS_CARTONS = MASTER(J,A17) - CARTONS_ACCEPTED;
IF WHSE_STORED_CARTONS > 0 THEN STORAGE_CHARGE = WHSE_STORED_CARTONS * WHSE_CARTON_CHARGE;
ELSE GO TO SHIP_TO_WHSE;
IF STORAGE_CHARGE < MIN_STORAGE_CHARGE;
THEN STORAGE_CHARGE = MIN_STORAGE_CHARGE;
WHSE_STORAGE_COST = WHSE_STORAGE_COST + STORAGE_CHARGE;
WHSE_STORAGE_DAYS = WHSE_STORAGE_DAYS + 1;
CUM_WHSE_STORED_CARTONS = CUM_WHSE_STORED_CARTONS + WHSE_STORED_CARTONS;
SHIP_TO_WHSE:
WHSE_STORED_CARTONS = WHSE_STORED_CARTONS + MASTER(J,A17);
WHSE_TRANSIT_TIME = WHSE_TRANSIT_TIME + 1;
IF WHSE_STORED_CARTONS > WHSE_STORED_CARTONS_HI
THEN WHSE_STORED_CARTONS_HI = WHSE_STORED_CARTONS;
IF WHSE_STORED_CARTONS > 0 THEN DO; IF WHSE_STORED_CARTONS < WHSE_STORED_CARTONS_LOW THEN WHSE_STORED_CARTONS_LOW = WHSE_STORED_CARTONS; END; DO I = 1 TO 5; MASTER(J,14 + IB) = 0; END; IF SLOT_1 > 0 THEN SLOT_2 = J; ELSE SLOT_1 = J; AGAIN: END CHECK_ORDER_ARRIVAL; IF EXCESS_CARTONS > 0 THEN GO TO LOW_STOCK_CHECK; IF WHSE_STORED_CARTONS > 0 THEN GO TO LOW_STOCK_CHECK; WHSE_STORAGE_DAYS = WHSE_STORAGE_DAYS + 1; STORAGE_CHARGE = WHSE_STORED_CARTONS * WHSE_CARTON_CHARGE; IF STORAGE_CHARGE < MIN_STORAGE_CHARGE THEN STORAGE_CHARGE = MIN_STORAGE_CHARGE; WHSE_STORAGE_COST = WHSE_STORAGE_COST + STORAGE_CHARGE; CUM_WHSE_STORED_CARTONS = CUM_WHSE_STORED_CARTONS + WHSE_STORED_CARTONS; REMOVE_FROM_WHSE: CARTONS_ACCEPTED = 0; IF STORE_UNIT_CAPACITY > UNITS_ONHAND + WHSE_STORED_CARTONS * UNITS_PER_CARTON THEN UNITS_ONHAND = UNITS_ONHAND + WHSE_STORED_CARTONS * UNITS_PER_CARTON; WHSE_TRANSIT_TIME = WHSE_TRANSIT_TIME + 1; WHSE_STORED_CARTONS = 0; GO TO LOW_STOCK_CHECK; ELSE BEGIN: DO L = A1 TO STORE_CARTON_CAPACITY; IF STORE_UNIT_CAPACITY > UNITS_ONHAND + L * UNITS_PER_CARTON THEN CARTONS_ACCEPTED = CARTONS_ACCEPTED + 1; ELSE GO TO LOOP50; END; LOOP50: IF CARTONS_ACCEPTED > WHSE_STORED_CARTONS THEN CARTONS_ACCEPTED = WHSE_STORED_CARTONS; UNITS_ONHAND = UNITS_ONHAND + CARTONS_ACCEPTED * UNITS_PER_CARTON; WHSE_STORED_CARTONS = WHSE_STORED_CARTONS - CARTONS_ACCEPTED; WHSE_TRANSIT_TIME = WHSE_TRANSIT_TIME + 1; CARTONS_ACCEPTED = 0; END; LOW_STOCK_CHECK: EXCESS_CARTONS = 0; IF LOW_STOCK_POINT = 0 THEN GO TO ORDER_ROUTINE; IF UNITS_ONHAND > LOW_STOCK_POINT THEN GO TO ORDER_ROUTINE; DO J = A1 TO A10; IF MASTER(J,A15) > 0 THEN IF TODAY + ORDER_DUE_IN_X_DAYS >= MASTER(J,A15) THEN Go TO ORDER_ROUTINE; END; IF ORDER = 1 THEN Go TO ORDER_ROUTINE; EMERGENCY_ORDER = 1; STOCK_REVIEW_DAY = TODAY; ORDER_ROUTINE: IF TODAY = STOCK_REVIEW_DAY THEN Go TO CHECKOUT; STOCK_REVIEW_DAY = TODAY * STOCK_REVIEW_PERIOD; IF EMERGENCY_ORDER = 0 THEN NORMAL_REVIEW_COUNT = NORMAL_REVIEW_COUNT + 1; ELSE EMERGENCY_REVIEW_COUNT = EMERGENCY_REVIEW_COUNT + 1; IF EMERGENCY_ORDER > 0 THEN EXPECTED_CYCLE_TIME = EXPECTED_EMERGENCY_CYCLE_TIME; ELSE EXPECTED_CYCLE_TIME = EXPECTED_NORMAL_CYCLE_TIME; IF CONSTANT_ORDER_SIZE <= 0 THEN Go TO CALCULATE_ORDER_SIZE; CARTON_ORDER_SIZE = TRUNC((CONSTANT_ORDER_SIZE/UNITS_PER_CARTON) * .7)); Go TO SCHEDULE_SHIPMENTS; CALCULATE_ORDER_SIZE: AVERAGE_DAILY_DEMAND = TRUNC((DEMAND_SUM/DEMAND_ARRAY_LENGTH) * .5)); UNIT_ORDER_SIZE =
((STOCK_REVIEW_PERIOD + EXPECTED_CYCLE_TIME) * AVERAGE_DAILY_DEMAND) -
(UNIT_ORDER * (UNIT_ORDER_SIZE + ORDER_MULTIPLY_FACTOR));
UNIT_ORDER_SIZE = UNIT_ORDER_SIZE + ORDER_ADDITIVE_FACTOR;
CARTON_ORDER_SIZE = TRUNC((UNIT_ORDER_SIZE/UNITS_PER_CARTON) + 0.7);
IF CARTON_ORDER_SIZE < 0 THEN CARTON_ORDER_SIZE = 0;
IF CARTON.Order_SIZE <= (UNIT_ORDER_SIZE/UNITS_PER_CARTON) THEN DO;
ORDERS CANCELLED + ORDERS CANCELLED + 1;
CARTONS CANCELLED = CARTONS CANCELLED + CARTON_ORDER_SIZE;
CARTON_ORDER_SIZE = 0;
GO TO CHECKOUT;
END; SCHEDULE_SHIPMENTS:
K = 0;
IF EMERGENCY_ORDER > 0
THEN EMERGENCY_ORDERS_COUNT = EMERGENCY_ORDERS_COUNT + 1;
ELSE NORMAL_ORDERS_COUNT = NORMAL_ORDERS_COUNT + 1;
IF EMERGENCY_ORDER = 1 THEN ORDER = 1;
SCHEDULE:
TEMP_ORDER_VARIABLE = 0;
IF CARTON_ORDER_SIZE <= TRUCK_LD_SIZE THEN GO TO SLOT_FINDER;
CARTON_ORDER_SIZE = TRUCK_LD_SIZE;
CARTON_ORDER_SIZE = TRUCK_LD_SIZE;
SLOT_FINDER:
IF SLOT_1 > 0 THEN GO TO RANDOM_ROUTINE;
DO 1 = A1 TO A10;
IF MASTER(A1, A15) > 0 THEN GO TO AGAIN1;
IF SLOT_1 > 0 THEN DO;
SLOT_2 = 1;
GO TO RANDOM_ROUTINE;
END;
ELSE SLOT_1 = 1;
AGAIN1: END;
PRINTLINE = ' TOO MANY ORDERS. ORDER DELETED'; WRITE FILE(TERMOUT) FROM
(PRINTLINE); GO TO CHECKOUT;
RANDOM_ROUTINE:
ROUTINE = ORDER_PROCESSING_DELAY;
GO TO RANDOM_GENERATOR_2;
ORDER_PROCESSING_DELAY:
IF COMMUNICATIONS_MODE > 1
THEN GO TO SHIP_ON_DATE;
IF EMERGENCY_ORDER = 1
THEN COMM_FACTOR = COMMUNICATIONS_FACTOR;
ELSE COMM_FACTOR = 0;
SHIP_ON_DATE:
MASTER(SLOT_1, A18) = TODAY + MASTER(1, A3) - COMM_FACTOR;
IF K = 0 THEN DO;
IF COMM_FACTOR > 0 THEN TELEPHONE_COUNT = TELEPHONE_COUNT + 1;
ELSE MAIL_COUNT = MAIL_COUNT + 1;
END;
ROUTINE = SHIPMENT_TRANSIT_TIME;
GO TO RANDOM_GENERATOR_2;
SHIPMENT_TRANSIT_TIME:
SHIPMENT_SPEED_FACTOR = 100;
IF (SHIPMENT_MODE = 3) & (SHIPMENT_MODE = 1 & EMERGENCY ORDER = 1)
THEN DO;
COLUMN = 5;
MASTER(SLOT_1, A19) = 2;
GO TO ACTUAL_ARRIVAL_DATE;
END;
ELSE DO;
COLUMN = 4;
MASTER(SLOT_1, A19) = 1;
END;
IF CARTON_ORDER_SIZE >= TRUCKLD_SIZE_FACTOR
THEN SHIPMENT_SPEED_FACTOR = 70;
-ACTUAL_ARRIVAL_DATE:
MASTER(SLOT_1, A16) = MASTER(SLOT_1, A18) +
TRUE((MASTER(1,COLUMN) * SHIPMENT_SPEED_FACTOR)/100) * .9);
-EXPECTED_ARRIVAL_DATE:
MASTER(SLOT_1, A15) = TODAY + EXPECTED_CYCLE_TIME;
MASTER(SLOT_1, A17) = CARTON_ORDER_SIZE;
-ORDER_STATISTICS_ROUTINE:
UNITS_ON_ORDER = UNITS_ON_ORDER + CARTON_ORDER_SIZE * UNITS_PER_CARTON;
CARTONS_ORDERED = CARTONS_ORDERED + CARTON_ORDER_SIZE;
DO i = A1 TO A6;
IF CARTON_ORDER_SIZE <= MASTER(1, A6)
THEN GO TO SHIPMENT_UPDATE;
END;
-SHIPMENT_UPDATE:
IF MASTER(SLOT_1, A19) = 1 THEN L = 0;
ELSE L = 1;
MASTER(1, A9 + L) = MASTER(1, A9 + L) * L;
MASTER(1, A11 + L) = MASTER(1, A11 + L) *
CARTON_ORDER_SIZE = MASTER(1, A7 + L);
SLOT_1 = SLOT_2; SLOT_2 = 0;
IF TEMP_ORDER_VARIABLE > 0
THEN DO;
CARTON_ORDER_SIZE = TEMP_ORDER_VARIABLE;
K = 10;
GO TO SCHEDULE;
END;
-CHECKOUT:
IF TODAY = REPORT_DAY & TODAY = FIRST_DAY & TODAY = LAST_DAY
THEN GO TO LAST_DAY_CHECK;
IF TODAY = REPORT_DAY THEN REPORT_DAY = TODAY + REPORT_PERIOD;
-DETERMINE_NEXT_ORDER_DUE:
NEXT_ORDER_DUE = 20000;
NEXT_ORDER_SIZE = 0;
TEMP = 0;
DO i = A1 TO A10;
IF MASTER(1, A15) > 0 & MASTER(1, A15) < NEXT_ORDER_DUE
THEN DO;
NEXT_ORDER_DUE = MASTER(1, A15);
NEXT_ORDER_SIZE = MASTER(1, A17);
TEMP = MASTER(1, A19);
END;
END;
IF NEXT_ORDER_DUE > 18000 THEN NEXT_ORDER_DUE = 0;
IF TEMP = 1 THEN MODE = 'TRUCK'; IF TEMP = 2 THEN MODE = 'AIR';
IF TEMP = 0 THEN MODE = ' - ';
PUT STRING(PRTLNE)
EDIT(TODAY, CULL_UNIT_DEMAND, UNIT_SALES, DEMAND_SUM, UNITS_ONHAND, (UNITS_STORED_CARTONS * UNITS_PER_CARTON),
UNITS_UN_ORDER, NEXT_ORDER_DUE,
(X(3), F(3), X(3), F(6), X(2), F(6), X(4), F(6), X(4), F(6), X(1), F(6), X(3), F(5),
X(8), F(3), X(3), F(5), X(4), A(5)));
SIGNAL CONDITION (SPACER);
WRITE FILE (TERMOUT) FROM (PRTLNE);
-LAST_DAY_CHECK:
E H D START;
SPACES = 3; SIGNAL CONDITION (SPACER);
-PUT STRING (PTRLNE) EDIT ("***** END OF QUARTER 'MASTER(A12,A2)")(X5),A,F(2));
WHITE FILE (TERMDUT) FROM (PRTLNE) ;
-UPDATE_MASTER_ARRAY:
MASTER(A15,A1) = TODAY - 1;
MASTER(A15,A3) = REPORT DAY;
MASTER(A15,A4) = STOCK REVIEW DAY;
MASTER(A7,A9) = HAIL_COUNT;
MASTER(A8,A9) = TELEPHONE_COUNT;
MASTER(A9,A9) = NORMAL_ORDER_COUNT;
MASTER(A10,A9) = EMERGENCY_ORDER_COUNT;
MASTER(A11,A9) = CARTONS ORDERED;
MASTER(A12,A9) = ORDERS CANCELLED;
MASTER(A13,A9) = CARTONS CANCELLED;
MASTER(A15,A0) = EMERGENCY REVIEW COUNT;
MASTER(A14,A0) = NORMAL REVIEW COUNT;
MASTER(A7,A11) = UNIT_STOCKOUT_COUNT;
MASTER(A6,A11) = UNITS_STOCKOUT_TOTAL;
MASTER(A10,A11) = UNISE_STORAGE_DAYS;
MASTER(A12,A11) = UNISE_STORED_CARTONS_HI;
MASTER(A13,A11) = UNISE_STORED_CARTONS_LO;
MASTER(A14,A11) = UNISE_TRANSIT_TIME;
MASTER(A7,A13) = CUM_UNIT_DEMAND;
MASTER(A8,A13) = UNIT SALES;
MASTER(A10,A13) = UNISE_STORAGE_COST + .5;
MASTER(A11,A13) = CUM UNITS DEMAND;
MASTER(A12,A13) = CUM UNISE STORED CARTONS;
MASTER(A12,A16) = DEMAND_SUM;
MASTER(A12,A16) = UNITS_DL_ORDER;
MASTER(A13,A16) = UNITS DHHAND;
MASTER(A14,A16) = UNISE_STORED_CARTONS;
L = 0B;
COMPRESSION: DO I = A1 TO A10;
IF MASTER(I,A15) = 0 THEN BEGIN;
 J = J + 1;
DO J = J TO A10;
IF MASTER(J,A15) = 0 THEN GO TO END1;
DO K = 1 TO 5;
MASTER(I,A14 + K) = MASTER(J,A14 + K);
MASTER(J,A14 + K) = 0;
END;
L = L + 1B;
GO TO END_COMPRESS;
END1: END;
GO TO MORE_MASTER_UPDATES;
END;
L = L + 1B;
END_COMPRESS: END COMPRESS;
MORE_MASTER_UPDATES:
MASTER(A14,A15) = MASTER(A15,A15) = 0;
IF L + 1B < 10 THEN MASTER(A14,A15) = L + 1B;
IF L + 10B < 10 THEN MASTER(A15,A15) = L + 10B;
MASTER(A11,A15) = Y;
MASTER(A12,A15) = 2;
MASTER(A9,A13) = MASTER(A13,A13) = 0;
CUM STATISTICS_UPDATE:
DO I = A7 TO A15;
MASTER(1,A10) = MASTER(1,A10) + MASTER(1,A9);
MASTER(1, A12) = MASTER(1, A12) + MASTER(1, A11);
MASTER(1, A14) = MASTER(1, A14) + MASTER(1, A13);
END CUM_STATISTICS_UPDATE;

