A COMPUTER SIMULATION EXPERIMENT WITH SELECTED COMMUNICATION AND INDIVIDUAL BEHAVIORAL VARIABLES IN THE BUSINESS FIRM

By

Henry Paul Sims, Jr.

This research is a computer simulation experiment involving a limited number of factors that affect the productivity of a business organization. The focus is on the psychological motivation of the individual in a business organization, and how that motivation influences the productivity of the organization. The primary objective of the research is to demonstrate how computer simulation can be useful as an experimental vehicle to develop additional insight into the behavior of individuals in organizations.

The specific setting is a hypothetical business firm that manufactures and markets a multi-product line. The primary decision considered in the model is the allocation of sales effort among different products in the product line, and the effect of that allocation on the firm's profitability.

For behavioral theoretical background, the research relies primarily on the work of Vroom regarding participation in decision-making. The specific mechanisms through which participation may influence productivity are examined, particularly the classification of participation effects into "decision quality" and "ego-involvement."

The model also draws upon the work of Likert regarding the effects of communication links in an organization. Selected communication links are incorporated for study. In particular, the link between production and sales concerning knowledge of inventory position is considered. Also included for investigation is an intercommunication link between territorial salesmen regarding characteristics of the market.

The primary response variable that is selected for analysis is the profitability of the firm. A complete 2^6 factoral experimental design is utilized, concentrating on the following experimental variables:

- Stability of demand: stable vs. volatile.
- Market response to sales effort: uniform response vs. non-uniform response.
- Knowledge of inventory by sales department: no knowledge vs. knowledge.
- Salesmen intercommunication: no information exchange vs. information exchange.
- Sales manager style: authoritarian vs. equalitarian.

- Salesmen personality: low vs. high need for independence.

Two factors, stability of demand and the inventory communication link, were found to have little effect on profitability, primarily because of counterbalancing mechanisms that tended to result in opposing effects. The intercommunication of salesmen was found to be insignificant because of the lack of substantive information transfer. The strongest effect on profitability was caused by participation in the sales-effort allocation decision, especially when considered in conjunction with valid market information and salesmen characterized by a high need for independence.

The model demonstrated a structure which explicated the partialling of the effects of participation into an information transfer component and an ego involvement component, each acting independently of the other.

The experiment has provided an initial step toward the integration of "macro" and "micro" type simulations, as well as demonstrated the viability of simulation as a means of explicating the structural mechanism underlying behavioral theory. The major contribution of the experiment is the demonstration of the usefulness of computer simulation as a vehicle for the exploration of behavioral theory.

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To My Parents

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CHAPTER 1

INTRODUCTION

What causes people to willingly contribute to the productivity of an organization? The quest for the answer to this question is a continuing challenge to both managers and behavioral scientists. Occasionally relatively simple answers are proposed, e.g., a "Theory Y" versus a "Theory X." But simplified theories cannot adequately explain the exceedingly complex interactions of the myriad of factors that influence an organization's performance. Indeed, even the concept of "productivity" has become rather blurred in recent years. In the past, profitability was normally a sufficient measure of productivity. Today, however, a business organization is accountable not only to stockholders or owners, but also to employees, customers, and ultimately to society as a whole. In addition to the responsibility of achieving profit objectives, management must also face the problem of fulfilling a multitude of objectives which are frequently ill-defined and difficult to measure. In an overall sense, a business firm continually attempts to optimize an ill-defined multiple criterion function, with constantly changing operating constraints.

This research is an experiment involving a limited number of factors that affect the productivity of a business organization. The focus is on the psychological motivation of the individual in a business organization, and how that motivation influences the productivity (as measured by profitability) of the organization. A secondary focus is concerned with the effect of selected communication links on productivity. The level of technology as well as the technical competence of individuals is assumed to be constant and is not directly considered. The primary objective of the research is to demonstrate how a relatively new methodology--computer simulation--can be useful as an experimental vehicle to develop additional insight into the behavior of individuals in organizations. It is an exploration aimed at elucidating behavioral theory by subjecting that theory to a simulation process and observing whether or not the simulation approach leads to an understanding of gaps, or inconsistencies, that may exist within the formulation.