IHV_CARRYING_COST_UPDATE:
    TEMP = (CUM_UNITS_ONHAND + CUM_UNITS_STORED_CARTONS * UNITS_PER_CARTON) / 
          MASTER(A9, A13) - TRUNC([TEMP + MASTER(A9, A6)]/100) + .7;
    MASTER(A9, A14) = MASTER(A9, A14) + MASTER(A9, A13);
END STORE;
Report Procedure

*PROCESS ('CH=(2,80,1),OPT=2,ST,HT,LC=60,NO,L,FE');
REPORT: PROCEDURE;

-DECLARE
PRTLNE CHAR(115) VARYING EXTERNAL,
I FIXED BINARY(25),
J FIXED BINARY(25),
MASTER(15,22) FIXED DECIMAL(6) EXTERNAL,
SYSPRINT FILE STREAM OUTPUT INTERNAL ENV(V(120) BUFFERS(1)),
SPACES FIXED DECIMAL(1) EXTERNAL, BLINE CHAR(1) INIT(' ') EXTERNAL,
TERM OUT FILE SEQUENTIAL RECORD UNBUF OUTPUT ENV(V(120) CONSECUTIVE),
TERM OUT FILE SEQUENTIAL RECORD UNBUF INPUT ENV(U(120) CONSECUTIVE),
ORDCOST,CUMORDCOST,CUMTRKCost,TRUCK_COST,AIR_COST,CUMCOG,
#TRKSHIPS,#AIRSHIPS,CURRSECOST,CUMSECOST,SREVCUR,SREVCUM,CURCOG,
CURGSRGN,CURGSRGM,TOTAL1,TOTAL2,TOTAL3,TOTAL4,FIXED DECIMAL(6) INIT(0),
CODE CHAR(10) INIT('---------------------'),
WHAT CHAR(40) VARYING INIT('AA') EXTERNAL,
WHERE CHAR(20) EXTERNAL INIT('AA'),
NAME CHAR(25) VARYING INIT('AA') EXTERNAL,
NUMBER EXTERNAL PICTURE 'A99999',
NODE CHAR(5),
TIMEH FIXED DECIMAL(6) INIT(0) EXTERNAL,
VALUES FILE Record KEYED ENV(F(1320) GENKEY HCPI(2) NOWRITE INDEXED),
ERROR ENTRY EXTERNAL,
DEBUG FIXED DECIMAL(6) EXTERNAL,

-ON ERROR CALL ERRORP;
SPACES = 1;
PRINT_PANDL_REPORT: SPACES = 2; SIGNAL CONDITION (SPACER);
PRTLNE = 'NEW PAGE, PLEASE'; WRITE FILE (TERMOUT) FROM (PRINTLINE);
READ FILE INTO (PRTLNE); SIGNAL CONDITION (SPACER);
PUT STRING (PRTLNE) EDIT('QUARTERLY FINANCIAL STATEMENT') (X(38),A);
WRITE FILE (TERMOUT) FROM (PRINTLINE); SPACES = 2;
SIGNAL CONDITION (SPACER);
PUS STRING (PRTLNE) EDIT('MANAGER: ', NAME,1 QUARTER:', MASTER(12,2),
'NOTE: \nCALCULATIONS BASED ON SALES REVENUE') (A,A,A,F(2),X(15),A);
WRITE FILE (TERMOUT) FROM (PRINTLINE);
SIGNAL CONDITION (SPACER);
PUS STRING (PRTLNE) EDIT('<------------------ CURRENT QUARTER ------------------->'),
'<----------------- YEAR-TO-DATE ------------------->') (X(22),A,X(5),A);
WRITE FILE (TERMOUT) FROM (PRINTLINE);
SIGNAL CONDITION (SPACER);
SREVCUR = MASTER(8,13) * MASTER(9,6);
SREVCUM = MASTER(8,14) * MASTER(9,6);
CURCOG = MASTER(8,13) * MASTER(10,6);
CUMCOG = MASTER(8,14) * MASTER(10,6);
IF SREVCUR = 0 THEN SREVCUR = 100;
CURGSRGN = SREVCUR - CURCOG;
CURGSRGM = SREVCUM - CUMCOG;
SPACES = 1;
DO 1 = 1 TO 6;
TRUCK_COST = TRUCK_COST + MASTER(1,11);
AIR_COST = AIR_COST + MASTER(1,12);
#TRKSHIPS = #TRKSHIPS + MASTER(1,9);
#AIRSHIPS = #AIRSHIPS + MASTER(1,10);
END;
MASTER(15,13),ORDCOST = (MASTER(7,9) * MASTER(14,7)) +
(MASTER(8,9) * MASTER(15,7)) +
(MASTER(14,9) + MASTER(15,9)) + MASTER(15,6)) +
(#TRKSHIPS * MASTER(7,7)) + (#AIRSHIPS * MASTER(7,8));
MASTER(1,14) = MASTER(1,14) + #TRKSHIPS;
CUM TRKCOST = MASTER(2,14) + TRUCK_COST;
MASTER(3,14) = MASTER(3,14) + AIRSHIPS;
CUMAIRCOST = MASTER(4,14) + AIR_COST;
CUMORDCOST = MASTER(10,14) + MASTER(14,11) + MASTER(12,6);
CUMWHSECOST = MASTER(10,14) + MASTER(14,12) + MASTER(12,6);

PUT STRING (PRTLNE) EDIT
('SALES REVENUE (NET)', 'S', SREVCUR, '100.0', ' $', 'S', SREVCUM, '100.0', ' %') (A(42), 2 (A,F(G),X(2),F(6,1),A,X(27)));

SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
PUT STRING (PRTLNE) EDIT
('LESS: COST OF GOODS SOLD', 'S', CURCOG, ((CURCOG/SREVCUR)*100), ' $', 'S', CUMCOG, ((CUMCOG/SREVCUM)*100), ' $') (A(42), 2 (A,F(G),X(2),F(6,1),A,X(27)));

SIGNAL CONDITION (SPACER); WRITE FILE(TERMOUT) FROM (PRTLNE);

PUT STRING (PRTLNE) EDIT
('TOTAL VARIADLE EXPENSES:', 'S', TOTAL1, ((TOTAL1/SREVCUR)*100), ' $', 'S', TOTAL1, ((TOTAL1/SREVCUM)*100), ' $');
TOTAL2 = ((TOTAL2/SREVCUM) * 100);

{X(4), A(35), 2 (A, F(6), X(2), F(6,1), A, X(27))};
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
PUT STRING (PRTLNE) EDIT (CODE, CODE) (X(40), A, X(24), A);
PUT STRING (PRTLNE) EDIT ('$ ' , TOTAL2 , ( (TOTAL2/SREVCUM)*100) , '  i ' )

(X(4), A(35), 2 (A, F(6), X(2), F(6,1), A, X(27)));
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
PUT STRING (PRTLNE) EDIT ('$ ' , TOTAL2 , ( (TOTAL2/SREVCUM)*100) , '  i ' )

(X(4), A(35), 2 (A, F(6), X(2), F(6,1), A, X(27)));
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
PUT STRING (PRTLNE) EDIT ('$ ' , TOTAL2 , ( (TOTAL2/SREVCUM)*100) , '  i ' )

(X(4), A(35), 2 (A, F(6), X(2), F(6,1), A, X(27)));
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
PUT STRING (PRTLNE) EDIT (CODE, CODE) (X(40), A, X(24), A);
PUT STRING (PRTLNE) EDIT ('$ ' , TOTAL2 , ( (TOTAL2/SREVCUM)*100) , '  i ' )
(A(37), 2 (F(6), X(17))); SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);

PUT STRING (PRTLNE) EDIT ('LOST SALES (UNITS)'), (MASTER(7, 13) - MASTER(8, 13), (MASTER(7, 14) - MASTER(8, 14))) (A(37), 2 (F(6), X(17))); SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);

PRTLNE = '***** INVENTORY STATISTICS *****'; SPACES = 2;

SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);

SPACES = 1;

ATOTAL1 = (MASTER(12, 3) * MASTER(12, 2));
ATOTAL2 = (MASTER(12, 13) * MASTER(7, 6));
ATOTAL3 = (MASTER(12, 14) * MASTER(7, 6));
ATOTAL4 = MASTER(10, 11) + 1;
ATOTAL5 = MASTER(10, 12) + 1;

PUT STRING (PRTLNE) EDIT ('STORE AVERAGE (UNITS)'), (MASTER(11, 13) / MASTER(12, 3), (MASTER(11, 14) / ATOTAL1)) (A(37), 2 (F(6), X(17))); SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);

PUT STRING (PRTLNE) EDIT ('NORMAL STOCK REVIEWS (DAYS)'), MASTER(10, 11); MASTER(10, 12)) (A(37), 2 (F(6), X(17))); SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);

PUT STRING (PRTLNE) EDIT ('EMERGENCY STOCK REVIEWS (DAYS)'), MASTER(15, 9); MASTER(15, 10)) (A(37), 2 (F(6), X(17))); SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);

PRTLNE = '**** ORDER STATISTICS ****'; SPACES = 2;

SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);

SPACES = 1;

PUT STRING (PRTLNE) EDIT ('NORMAL ORDERS PLACED'), MASTER(9, 9), MASTER(9, 10) (A(37), 2 (F(6), X(17))); SIGNAL CONDITION (SPACER);

PUT STRING (PRTLNE) EDIT ('EMERGENCY ORDERS PLACED'), MASTER(10, 9), MASTER(10, 10)) (A(37), 2 (F(6), X(17))); SIGNAL CONDITION (SPACER);

WRITE FILE (TERMOUT) FROM (PRTLNE);

PUT STRING (PRTLNE) EDIT ('ORDERS CANCELLED'), MASTER(12, 9), MASTER(12, 10)) (A(37), 2 (F(6), X(17))); SIGNAL CONDITION (SPACER);

WRITE FILE (TERMOUT) FROM (PRTLNE);

PUT STRING (PRTLNE) EDIT ('ORDERS SHIPPED'), MASTER(13, 9) * MASTER(7, 6));
(MASTER(13, 10) = MASTER(7, 6)) (A(37), 2 (F(6), X(17))); SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);

SPACES = 1;

SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);

PUT STRING (PRTLNE) EDIT ('SHIPPING ANALYSIS (ALL FIGURES IN CARTONS)'), (X(6), A); WRITE FILE (TERMOUT) FROM (PRTLNE);

PUT STRING (PRTLNE) EDIT ('SHIPPED', 'TRUCK', 'AIR', 'TRUCK') (X(7), A, X(4), A, X(7), A, X(6), A, X(4), A);

SIGNAL CONDITION (SPACER); SPACES = 1;

WRITE FILE (TERMOUT) FROM (PRTLNE);

PUT STRING (PRTLNE) EDIT ('SIZE (UP TO)'), (X(4), A, X(2), A, X(4), A, X(4), A, X(5), A); WRITE FILE (TERMOUT) FROM (PRTLNE);

TOTAL1, TOTAL2, TOTAL3, TOTAL4 = 0;

DO 1 = 1 TO 6;

PUT STRING (PRTLNE) EDIT (MASTER(1, 6), MASTER(1, 9), MASTER(1, 10), (MASTER(1, 13), MASTER(1, 10)) (X(7), F(5), X(6), F(5), X(6), F(5), X(6), F(5)); SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
TOTAL1 = TOTAL1 + MASTER(1,9); TOTAL2 = TOTAL2 + MASTER(1,10);
TOTAL3 = TOTAL3 + MASTER(1,11); TOTAL4 = TOTAL4 + MASTER(1,12);
END; SIGNAL CONDITION (SPACER);
PUT STRING (PRTLNE) EDIT ('TOTALS', TOTAL1, TOTAL2, 'MASTERS', TOTAL3, TOTAL4);
(X(4), A, X(4), F(6), X(5), F(6), X(4), A, F(5), X(3), A, F(5));
WRITE FILE (TERMOUT) FROM (PRTLNE);
PRACTICE: IF MASTER(1,5) > 0 THEN GO TO WRAPUP;
SPACES = 3; SIGNAL CONDITION (SPACER);
PUT STRING (PRTLNE) EDIT ('*** END OF PRACTICE RUN ***') (A);
WRITE FILE (TERMOUT) FROM (PRTLNE);
MASTER = 0;
OPEN FILE (VALUES) DIRECT UPDATE;
READ FILE (VALUES) INTO (MASTER) KEY (NUMBER);
MASTER(14,5) = 99;
REWRITE FILE (VALUES) FROM (MASTER) KEY (NUMBER);
PUT STRING (PRTLNE) EDIT ('USE THE FOLLOWING VALUES AS THE BASIS FOR YOUR INITIAL INVENTORY',
'STRATEGY') (A, A); SIGNAL CONDITION (SPACER);
WRITE FILE (TERMOUT) FROM (PRTLNE);
SPACES = 1;
SIGNAL CONDITION (SPACER);
PUT STRING (PRTLNE) EDIT ('THERE ARE MASTER(13,16), UNITS OF INVENTORY ON HAND IN THE STORE')
(A, F(5), A); WRITE FILE (TERMOUT) FROM (PRTLNE);
PUT STRING (PRTLNE) EDIT ('THERE ARE MASTER(14,16) * MASTER(7,6), UNITS IN THE WAREHOUSE')
(A, F(5), A); SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
PUT STRING (PRTLNE) EDIT ('THERE ARE MASTER(12,16), UNITS ON ORDER AND IN TRANSIT') (A, F(5), A)
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
IF MASTER(1,15) = 0 THEN GO TO NEXTDO;
PUT STRING (PRTLNE) EDIT ('EXPECTED', 'SIZE(UNITS)', 'MODE') (X(10), 3 (X(2)));
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
DO I = 1 TO 10;
IF MASTER(1, I) = 0 THEN GO TO NEXTDO;
IF MASTER(1, I) = 1 THEN MODE = 'TRUCK';
ELSE MODE = 'AIR';
PUT STRING (PRTLNE) EDIT ('DAY', MASTER(1,15), MASTER(1,17) = MASTER(7,6)),
(MODE) (X(11), A, F(4), X(3), F(6), X(7), A);
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
END;
NEXTDO:
PRTLNE = 'THE NEXT SESSION WILL BE FOR THE RECORD. GOOD LUCK.';
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE);
IF MASTER(11,4) > 0 THEN DO;
PRTLNE = 'REMEMBER TO PREPARE YOUR ANALYSIS FOR THE OPERATIONS MEMO';
SIGNAL CONDITION (SPACER); WRITE FILE (TERMOUT) FROM (PRTLNE); END;
RETURN;
WRAPUP:
MASTER(13,2) = SUBSTR (TIME, 1, 6);
IF DEBUG > 0 THEN DO;
PUT EDIT (MASTER) (SKIP, 22 F(5));
PUT EDIT ('') (X(119), A); END;
OPEN FILE (VALUES) DIRECT UPDATE;
REWRITE FILE (VALUES) FROM (MASTER) KEY (NUMBER);
RETURN;
END;
**Errorrp Procedure**