Theoretical Background

In discussing the interrelationship of work and motivation, Vroom (1964, p. 6) specified three phenomena which have attracted the attention of behavioral scientists:

1. The choices made by persons among work roles.
2. The extent of their satisfaction with their chosen work roles.
3. The level of their performance or effectiveness in their chosen work roles.

This research concentrates on the third phenomenon. In particular, it focuses on the effect participation in decision-making has on productivity. The specific setting is a hypothetical business firm that manufactures and markets a multi-product line. The primary decision considered in the model is the allocation of sales effort among different products in the product line, and the effect of that allocation on the firm's profitability.

For behavioral theoretical background, the research relies primarily on the work of Vroom (1960, 1964) regarding participation in decision-making. In a study of supervisors, he found that individual personality differences constitute important moderators in the relationship between participation in decision-making and performance. The amount of psychological participation was found to be highly related to performance in those subjects who were high in need for independence; however, such participation was unrelated to the level of performance in those scoring low in measured need for independence. Vroom's findings regarding the moderating effects of subordinates' need for independence are incorporated into this model.

In this experiment, two types of individual salesmen are specified. The first type has high need for independence and derives intrinsic satisfaction from the opportunity to exert perceived influence on the decision-making of his superiors. The second type has low need for independence and places no personal value on the opportunity to influence decision-making. It is recognized that in a given population of actual individuals, the attribute of need-independence will be distributed along a continuum. For purposes of experimental control, however, the model assumes dichotomous polar levels of need-for-independence.

The specific mechanisms through which participation may influence productivity are also examined by this research--particularly the classification of participation effects into "decision quality" and "ego-involvement." In discussing decision quality, Vroom (1964, p. 7) observed that:

> Differences in the quality of decisions reached democratically and autocratically are probably dependent on a large number of factors, including the extent to which supervisors and subordinates have information relevant to judging the organizational consequences of different courses of action and the extent to which the interests of each are in harmony with organizational objectives. It is extremely unlikely that democratic decisions are <u>always</u> higher in quality than autocratic ones or vice versa.

In addition to the information quality aspects of decision-making, this experiment also attempts to demonstrate the relationship between participation and ego-involvement in decisions, and how this relationship can influence the productivity of the organization.

> It is also possible that people become "ego involved" in decisions in which they have had influence. If they have helped to make a decision it is "their decision," and the success or failure of the decision is their success or failure. Intuitively it would appear that the amount of personal involvement of people in decisions is dependent on the amount of influence they have had in the decision and on the extent to which they pride themselves on their ability to make that kind of decision. If, for example, a person who conceives himself to be a brilliant scientist shares in the making of a decision which he believes requires scientific judgement, the outcome of that decision is a test of the adequacy of his self-conception. A

> successful decision confirms his self-concept; an unsuccessful decision threatens it. On the other hand, when he helps to make a decision on an administrative matter he has less "at stake." Neither a successful nor an unsuccessful decision would be greatly inconsistent with his self-concept (Vroom, 1964, p. 7).

The model also relates individual motivation and performance to the overall performance of the organization, incorporating an elementary theory of individual motivation, the Vroom concept of "Expectancy Theory" (1964). The structure of the model thus is dependent on the theoretical and empirical framework used to portray individual behavior in organizations.

Vroom's conceptualization of Expectancy Theory may be referred to as the instrumentality-valence model, which is stated in two propositions:

> Proposition 1. The valence of an outcome to a person is a monotonically increasing function of the algebraic sum of the products of the valences of all other outcomes and his conceptions of its instrumentality for the attainment of these outcomes.

Valence is defined as "anticipated satisfaction from an outcome."

> Proposition 2. The force on a person to perform an act is a monotonically increasing function of the algebraic sum of the products of the valences of all outcomes and the strength of his expectancies that the act will be followed by the attainment of these outcomes.
>
> It is also assumed that people choose from among alternative acts the one corresponding to the strongest positive (or weakest negative) forces (Vroom, 1964, p. 17).

Thus, in Vroom's model, each individual has internal attributes such as expectancies, instrumentalities, valences of particular states, forces to perform particular acts, and skill levels.