• PROCESS ('SM-(2,80,1),OPT=2,ST,NT,LC=60,HOL,HIS,FE');

  ERRORP: PROCEDURE;

  DECLARE WHAT CHAR(40) VARYING INIT('AA') EXTERNAL,
  WHERE CHAR(20) INIT('AA') EXTERNAL,
  CODE FIXED BINARY(15,0),
  SYSPRINT FILE STREAM OUTPUT INTERNAL ENV(V(120)) BUFFERS(1)),
  SPACES FIXED DECIMAL(1) EXTERNAL, BLINE CHAR(1) INIT(' ' ) EXTERNAL,
  TERMIN FILE SEQUENTIAL RECORD UNBUF OUTPUT ENV(V(120)) CONSECUTIVE,
  TERMIN FILE SEQUENTIAL RECORD UNBUF INPUT ENV(V(120)) CONSECUTIVE,
  PRTLNE CHAR(115) VARYING EXTERNAL,
  MASTER(15,22) DECIMAL(6) FIXED EXTERNAL,

  IF CODE = 0000;
  IF CODE = 3 THEN GO TO NORMAL;
  IF CODE = 510 | CODE = 511 THEN DO;
    PUT STRING (PRTLNE) EDIT('CHECK RAISED ',WHERE,' WHAT',NORMAL RETURN')
    (A,X(S),A,X(S),A,A,X(S),A);
    WRITE FILE (TERMI) FROM (PRTLNE); RETURN; END;
  PUT STRING (PRTLNE) EDIT('ERROR CODE', WHERE,' WHAT')
    (A,X(S),A,X(S),A,X(S),A);
  WRITE FILE (TERMI) FROM (PRTLNE);
  PUT STRING (PRTLNE) EDIT(ONCODE,WHERE,WHAT)
    (X(3),F(4),X(5),A,X(4),A);
  WRITE FILE (TERMI) FROM (PRTLNE);
  PUT EDIT(MASTER) (SKIP,F(S),21 (F(S)));
  RETURN;
  RETURN;

  NORMAL: PUT STRING (PRTLNE) EDIT('ERROR CODE', WHERE,' WHAT')
    (X(3),A,X(S),A,X(S),A);
  WRITE FILE (TERMI) FROM (PRTLNE);
  PUT STRING (PRTLNE) EDIT(ONCODE,WHERE,WHAT)
    (X(3),F(4),X(5),A,X(S),A);
  WRITE FILE (TERMI) FROM (PRTLNE);
  PUT EDIT(MASTER) (SKIP,F(S),21 (F(S)));
  RETURN;
END;

THIS IS IN PLACE OF A /* CARD-REPLACE TO RUN PROGRAM
"/"liked exec pgm=ieul, parm='xref,ovly',cond=(16,eq,chp),time=(30)
"/syslib dd dsn=syslib,disp=shr
"/sysul dd dsn=cea570,proglib(game),disp=(old,keep)
"/ unit=3330,vol=sec=1rcc73,space=(trak,(10,5,1))
"/ dcu=(dsorg=p0,recfm=u,rlcl=13000,blksiz=13000)
"/ syssu1 dd unit=syssda,space=(cy1,(1,1))
"/sysprint dd sysout=a
"/syslin dd dsn=cmp,syssli,disp=(old,delete)
"/ od

OVERLAY A
INSERT SETUP
INSERT **SETUPA
OVERLAY A
INSERT STORE
INSERT **STOREA
OVERLAY A
INSERT REPORT
INSERT REPORTA

THIS IS IN PLACE OF A /* CARD-REPLACE TO RUN PROGRAM
"/
APPENDIX F

Student Data Record File Program
Student Data Record File

The Student Data Record File resides on magnetic disk storage facilities and contains one Student Data Record for each participant—student or team—in the exercise. Each Student Data Record is 1320 characters in length, and is stored in memory in a 15 row by 22 column matrix. Each matrix cell contains a specific control, information, or history value associated with the student's simulation sessions. Each cell can hold one six-digit number and its corresponding sign.

The matrix is identified in the procedures by the variable name MASTER. The MASTER cell involved in a particular operation is identified by the row and column numbers contained in the parenthesis following MASTER. For example, MASTER (11,21) specifies that the numeric value contained in row 11, column 21 of MASTER is to be used for this computing operation.

The MASTER matrix is divided into 10 sections, each section representing a particular collection of control, information, and history values. The diagram shown in Exhibit XIV delineates the general location of each section. The paragraphs following the exhibit describe the general role of the values in the section and define the specific role of each matrix cell in the operation of the
model. The initial values of the MASTER matrix used for the experiment are shown in Exhibit XV.

Exhibit XIV
MASTER Matrix Section Layout$^a$

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<table>
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<tr>
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</thead>
<tbody>
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<td># 1</td>
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<td># 6</td>
<td># 7</td>
<td># 9</td>
<td>#10</td>
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<tr>
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<td>R</td>
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<td>R</td>
</tr>
<tr>
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<td>1-6</td>
<td>1-10</td>
<td>1-15</td>
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</tr>
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<td>6-12</td>
<td>13-14</td>
<td>15-19</td>
<td>20</td>
<td>21-22</td>
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<td># 4</td>
<td># 5</td>
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<tr>
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<td>9-14</td>
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<tr>
<td>6-8</td>
<td>9-14</td>
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<td># 8</td>
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<td>R</td>
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<tr>
<td>1-5</td>
<td></td>
<td>15-19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^a$# denotes the section number. R denotes the row(s) included in the section. C denotes the column(s) included in the section.

Section 1

Section 1 of the matrix contains the values associated with the probabilistic elements of the model. When a variable whose value is determined by 'random' events is to be used in the model, a random number between 1 and 99 is
<table>
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<td></td>
</tr>
</tbody>
</table>
generated by the model. The model then sequentially compares this number to each of the cell values in rows 1 through 10 of column 1, which are in ascending order. When the number in column 1 is greater than the random number, the value associated with the "occurrence" of this random event is selected from the corresponding row location in one of the other four columns of Section 1.

Each of the other columns is associated with a particular function of the model, as follows:

<table>
<thead>
<tr>
<th>Column</th>
<th>Contains</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Daily unit demand values</td>
</tr>
<tr>
<td>3</td>
<td>Order transmission and processing delay values</td>
</tr>
<tr>
<td>4</td>
<td>Less-than-truckload shipment transit times</td>
</tr>
<tr>
<td>5</td>
<td>Air shipment transit times</td>
</tr>
</tbody>
</table>

Section 2

Section 2 of the matrix contains various simulation session control, reporting, and identification information. Each cell is identified by (row, column) location coordinates.

<table>
<thead>
<tr>
<th>Cell</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>(11,1)</td>
<td>Contains last five digits of the student's identification code.</td>
</tr>
<tr>
<td>(11,2)</td>
<td>Defines the minimum number of days allowed between simulation sessions.</td>
</tr>
<tr>
<td>(11,3)</td>
<td>Not used.</td>
</tr>
<tr>
<td>(11,4)</td>
<td>If greater than zero, a written assignment is required.</td>
</tr>
<tr>
<td><strong>Cell</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>(11,5)</td>
<td>If greater than zero, the student can run the model more than once in the same terminal session. It is used primarily for model testing purposes.</td>
</tr>
<tr>
<td>(12,1)</td>
<td>Contains the calendar date on which the simulation session represented by the matrix values was conducted.</td>
</tr>
<tr>
<td>(12,2)</td>
<td>Contains the sequential number of the simulation run represented by the matrix values.</td>
</tr>
<tr>
<td>(12,3)</td>
<td>Defines the number of days to be simulated in each decision period.</td>
</tr>
<tr>
<td>(12,4)</td>
<td>Not used.</td>
</tr>
<tr>
<td>(12,5)</td>
<td>If greater than zero, the entire MASTER matrix is printed on the terminal at the end of a simulation session. It is used primarily for model testing and debugging.</td>
</tr>
<tr>
<td>(13,1)</td>
<td>Contains the start time of the simulation sessions in terms of a 24-hour clock: hh:mm:ss.</td>
</tr>
<tr>
<td>(13,2)</td>
<td>Contains the ending time of the simulation session.</td>
</tr>
<tr>
<td>(13,3)</td>
<td>Defines the number of days in the Weekly Operations Report reporting cycle.</td>
</tr>
<tr>
<td>(13,4)</td>
<td>If greater than zero, indicates that this student receives full information.</td>
</tr>
<tr>
<td>(13,5)</td>
<td>Contains the learning environment group number for this student.</td>
</tr>
<tr>
<td>(14,1)</td>
<td>Defines the last calendar day on which this student can run the model.</td>
</tr>
<tr>
<td>(14,2)</td>
<td>Defines the maximum number of simulated periods of operation allowed.</td>
</tr>
<tr>
<td>(14,3)</td>
<td>Not used.</td>
</tr>
<tr>
<td>(14,4)</td>
<td>If greater than zero, daily unit demand as determined by the model is multiplied by this value.</td>
</tr>
</tbody>
</table>
Section 3

Section 3 of the matrix contains the information and history values associated with the shipping modes of the model. Shipping costs and trips are calculated and accumulated by shipment size, defined in terms of cartons. In the experiment, ten units of product were in one carton; however, see Section 4, cell (7,6).

This section is organized as follows:

<table>
<thead>
<tr>
<th>Column</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Defines the shipment size breakpoints for determining per carton shipping costs.</td>
</tr>
<tr>
<td>7</td>
<td>Defines the per carton shipping cost for truck shipments less than the quantity specified in the corresponding row cell of column 6.</td>
</tr>
<tr>
<td>Column</td>
<td>Purpose</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>8</td>
<td>Defines the per carton shipping cost for air shipments less than the quantity specified in the corresponding row cell of column 6.</td>
</tr>
<tr>
<td>9</td>
<td>Contains the number of truck shipments of this size made during this decision period.</td>
</tr>
<tr>
<td>10</td>
<td>Contains the number of air shipments of this size made during this decision period.</td>
</tr>
<tr>
<td>11</td>
<td>Contains the total transport cost of truck shipments of this size made during this decision period.</td>
</tr>
<tr>
<td>12</td>
<td>Contains the total transport cost of air shipments of this size made during this decision period.</td>
</tr>
</tbody>
</table>

Section 4

Section 4 of the matrix contains various cost and time parameters for the model.

<table>
<thead>
<tr>
<th>Cell</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>(7,6)</td>
<td>Defines the number of product units per carton.</td>
</tr>
<tr>
<td>(7,7)</td>
<td>Defines the dollar cost of placing an order for shipment by truck.</td>
</tr>
<tr>
<td>(7,8)</td>
<td>Defines the dollar cost of placing an order for shipment by air.</td>
</tr>
<tr>
<td>(8,6)</td>
<td>Defines the unit capacity of the store.</td>
</tr>
<tr>
<td>(8,7)</td>
<td>Defines the expected number of days required to receive a less-than-truckload shipment.</td>
</tr>
<tr>
<td>(8,8)</td>
<td>Defines the expected number of days required to receive an air shipment.</td>
</tr>
<tr>
<td>(9,6)</td>
<td>Defines the per unit retail price of the product.</td>
</tr>
<tr>
<td>Cell</td>
<td>Purpose</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>(9,7)</td>
<td>Defines the per cent of maximum shipment size above which truckload transit times will be used.</td>
</tr>
<tr>
<td>(9,8)</td>
<td>Defines the expected length of the order processing period at the factory.</td>
</tr>
<tr>
<td>(10,6)</td>
<td>Defines the per unit product cost billed to the store.</td>
</tr>
<tr>
<td>(10,7)</td>
<td>Defines the percentage value of less-than-truckload transit times used to calculate truckload transit times.</td>
</tr>
<tr>
<td>(11,6)</td>
<td>Defines the per unit cost per day for carrying inventory in San Francisco.</td>
</tr>
<tr>
<td>(11,7)</td>
<td>Contains the fixed dollar expense charge for rents, salaries, etc.</td>
</tr>
<tr>
<td>(12,6)</td>
<td>Defines the dollar cost of a trip between the store and the public warehouse.</td>
</tr>
<tr>
<td>(12,7)</td>
<td>Contains the fixed dollar expense charge for unallocated corporate overhead.</td>
</tr>
<tr>
<td>(13,6)</td>
<td>Defines the per day cost of storing one carton of product in the public warehouse.</td>
</tr>
<tr>
<td>(13,7)</td>
<td>Defines the percentage value of the basic order communication and processing delay when telephone is used, rather than mail.</td>
</tr>
<tr>
<td>(14,6)</td>
<td>Defines the minimum public warehouse cost per day when any cartons are stored there.</td>
</tr>
<tr>
<td>(14,7)</td>
<td>Defines the cost of writing an order and sending it by mail.</td>
</tr>
<tr>
<td>(15,6)</td>
<td>Defines the cost of conducting an in-store inventory review.</td>
</tr>
<tr>
<td>(15,7)</td>
<td>Defines the cost of writing an order and using telephone to transmit it to the factory.</td>
</tr>
<tr>
<td>(10-15,8)</td>
<td>Not used.</td>
</tr>
</tbody>
</table>
Section 5

Section 5 of the matrix contains current and year-to-date statistics about the results of the simulation sessions. Each category consists of two cells; one for the value realized during the current period, and one for the value realized since the beginning of the simulation sessions. The first cell listed contains the current period value.

<table>
<thead>
<tr>
<th>Cells</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>(7,9)</td>
<td>Contain the number of orders sent by mail.</td>
</tr>
<tr>
<td>(8,9)</td>
<td>Contain the number of orders sent by telephone.</td>
</tr>
<tr>
<td>(9,9)</td>
<td>Contain the number of normal orders sent to the factory.</td>
</tr>
<tr>
<td>(10,9)</td>
<td>Contain the number of emergency orders sent to the factory.</td>
</tr>
<tr>
<td>(11,9)</td>
<td>Contain the total number of cartons ordered.</td>
</tr>
<tr>
<td>(12,9)</td>
<td>Contain the number of orders cancelled.</td>
</tr>
<tr>
<td>(13,9)</td>
<td>Contain the number of cartons cancelled.</td>
</tr>
<tr>
<td>(14,9)</td>
<td>Contain the number of normal inventory reviews conducted.</td>
</tr>
<tr>
<td>(15,9)</td>
<td>Contain the number of emergency inventory reviews conducted.</td>
</tr>
<tr>
<td>(7,11)</td>
<td>Contain the number of days partially or totally out-of-stock.</td>
</tr>
<tr>
<td>(8,11)</td>
<td>Contain the number of units demanded but not sold due to stockouts.</td>
</tr>
<tr>
<td>(9,11)</td>
<td>Not used.</td>
</tr>
</tbody>
</table>
### Cells

| (10,11) | (10,12) | Contain the number of days cartons were stored in the public warehouse. |
| (11,11) | (11,12) | Not used. |
| (12,11) | (12,12) | Contain the highest number of cartons stored in the warehouse. |
| (13,11) | (13,12) | Contain the lowest number—other than zero—of cartons stored in the warehouse. |
| (14,11) | (14,12) | Contain the number of trips made between the store and the warehouse. |
| (15,11) | (15,12) | Not used. |
| (7,13)  | (7,14)  | Contain unit demand totals. |
| (8,13)  | (8,14)  | Contain unit sales totals. |
| (9,13)  | (9,14)  | Contain inventory carrying cost totals. |
| (10,13) | (10,14) | Contain public warehouse storage cost totals. |
| (11,13) | (11,14) | Contain the number of inventory unit-days for the store. |
| (12,13) | (12,14) | Contain the number of inventory carton-days for the warehouse. |
| (13,13) | (13,14) | Contain the total ordering expense. |
| (14,13) | (14,14) | Not used. |
| (15,13) | (15,14) |

### Section 6

Section 6 of the matrix contains cumulative summary values relating to the transportation segment of the model, as follows:
Cell | Purpose
--- | ---
(1,14) | Contains the total number of truck shipments made.
(2,14) | Contains the total dollar truck shipments expense.
(3,14) | Contains the total number of air shipments made.
(4,14) | Contains the total dollar air shipments expense.
(1-4,13) | Not used.
(5-6,13-14) | Not used.

Section 7

Section 7 of the matrix contains information concerning the orders placed and shipped during the simulated period. Once an order is received by the store, its entry is deleted.

The section is organized on a row-by-row basis, with each row representing an order. The columns are organized as follows:

Column | Purpose
--- | ---
15 | Contains the date on which the order is expected to arrive at the store.
16 | Contains the date on which the order will actually arrive at the store.
17 | Contains the size of the order, in cartons.
18 | Contains the date on which the order is scheduled to be shipped from the factory, i.e., the date to which the shipment transit times are added.
Column Purpose
19 Contains the value defining the shipment mode: 1 for truck; 2 for air.

Section 8

Section 8 of the matrix contains miscellaneous control and summary information, as follows:

Cell Purpose
(11,15) Contains the six-digit number used as the "seed" for random number generator 1.
(12,15) Contains the six-digit number used as the "seed" for random number generator 2.
(13,15) Not used.
(14,15) Contains the number of a currently empty row in Section 7.
(15,15) Contains the number of another currently empty row in Section 7.
(11,16) Contains the cumulated unit demand total for the number of days specified by the demand average decision variable.
(12,16) Contains the number of product units currently on order.
(13,16) Contains the number of product units on hand in the store at the end of the quarter.
(14,16) Contains the number of product units stored in the warehouse at the end of the quarter.
(15,16) Not used.
(11-15,17) (11-15,18) (11-15,19)
Section 9

Section 9 of the matrix is a 15 element column array continuing the last \( n \) days demand, where \( n \) is the value of the days in demand average decision variable.

Section 10

Section 10 of the matrix contains the decision variable control codes and values for the model. There are locations for 15 decision variables in this section, using two row-adjacent cells for each variable. The left-most cell of each pair, i.e., the cell in column 21, contains a control value coded as follows: If the numeric value in the cell is negative, the decision variable is not used in the simulation model; if the cell value is zero, the decision variable is used in the model and the student is prompted to enter its value; and if the cell value is greater than zero, the value of the cell is the value of the decision variable and the model reports that value to the student.

The section is organized as follows:

<table>
<thead>
<tr>
<th>Cells</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1,21) (1,22)</td>
<td>Control code and variable value, respectively, for the constant order quantity option unit order size decision variable.</td>
</tr>
<tr>
<td>(2,21) (2,22)</td>
<td>Control code and variable value, respectively, for the order formula option multiplier decision variable.</td>
</tr>
<tr>
<td>(3,21) (3,22)</td>
<td>Control code and variable value, respectively, for the order formula option + - decision variable.</td>
</tr>
<tr>
<td>Cells</td>
<td>Purpose</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>(4,21)</td>
<td>Control code and variable value, respectively, for the order formula option minimum order size decision variable.</td>
</tr>
<tr>
<td>(5,21)</td>
<td>Control code and variable value, respectively, for the days in demand average variable.</td>
</tr>
<tr>
<td>(6,21)</td>
<td>Control code and variable value, respectively, for the number of days between inventory review periods decision variable.</td>
</tr>
<tr>
<td>(7,21)</td>
<td>Control code and variable value, respectively, for the inventory low stock point decision variable.</td>
</tr>
<tr>
<td>(8,21)</td>
<td>Control code and variable value, respectively, for the cancel if order due in ___ days decision variable.</td>
</tr>
<tr>
<td>(9,21)</td>
<td>Control code and variable value, respectively, for the shipment mode decision variable.</td>
</tr>
<tr>
<td>(10,21)</td>
<td>Control code and variable value, respectively, for the communications mode decision variable.</td>
</tr>
<tr>
<td>(11-15,21)</td>
<td>Not used.</td>
</tr>
</tbody>
</table>

**Student Data Record File Program**

The Student Data Record File Program builds the data file containing the Student Data Records. The use of n in the number of cards column indicates that the number of cards necessary depends on the particular situation involved. The program reads in the values of the MASTER matrix as discussed below. However, up to 20 changes to the basic
MASTER matrix values can be made for each student, if desired. See the discussion of the PARAMETERS, COORDINATES, and STUDENT cards for details.

The program requires the following source documents to build the file.