An individual's performance may be regarded as a function of his ability and motivation. In this model, all salesmen are assumed to have equal and constant ability and technical competence. Variations in performance, then, depend only on changing levels of motivation.

Vroom specified three possible relationships between motivation and performance: linear, negatively accelerated approaching an upper limit, and an inverted U function. Vroom generally favors the inverted U function, quoting evidence, and offering two possible explanations. One reason for the decline of performance under very high levels of motivation may be a narrowing of the cognitive field. Another reason may be an association between anxiety and a high level of motivation. In this model, it is assumed that the levels of motivation in organizations are generally not the very high levels that are associated with a reduced cognitive field or high anxiety. Therefore, the declining portion of the inverted U function is ignored, resulting in a negatively accelerated relationship between motivation and performance that reaches an upper limit.

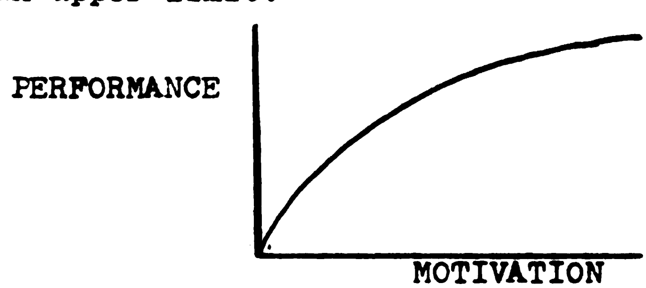

Figure 1-1. Vroom's Concept of the Relationship Between Motivation and Performance

In the model, individual performance of a salesman is defined in terms of the total amount of personal effort that a salesman expends in selling his products to customers. The individual level of motivation (effort) is regarded as a choice made by the individual. In terms of the instrumentality-valence model, he selects a level of effort that is consistent with the highest possible force. For salesmen with high need-independence, the opportunity of influencing his superior's decision-making is regarded as possessing high instrumentality because the outcome of perceived influence with the superior is intrinsically rewarding. Opportunity to participate therefore becomes a motivating factor for the salesman. For salesmen with low need-independence, the opportunity to exert influence in decision-making is regarded as possessing low instrumentality because the outcome of perceived influence with the superior is not regarded as rewarding in itself and is therefore not a motivating factor.

The model provides a mechanism by which the effect of the salesman's motivation-effort reaction is related to the determination of the overall performance of the firm.

This experiment also draws upon the work of Likert regarding the effects of communication links in an organization. In particular, the model incorporates selected cross-communication links that are included as determinants in decision processes.

Likert defined the "linking-pin" communication link concept as a key causal variable that differentiates a

"System 2" from a "System 4" type of managerial style.

> System 4 management...uses an overlapping group form of structure with each work group linked to the rest of the organization by means of persons who are members of more than one group. These individuals who hold overlapping group membership are called "linking pins" (Likert, 1967, p. 50).

He concluded that the information transfer and motivational effects of group decision-making are key behavioral elements that lead to high performance by an organization.

Likert defined his System 2 as "benevolent-authoritative" while System 4 was described as "participative-group." System 2 is characterized by a traditional "chain-of-command" authority structure while System 4 is characterized by supportive relationships, group decision-making, and high performance goals.

In this experiment, selected communication links are incorporated for study. In particular, the link between production and sales concerning knowledge of inventory position was considered. Also included for investigation is an intercommunication link between territorial salesmen regarding characteristics of the market.

In summary, this research attempts to incorporate selected theoretical and empirical conclusions of Vroom and Likert as the primary theoretical framework for the experiment.

Methodology Background

The influence of human behavior on the performance of an organization is a complex, interactive process. Various investigative techniques have traditionally been useful in the quest for knowledge about behavioral processes. One methodology that has been in the forefront in the development of social science theories is field research, or "survey" research (as typified by the work of the Institute for Social Research at the University of Michigan, or the Ohio State Leadership Studies). A second technique, laboratory experimentation, has been useful in isolating specific behavioral variables from random variations and confounding factors, thus facilitating the observation of outcomes that are strictly controlled by the experimental treatment.