<table>
<thead>
<tr>
<th>Number of Cards</th>
<th>Card Column(s)</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-10</td>
<td>PARAMETERS.</td>
</tr>
<tr>
<td></td>
<td>11-20</td>
<td>Number of changes—up to 20—to basic MASTER matrix to be made for each student. Punch 0 or a positive number.</td>
</tr>
<tr>
<td></td>
<td>21-30</td>
<td>If &gt; 0, then program assigns students to learning environment groups. If ≤ 0, then each student card contains the group number to which he is to be assigned.</td>
</tr>
<tr>
<td>n</td>
<td>1st 110 charac-ters of each 2-card set</td>
<td>Punch the greeting to be displayed by the program at the beginning of a simulation session. The greeting must end with a ##. There must be an even number of cards in the section, even if the last card is entirely blank. Each greeting line consists of the first 110 characters from each two cards. There is no limit to the number of greeting lines used in the program.</td>
</tr>
<tr>
<td>15</td>
<td>1-35; anywhere</td>
<td>The first 35 characters contain the name of the decision variable being defined. The order of these cards must correspond with the decision variable cells in the MASTER matrix. The next two values on the card are the lower and upper limits of the variable</td>
</tr>
<tr>
<td>Number of Cards</td>
<td>Card Column(s)</td>
<td>Contents</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------</td>
<td>----------</td>
</tr>
</tbody>
</table>
| 1               | 1-10           | content 1
| n               | Anywhere       | content 2 |
| n               | 1-11           | content 3 |

value. They may be punched anywhere after column 36, but there must be at least one blank space or a comma between them.

**MASTERFILE.**

Punch the 330 values to be inserted in the MASTER matrix in row-wise fashion, i.e., value for (1,1), value for (1,2), etc. A comma or blank is necessary to separate values. Continue punching cards until all values have been punched. No decimal values may be used.

**COORDINATES.**

This card is necessary only if you wish to change one or more MASTER matrix values for each student. Do not include this case if you indicated 0 changes on card 1.

Punch one pair of cell coordinates for each change to be made. Each student card must contain some value for each change. Up to 20 changes can be made by the program.

**STUDENTS.**

Punch student identification code.

Punch student's section identifier (any 4 letters or numbers). Student cards need not be in order.
<table>
<thead>
<tr>
<th>Number of Cards</th>
<th>Card Column(s)</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-17</td>
<td></td>
<td>Punch 0 if program is to assign student to groups. Punch group number, otherwise.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A maximum of 200 student records can be constructed with this program.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The last card of student section must have 299999 punched in columns 1-6.</td>
</tr>
</tbody>
</table>

The program will print the following items and reports concerning the file:

1. Messages indicating when duplicate student cards have been encountered, and which card was used for the file.

2. Messages indicating errors in the parameters card heading. These errors will terminate the program.

3. A listing of the greeting for the simulation model.

4. A listing of the decision variable labels and limits.

5. A summary of the group assignment results, if performed by the program.

6. A listing of the student input cards and change values, if any.

7. A listing of the basic MASTER matrix.
8. The program then reads the created disk file and prints the following items and their file labels:
   A. Greetings
   B. Variable labels and limits
   C. Each student's Data Record

9. After reading the file, the program:
   A. Summarizes the number of sections and enrollment in each section.
   B. Prints a listing of each section, by student number, group number, and MASTER matrix changes made, if any.
   C. Summarizes the number of each student assigned to each group.
   D. Provides a grand total of the number of students in each group.
DECLARE
CARD_TYPE CHAR(13) VARYING,
A CHAR(1),
AB CHAR(1),
#_CHANGES FIXED DECIMAL(6),
VALUES_FILE_RECORD ENYVF(1320) INDEXED GENKEY),
CODE CHAR(6),
CHRBUF(12) CHAR(110),
CHRBUF2 CHAR(160),
CHRBUF3 CHAR(1320),
LABELS (15) CHAR(35),
DATA_ARRAY (200,23) CHAR(6),
STUDENT_CODE PICTURE 'A99999',
DUP_RECORD (23) CHAR(6),
LIMITS_STRING (15,2) CHAR(6),
ERROR_LABEL CHAR(25) VARYING,
MASTER (15,22) FIXED DECIMAL(6),
LOCATE (20,2) FIXED DECIMAL(2),
CHAR1 CHAR(1),
CHAR5 CHAR(5),
(1, K, L) FIXED DECIMAL(3),
RANDOM FIXED DECIMAL(6),
DIST(4) FIXED DECIMAL(2),
RANDOM # FIXED DECIMAL(1),
RANK(4) FIXED DECIMAL(2),
SECTION # (10) CHAR(6),
SECTION # TOTAL(10) FIXED DECIMAL(6),
#_SECTIONS FIXED DEC(3),
GROUP # TOTAL(4,2) FIXED DECIMAL(6),
#_STUDENTS FIXED DECIMAL(3),
TEMP1 CHAR(7),
TEMP2 CHAR(7),

-MASTER = 0;
-ON KEY(VALUES) BEGIN;
IF CODE = 52 THEN DO;
ADD = AB + '1';
IF K > 0 THEN GO TO WRITE_RECORD;
ELSE GO TO ENTER;
END;
ELSE PUT EDIT(CODE) (SKIP(1),A);
STOP;
END;

-OPEN FILE (VALUES) SEQUENTIAL OUTPUT KEYED;
-CHRBUF2 = '1';
GET EDIT (CARD_TYPE, #_CHANGES, RANDOM) (A(13), 2 F(10));
ERROR_LABEL = 'VALUES FILE DATA INPUT';
PUT EDIT (ERROR_LABEL) (SKIP(2),A);
IF CARD_TYPE "= 'PARAMETERS' THEN GO TO ERROR_ROUTINE;
PUT SKIP(4);
ERROR_LABEL = '#_CHANGES ERROR';
IF #_CHANGES > 20 THEN GO TO ERROR_ROUTINE;
CHRBUF = '1';
CHRBUF2 = '1';
CHRBUF3 = '1';
AB = '1';
GET_HEADER_LOOP:
CODE = '#HEAD' | AB;
DO I = 1 TO 12;
GET EDIT (CHRBUF(I)) (SKIP(1),A(110));
K = INDEX (CHRBUF(I), '#');
IF K > 0 THEN GO TO WRITE_RECORD;
END;
ENTER:
WRITE FILE (VALUES) FROM (CHRBUF) KEYFROM(CODE);
PUT EDIT ((CHRBUF(J) DO J = 1 TO 12)) (SKIP(2),A(110));
AB = AB + '1';
CHRBUF = ' ';
GO TO GET_HEADER_LOOP;
WRITE_RECORD:
WRITE FILE (VALUES) FROM (CHRBUF) KEYFROM(CODE);
LABELS = 1;
LIMITS_STRING = 0;
ERROR_LABEL = 'LABELS CARD MISSING';
GET EDIT (CARD_TYPE) (SKIP(1),A(13));
IF CARD_TYPE = 'LABELS-LIMITS' THEN GO TO ERROR_ROUTINE;
PUT PAGE;
DO I = 1 TO 15;
GET EDIT (LABELS(I)) (SKIP(1),A(35));
GET LIST(TEMP1, TEMP2);
LIMITS_STRING(I,1) = SUBSTR(TEMP1,2,6);
LIMITS_STRING(I,2) = SUBSTR(TEMP2,2,6);
END;
CHRBUF3 = STRING(LABELS);
SUBSTR(CHRBUF3,61,100) = STRING(LIMITS_STRING);
CODE = '#LABELS';
WRITE FILE (VALUES) FROM (CHRBUF3) KEYFROM(CODE);
CHRBUF = 0;
DO I = 1 TO 15;
CHRBUF(I) = SUBSTR(CHRBUF3,((I*35) - 34),35);
PUT EDIT(CHRBUF(I),LIMITS_STRING(I,1),LIMITS_STRING(I,2)) (SKIP(2),A(35), 2 (X(4),A(6)));
END;
ERROR_LABEL = 'MASTERFILE CARD MISSING';
GET EDIT (CARD_TYPE) (SKIP(1),A(13));
IF CARD_TYPE = 'MASTERFILE' THEN GO TO ERROR_ROUTINE;
GET LIST (MASTER);
CODE = '#MASTER';
WRITE FILE (VALUES) FROM (MASTER) KEYFROM(CODE);
IF #_CHANGES = 0 THEN GO TO ENTRY1;
GET EDIT (CARD_TYPE) (SKIP(1),A(13));
ERROR_LABEL = 'COORDINATES CARD MISSING';
IF CARD_TYPE = 'COORDINATES' THEN GO TO ERROR_ROUTINE;
DO I = 1 TO #_CHANGES;
GET LIST (LOCATE(I,1), LOCATE(I,2));
END;
ENTRY1:
ERROR_LABEL = 'STUDENTS CARD MISSING';
GET EDIT (CARD_TYPE) (SKIP(1),A(13));
IF CARD_TYPE = 'STUDENTS' THEN GO TO ERROR_ROUTINE;
DATA_ARRAY = 0;
DATA_ARRAY(1,1) = 'ZZZZZZ';
DUP_RECORD = 0;
STUDENTS = 0;
PUT EDIT ('INPUT ERRORS') (PAGE,SKIP(2),A);
-NEW_RECORD:
DO I = 1 TO 200;
GET EDIT (STUDENT_CODE) (SKIP(1),A(6));
IF STUDENT_CODE < 'Z99999' THEN GO TO ERROR_ROUTINE;
-SEARCH:
DO J = 1 TO 200;
ERROR_LABEL = 'ARRAY SEARCH(200)';
IF DATA_ARRAY(J,1) = 'ZZZZZZ' THEN GO TO FILL_ARRAY;
IF STUDENT_CODE > DATA_ARRAY(J,1) THEN GO TO END_SEARCH;
IF STUDENT_CODE = DATA_ARRAY(J,1) THEN GO TO DUPLICATE_RECORD;
-PUSHDOWN:
DO IJ = #STUDENTS TO 1 BY -1;
-HOKEIT:
DO IK = 1 TO 23;
DATA_ARRAY (IJ + 1,IK) = DATA_ARRAY (IJ,IK);
END HOKEIT;
IF IJ = J THEN GO TO FILL_ARRAY;
END PUSHDOWN;
PUT LIST ('PUSHDOWN ROUTINE DOES NOT WORK.');
GO TO END_OF_PROGRAM;
-DUPLICATE_RECORD:
GET LIST(DUP_RECORD(22),DUP_RECORD(23),(DUP_RECORD(IJ + 1) DO IJ = 1 TO
#_CHANGES));
DUP_RECORD (1) = STUDENT_CODE;
ERROR_LABEL = 'DUPLICATE RECORD CHECK';
DO IL = 1 TO 23;
IF DUP_RECORD (1L) = DATA_ARRAY (J,1L) THEN DO;
PUT EDIT ('DUPLICATE RECORD FOUND. ALL ITEMS NOT EQUAL.')
(SKIP(4),A);
PUT EDIT (DATA_ARRAY(J,1)) (SKIP(2),X(1),A);
PUT EDIT (DATA_ARRAY(J,1A) DO 1A = 2 TO 23)
(SKIP(2),X(1),22 A(6));
PUT EDIT (DUP_RECORD(1)) (SKIP(2),X(1),A);
PUT EDIT (DUP_RECORD(1A) DO 1A = 2 TO 23)
(SKIP(2),X(1),22 A(6));
PUT EDIT ('FIRST RECORD PRINTED USED FOR FILE')
(SKIP(2),A);
GO TO END_NEW_RECORD;
END;
END;
PUT EDIT ('DUPLICATE RECORD FOUND. ALL ITEMS EQUAL, DUPLICATE IGNORED',
DUP_RECORD(1)) (SKIP(4),A,X(10),A);
GO TO END_NEW_RECORD;
-FILL_ARRAY:
DATA_ARRAY(J,1) = STUDENT_CODE;
GET EDIT
(DATA_ARRAY(J,22),DATA_ARRAY(J,23),DATA_ARRAY(J,K + 1) DO K = 1 TO
*CHANGES) (X(3),A(4),X(2),A(2));
#_STUDENTS = #_STUDENTS + 1;
GO TO END_NEW_RECORD;
-END_SEARCH; END SEARCH;
-END_NEW_RECORD; END NEW_RECORD;
-PUT EDIT
('MORE THAN 200 STUDENT RECORDS IN INPUT, ONLY FIRST 200 ARE USED.')
(SKIP(2),A);
-END_INPUT;
-IF RANDOM <= 0 THEN GO TO PRINT_IT;
-RANDOM_ROUTINE:
Y = 123456;
D = 65539;
DIST = 0;
DO I = 1 TO #_STUDENTS;
Y = MOD(Y*6,10000);
RANDOM# = TRUNC(Y*Y/10000) + .55;
IF RANDOM# <= 0 THEN RANDOM# = 1;
IF RANDOM# > 4 THEN RANDOM# = 4;
DATA_ARRAY(1,23) = RANDOM#;
DIST(RANDOM#) = DIST(RANDOM#) + 1;
END;
-ANALYZE_DIST:
J = TRUNC(#_STUDENTS/6) + 1;
IF (RANDOM# >= #_STUDENTS) THEN RANDOM = TRUNC(#_STUDENTS/6) + 1;
PUT EDIT('RANDOM:', RANDOM#) (SKIP(2),A,F(6),A,F(4))
DIST(*) = DIST(*) - RANDOM;
PUT EDIT('RANDOM:', RANDOM#) (SKIP(2),A,F(6),A,F(4));
-CHECK:
DO I = 1 TO 4;
IF DIST(I) < 0 THEN GO TO COMPARE;
END;
PUT EDIT('RANDOM:', RANDOM#) (SKIP(2),A,F(6),A,F(4));
GO TO PRINT_IT;
-COMPARE:
IK = 0;
IF DATA_ARRAY(J,23) = CHAR(1,6) THEN GO TO NEXT_ONE;
IF DIST(DATA_ARRAY(J,23)) <= 0 THEN GO TO NEXT_ONE;
DIST(DATA_ARRAY(J,23)) = DIST(DATA_ARRAY(J,23)) - 1;
DATA_ARRAY(J,23) = CHAR(1,6);
DIST(I) = DIST(I) + 1;
IF DIST(I) >= 0 THEN GO TO CHECK;
NEXT_ONE: J = J + 1;
IF J > #_STUDENTS THEN J = TRUNC(#_STUDENTS/10);
IK = IK + 1;
IF IK >= (#_STUDENTS - 20) THEN DO;
PUT EDIT('COMPARE ROUTINE ERROR') (SKIP(2),A);
PUT EDIT('DIST') (SKIP(2),F(6));
PUT EDIT('PAGE,A');
GO TO PRINT_IT;
ELSE GO TO COMPARE;
-PRINT_IT:
PUT EDIT
('THERE ARE', #_STUDENTS, 'RECORDS, EACH HAVING ', sharing', 'CHANGES.');
(PAGE,A,F(3),A,F(2),A);
PUT EDIT('PAGE,A');
PUT SKIP(2);
DO I = 1 TO #$STUDENTS;
PUT EDIT
(1, DATA_ARRAY(1, 1), (DATA_ARRAY(1, J + 1) DO J = 1 TO #$CHANGES), DATA_ARRAY(22),
DATA_ARRAY(1, 23))
(SKIP(2), X(1), F(3), X(4), A(6), X(4), #$CHANGES) (F(6), X(1)), 2 (A(6)));
END;
-PUT EDIT
(' MASTER ARRAY', (I DO I = 1 TO 22))
(PAGE, SKIP(6), A, SKIP(6)), 22 (X(4), F(2)));
PUT SKIP(6);
PUT EDIT ('MASTER_ARRAY_CHANGE_COORDINATES', (LOCATE(1, 1), ', ', LOCATE(1, 2)
DO I = 1 TO #$CHANGES)
(SKIP(6), A, SKIP(6), #$CHANGES) (X(4), F(2), A(1), F(2));)
-CREATE_STUDENT_RECORDS:
DO I = 1 TO #$STUDENTS;
CODE = DATA_ARRAY(1, 1);
-UPDATE_MASTER:
DO J = 1 TO #$CHANGES;
MASTERCLOCATE(J, 1), LOCATE(J, 2)) = DATA_ARRAY(1, J + 1);
END UPDATE_MASTER;
-MASTERC13, 5) = DEC(DATA_ARRAY(1, 23), 6, 0);
IF MASTERC13, 5) = 1 THEN MASTERC11, 4), MASTERC13, 4) = 2;
IF MASTERC13, 5) = 2 THEN DO;
MASTERC13, 4) = 0;
MASTERC11, 4) = 2;
END;
IF MASTERC13, 5) = 3 THEN DO;
MASTERC11, 4) = 0;
MASTERC13, 4) = 2;
END;
IF MASTERC13, 5) = 4 THEN MASTERC11, 4), MASTERC13, 4) = 0;
CHARS = SUBSTR(DATA_ARRAY(1, 1), 2, 5);
MASTERC11, 1) = DEC(CHARS, 6, 0);
IF DATA_ARRAY(1, 22) = 'DEMO' I DATA_ARRAY(1, 22) = 'DUMY'
THEN MASTERC15, 5) = 999;
ELSE MASTERC15, 5) = DEC(DATA_ARRAY(1, 23), 6, 0);
WRITE FILE (VALUES) FROM (MASTER) KEYFROM(CODE);
END CREATE_STUDENT_RECORDS;
-CLOSE FILE (VALUES);
ION ENDFILE (VALUES) BEGIN;
PUT EDIT
(END OF FILE: '.(1 - 1), ' STUDENTS RECORDS READ')
(SKIP(10), A, F(3), A);
GO TO CONTINUE;
END;
-READ FILE (VALUES) SEQUENTIAL INPUT KEYED;
PUT EDIT 
(')' (PAGE, A);
-READ_HEADER;
READ FILE (VALUES) INTO (CHRBUF3) KEYTO(CODE);
PUT EDIT ('KEY:', CODE) (SKIP(2), A, X(2), A(6));
PUT SKIP(2);
DO I = 1 TO 12;
CHRBUF(1) = SUBSTR(CHRBUF3, (I * 110) - 109, 110);
PUT EDIT(CHRBUF(1)) (SKIP(2), A(110));
K = INDEX(CHRBUF(1), '#');
IF K > 0 THEN GO TO READ_LABELS_LIMITS;
END;
GO TO READ_HEADER;
-READ_LABELS_LIMITS;
-READ FILE (VALUES) INTO (CHRBUF3) KEYTO(CODE);
DO I = 1 TO 15;
LABELS(I) = SUBSTR(CHRBUF3, (I * 35) - 34, 35);
END;
LIMITS_STRING = 0;
DO I = 1 TO 15;
CHRBUF(1) = SUBSTR(CHRBUF3, (660 + (I*12) - 11), 12);
LIMITS_STRING(1,1) = SUBSTR(CHRBUF(1),1,6);
LIMITS_STRING(1,2) = SUBSTR(CHRBUF(1),7,6);
END;
PUT EDIT (' KEY: ,CODE, (LABELS(1), LIMITS_STRING(1,1), LIMITS_STRING(1,2)
DO I = 1 TO 15)
(PAGE,SKIP(4),A,A, 15 (SKIP(3),X(1),A(35),X(10),A(6),X(10),A(6)));
PUT EDIT (**** STUDENT RECORDS ****) (PAGE,SKIP(4),A);
PUT SKIP(4);
PRINT_FILES:
DO I = 1 TO #_STUDENTS + 10;
READ FILE (VALUES) INTO (MASTER) KEYTO(CODE);
PUT EDIT (' KEY: ,CODE, MASTER)
(SKIP(4),A,A, 15 (SKIP(2),X(1),F(6), 13 F(5),F(6),7 F(5)));
PUT PAGE;
END PRINT_FILES;
-CONTINUE:
SECTION.# = '99';
SECTION.#_TOTAL = 0;
#_SECTIONS = 0;
GROUP.#_TOTAL = 0;
-BUILD_SECTION_ARRAY:
DO I = 1 TO #_STUDENTS;
-NEW_SLOT:
DO J = 1 TO 10;
IF DATA.ARRAYC1,22) = SECTION.#(J) THEN DO;
SECTION.#_TOTAL(J) = SECTION.#_TOTAL(J) + 1;
GO TO GET_NEW_STUDENT;
END;
IF SECTION.#(J) = '-99' THEN DO;
SECTION.#(J) = DATA.ARRAY(1,22);
SECTION.#_TOTAL(J) = SECTION.#_TOTAL(J) + 1;
#_SECTIONS = #_SECTIONS + 1;
GO TO GET_NEW_STUDENT;
END;
END NEW_SLOT;
-END BUILD_SECTION_ARRAY;
-REPORTS:
PUT EDIT ('VALUES FILE STATISTICS: THERE ARE #_STUDENTS, STUDENTS, GRO
PED INTO, #_SECTIONS, SECTIONS OF THE COURSE, AS FOLLOWS:')
(PAGE,SKIP(4),A,F(6),A,F(3),A);
DO I = 1 TO #_SECTIONS;
PUT EDIT (SECTION STUDENTS, (SECTION.#(1),SECTION.#_TOTAL(1))
DO I = 1 TO #_SECTIONS)
(SKIP(4),A, (F#_SECTIONS) (SKIP(2),X(2),A(6),X(7),F(6)));
END;
-SECTION_REPORT_L1:
DO I = 1 TO #_SECTIONS;
PUT EDIT ('STUDENT LIST FOR SECTION#, SECTION.#(1),#_SECTION.#_TOTAL(1),
#_STUDENTS,)
(PAGE,SKIP(4),A,X(2),A(6),A,F(6),A);
PUT EDIT ('STUDENT ID', 'SECTION ', 'GROUP NUMBER', 'MASTER ARRAY VALUES')
(SKIP(4), 4 (A,X(10)));
-SECTION_REPORT_L2:
DO J = 1 TO #_STUDENTS;
IF DATA_ARRAY(J, 22) = SECTION_(1) THEN GO TO PRINT_RECORD;
GO TO END_SECTION_REPORT_L2;
-PRINT_RECORD:
PUT EDIT (DATA_ARRAY(J, 1), DATA_ARRAY(J, 22), DATA_ARRAY(J, 23),
(DATA_ARRAY(J, K + 1) DO K = 1 TO #_CHANGES))
(SKIP(2), X(2), A(6), X(14), A(6), X(14), A(6), X(6), (#_CHANGES) X(3), A(6));
GROUP_#_TOTAL(DATA_ARRAY(J, 23), 1) = GROUP_#_TOTAL(DATA_ARRAY(J, 23), 1) + 1;
END_SECTION_REPORT_L2;
END_SECTION_REPORT_L2;
-PUT EDIT(' GROUP NUMBER', 'STUDENTS', (K, GROUP_#_TOTAL(K, 1) DO K = 1 TO 4)
(SKIP(4), A, X(10), A, 4 (SKIP(2), X(5), F(4), X(14), F(6)));
DO K = 1 TO 4;
GROUP_#_TOTAL(K, 2) = GROUP_#_TOTAL(K, 2) + GROUP_#_TOTAL(K, 1);
END;
GROUP_#_TOTAL(1, 1) = 0;
END_SECTION_REPORT_L1;
-PUT EDIT(' GROUP TOTAL:', 'GROUP NUMBER', 'STUDENTS', (K, GROUP_#_TOTAL(K, 2)
DO K = 1 TO 4);
(PAGE, SKIP(2), A, SKIP(3), A, X(10), A, 4 (SKIP(2), X(5), F(4), X(16), F(6)));
GO TO END_OF_PROGRAM;
-ERROR_ROUTINE:
PUT EDIT(' CARD TYPE EXPECTED: ', ERROR_LABEL, ' CARD TYPE READ: ', CARD_TYPE)
(PAGE, SKIP(6), A, A, SKIP(1), A, A);
GET SKIP(1);
DO I = 1 TO 1000;
GET EDIT(CCHRBUF2) (A(80));
PUT EDIT(CCHRBUF2) (A(80));
GET STRING(CCHRBUF2) EDIT(CODE) (A(6));
IF CODE = '299999' THEN GO TO END_OF_PROGRAM;
END;
STOP;
-END_OF_PROGRAM: END_BUILDER;
THIS IS IN PLACE OF A /* CARD-REPLACE TO RUN PROGRAM
// mixed EXEC PGM=ICL,PARM='XREF,LIST',TIME=(,30)
// SYSPRINT DD SYSOUT=A
// SYSLIB DD DSII=SYS1.PLI,LIB,DISP=SHR
// SYST1 DD UNIT=SYSDA,SPACE=(CYL,(2,1))
// SYSLIN DD DSII=ICL,LIB,DISP=OLD,DELETE
// SYSLOD DD DSII=MSSET(G0),DISP=(MOD,PASS),
// UNIT=SYSDA,SPACE=(1024,(50,20,1)),RLSE)
// GO EXEC PGM=.*,LKD=SYSLIB,TIME=1
// VALUES DD DS=CEA570.VALUES,DATA,DISP=NEW,KFEP)
// UNIT=1330, VOL=SER=1RCC73, SPACE=(CYL,(11)),
// DCB=(DSORG=1,RECFM=F, LRECL=1320, BLKSIZE=1320, KEYLEN=6)
// SYSPRINT DD SYSTOUT=A,DCB=(RECFM=FB, LRECL=133, BLKSIZE=133)
// SYS11 DD *
PARAMETERS 0 23
WELCOME TO THE PHOENIX INDUSTRIES, LTD., COMPUTER-ASSISTED CASE STUDY. PLEASE
REVIEW YOUR CASE WRITE-UP
INSTRUCTIONS BEFORE RUNNING THE MODEL. WHEN THE PROGRAM TYPES NEW PAGE, PLEASE
ROLL THE PAPER TO THE TOP OF THE NEXT PAGE. THEN, TYPE TOP, AND DEPRESS THE RETURN KEY. DO NOT USE THE KEY
ASKED AT ANY TIME. IF YOU
ACCIDENTLY DEPRESS IT, THE PROGRAM WILL STOP EXECUTING AND TYPE READY. DEPRESS
THE RETURN KEY TO RESUME
EXECUTION OF THE PROGRAM. GOOD LUCK.