A third methodology that has received significant and increasing attention is computer simulation. Simulation, as a technique, has been primarily utilized as a tool for the prediction, understanding, and explanation of existing systems (system analysis) or systems undergoing design (system design). In the field of business, computer simulation has been most frequently applied to the analysis of production, transportation, or marketing systems by focusing on the dynamic flow of materials or products. It has served as a substitute for more precise analytical optimization methods when such methods were inapplicable to complex systems. This experiment, however, is concerned with the use of simulation as a means of exploring social science theory in the context of the business firm. Since the focus is on behavior, rather than on the flow of materials, the experiment is classified as a "behavioral" simulation.

Simulation, of course, is far from new: "...man has been simulating things ever since he first scratched a pictorial representation of some real object on the wall of a cave" (Conway, et al., 1959, p. 92). Simulation is new, however, if one considers the subtle changes in the definition of the word. Webster's (1967, p. 811) rather broad definition of "simulate" ("to give the appearance of") can be applied to a wide variety of pictures, schematics, physical models, mathematical models, etc. In management and behavioral science literature, however, the word simulation has taken on a variety of new connotations: "One fact is certain. There is a computer simulation semantic jungle.. ..no consensus exists among writers on a definition of computer simulation" (Tarter, 1970, p. 2).

The following definition, however, best characterizes the intent of the present research:

> Computer simulation is an experimental method which utilizes a digital computer to operate a dynamic model for the purpose of theory development.

The subtle distinctions between the terms theory, model, and simulation are not always apparent. Theories are purposely broad. They attempt to provide a generalization to explain many specific cases. In the physical sciences, theories are generally formulated in mathematical terms, but, in the social sciences, real-world phenomena are not so amenable to mathematical expression. Social science theories are typically depicted verbally, although attempts are frequently made to reduce verbal expression to the more precise and rigorous mode of mathematics.

> . . .some social scientists have sought refuge in the domain of mathematics. The introduction of strict, emotionally neutral definitions and rigorously logical reasoning has considerable appeal. . . (Gullahorns [monograph, forthcoming]).

A theory, in entirety, may be too general to be tested in any meaningful way. A more specific expression may be required if a theory is to be tested; ergo, the need for a model. A model may thus be regarded as a specific manifestation of a theory. It is the unique mechanism by which theory is translated into a specific set of conditions and circumstances for the purposes of explanation and experimentation. Theory provides the basic framework for specification of a model and is the starting point for building the model. Barton (1970, p. 25) has discussed the relationship between theory and models:

> Theories are purposely broad; they try to generalize over many specific cases. This is really an economy of communication so that man does not need to pass hundreds and hundreds of detailed instances from one generation to the next. . . . To use theory, one must make the generalizations of theory specific enough to guide the making of observations and the taking of actions. Models serve this purpose.

Theory, therefore, is frequently expressed as a mathematical model. For complex systems, however, a mathematical description may be intractable to a closed analytical solution. Also, the restrictions imposed by the number of variables that can be interrelated by a mathematical model are limited. Other alternatives are needed. Because of its speed and symbol-manipulating capabilities, the digital computer provides a tool for the implementation of such an alternative. Not only mathematical, but logical models as well, can be specifically formulated for operation on a computer. The result is a computer simulation.

A computer simulation is a unique kind of model. It serves not only as an explication of a theory, but also provides the opportunity to set the model to work; to observe the behavior of the model over time and under varied sets of conditions. Since it typically incorporates the interrelationships of the system variables over time, a computer simulation is generally dynamic. A simulation is an abstraction of not only the static structural relationships, but the dynamic, process relationships as well. "It is the exhibition of process that distinguishes simulation from such static models as blueprints, dolls, etc." (Crow, 1967, pp. 11, 12). A behavioral simulation may thus be thought of as a special kind of dynamic model, i.e., an abstraction of reality that attempts to describe the socio-psychological components of the reality and to specify the dynamic nature of the relationships among those components.

Computer simulation provides a unique vehicle for the study, development, and explication of theory. Verba (1964, p. 499) discussed the role of simulation in the development of theory:

> One of the major contributions of simulation research [is] to the development of theory. . . . The process of designing a simulation forces the designer to explicate his model. . . . One is forced to make explicit what may have been

> the implicit assumptions about the subject matter --in order that these assumptions may be placed in the operating model . . . . a simulation differs [in] that it goes on from there. The explicated model is set to work and, over time, generates data on subsequent states of the simulation.