LABELS-LIMITS
CONSTANT ORDER QUANTITY (UNITS) : 200 3000
FORMULA X FACTOR (ENTER AS X.XX) : 60 150
FORMULA X FACTOR (+XXX OR -XXX) : -999 999
| **MINIMUM ORDER SIZE (IN UNITS)** | 0 2500 |
| **DAYS IN DEMAND AVERAGE (DAYS)** | 1 15 |
| **REVIEW INVENTORY EVERY X DAYS** | 2 30 |
| **LOW STOCK POINT (IN UNITS)** | 0 2000 |
| **CANCEL IF NEXT ORDER DUE IN X DAYS** | 0 30 |
| **SHIPPING MODE (ENTER AS 1, 2, OR 3)** | 1 3 |
| **COMMUNICATIONS METHOD (1, 2, OR 3)** | -99 -99 |

**MASTERFILE**

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This is in place of a /* CARD REPLACE TO RUN PROGRAM */
APPENDIX G

Statistical Procedures
THE MANN-WHITNEY U TEST

When at least ordinal measurement has been achieved, the Mann-Whitney U test may be used to test whether two independent groups have been drawn from the same population.

These are the steps in the use of the Mann-Whitney U test:

1. Determine the values of \( n_1 \) and \( n_2 \). \( n_1 \) = the number of cases in the smaller group; \( n_2 \) = the number of cases in the larger group.

2. Rank together the scores for both groups, assigning the rank of 1 to the score which is algebraically lowest. Ranks range from 1 to \( N = n_1 + n_2 \). Assign tied observations the average of the tied ranks.

3. Determine the value of \( U \) by determining the values of the following formulas:

\[
U_1 = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1
\]

and

\[
U_2 = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - R_2
\]

---


2Adapted from Siegel, ibid., pp. 116-126.
where $R_1$ is the sum of ranks of the smaller group and $R_2$ is the sum of ranks of the larger group.

$U$ is the smaller of the $R_1$ and $R_2$ values.

4. If $n_2$ is 20 or less, consult statistical tables to determine the significance of the observed value of $U$.³

If $n_2$ is greater than 20, a normal approximation formula may be used to determine the significance of the observed value of $U$, as follows:

$$Z = \frac{U - \frac{n_1n_2}{2}}{\sqrt{\frac{(n_1)(n_2)(n_1+n_2+1)}{12}}}$$

5. If the observed value of $U$ has an associated probability equal to or less than $\alpha$, reject $H_0$ in favor of $H_1$.

³See, for example, ibid, pp. 271-277.
THE KENDALL RANK CORRELATION COEFFICIENT

The Kendall rank correlation coefficient, \( \tau \), is suitable as a measure of correlation if at least ordinal measurement of both the X and Y variables has been achieved, so that every subject can be assigned a rank on both X and Y. \( \tau \) will give a measure of the degree of association or correlation between the two sets of ranks.

These are the steps in the use of the Kendall rank correlation coefficient:

1. Rank the observations on the X variable from 1 to N. Rank the observations on the Y variable from 1 to N.

2. Arrange the list of N subjects so that the X ranks of the subjects are in their natural order, that is, 1, 2, 3, ..., N.

3. Observe the Y ranks in the order in which they occur when the X ranks are in natural order. Determine the value of \( S \) for this order of the Y ranks as follows:
   a. Form all possible combinations of the first Y rank with the succeeding Y ranks.

---

4. Ibid., p. 213.
5. Adapted from ibid., pp. 213-223.
b. For each pair which is in "natural" order, i.e., the first Y rank is lower than the other rank in the pair, assign a value of +1. For each pair which is in "inverted" order, i.e., the first Y rank is higher than the other rank of the pair, assign a value of -1.

c. Sum the +1 and -1 values and assign the total to the first Y rank score.

d. Select the next Y rank, form all possible combinations using succeeding Y ranks, and assign values and sum as in steps 3.b and 3.c, above. Continue moving down the list until all possible combinations of Y ranks have been tabulated.

e. S is the sum of Y rank totals.

4. Tau is computed as follows:

\[ r = \frac{S}{\frac{1}{2}N(N-1)} \]

If there are tied scores in the X or the Y values, the values are given the average of the ranks they would have received without ties and the formula for tau must be modified.6

---

6Ibid., p. 218.
5. For samples of ten or less observations, statistical tables are used to determine the significance of tau. For samples larger than ten observations, a normal approximation can be computed as follows:

\[
Z = \sqrt{\frac{2(N + 5)}{9(N - 1)}},
\]

If the probability yielded by the appropriate method is equal to or less than \(\alpha\), \(H_0\) may be rejected in favor of \(H_1\).

\[\text{See, for example, ibid., p. 285.}\]
BIBLIOGRAPHY
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Columbus Dispatch. "Report Predicts Radical Teaching Aids This Century," June 1, 1972.


Silberman, Charles E. "Technology is Knocking at the Schoolhouse Door." Fortune, LXXIX, No. 8 (August, 1966), 120-125+.