A computer simulation can be regarded somewhat analagous to a laboratory experiment in that it provides the advantage of being able to attain a high degree of experimental control. Like a laboratory experiment, the results may thus lead to further confidence in the theory, disprove the theory, or possibly lead to further investigation that may modify the theory. Frijda (1967) also supports the concept of computer simulation as a useful tool for the development of theory:

> . . .computer programs can serve as unambiguous formulations of a theory. The program language is precise; the meaning of a given process is fully defined by what it does. . . . [It] is a means to demonstrate and test the consistency and sufficiency of a theory. If the behavioral data which the theory wants to explain are in fact reproduced by running the program, the theory has been proved capable of explaining these facts. Moreover, running the program under a variety of conditions may generate consequences of the theory which can be tested against new evidence. These consequences may be unforeseen and they may be quite important. . . . Extensive experimentation is possible by running different versions of the program . . . .

One of the byproducts of simulation is the necessity of guaranteeing sufficiency and completeness. "The computer simulation model will not operate if you forget anything. If you fail to take into account some necessary mechanism that, in the verbal description of a theory you might readily pass over, the computer simulation will not run" (Feigenbaum, 1963, p. 5). The Gullahorns found the same in their simulation of

George Homans' theory of social exchange:

> . . .the very process of translation [from verbal theory to computer program] forces one to be precise about variables and their relationships and thus helps one to recognize ambiguities in expression and implicit assumption in the verbal model. For example, if the verbal formulation contains qualifying phrases such as "other things being equal," in programming one must define precisely what these "other things" are and what it means for them to be "equal"; otherwise the computer simply will not operate--the programmed theory will not generate the expected consequences (Gullahorns, 1962, p. 5).

In the past, the primary development of theory has resulted from the collection of empirical data. The social scientists' objective was to devise a theory that would explain the data. The more data explained by the theory, the more confidence in the validity of the theory.

Computer simulation does not alter this objective, nor will simulation replace empirical data as the primary source of theory development. Rather, simulation becomes an additional tool, one that can lead to further insight regarding the theory. Through the computer, it becomes possible to perform analyses that would otherwise be impossible; to make further deductions regarding the dynamic implications of complex systems.

The use of computer simulation as a tool for theory development has been recently established in all the behavioral sciences, ranging from political science (which focuses on the nation as a behavioral entity) to psychology (which focuses on the individual as a behavioral entity). Selected examples may be found in Ableson and Bernstein (1963), Amstutz

(1967), Carroll (1969), Guetzkow (1962), Guetzkow, et. al. (1963), McPhee (1961), Schelling (1961), and Tomkins and Messick (1963). Some attention has also been directed toward the use of computer simulation as a methodological technique in doctoral dissertation research. A number of dissertations that employ computer simulation as a research methodology can be found in Tuason (1965), Bellman (1969), Uhr (1969), Chervany (1968), Siemens (1967), Cleveland (1967), Miller (1962), Summit (1965), Desjardins (1964), Hutchinson (1964), Wallace (1961), Green (1960), Benson (1963), Hershaur (1969), Stallings (1970), Parker (1970), Hunt (1970), Fondren (1963), Kaczka (1966), Gensch, (1967), Norek (1970), Brightman (1970), Srinivas (1970), Bettman (1969), and Weber (1970).

Macro and Micro Models

In this investigation of human behavior in organizations, computer simulation is employed to generate an artificial history of a hypothetical firm for purposes of analysis. The research attempted to integrate two major trends which have characterized behavioral simulation: the "macro" versus the "micro" approach. The Gullahorns (1969, p. 3) take note of these trends in their review of social system simulations:

> In endeavoring to organize the varied types of simulations that were retrieved in our bibliographic search, we have distinguished between models that emphasize universal processes affecting a social system as opposed to those that focus on micro-behavioral processes within sociocultural contexts. The distinction is by no means clear-cut. However, while not all of the models

simulating total system process exhibit a "black box" approach to individual decision making, they nevertheless tend to trivialize autonomous information processing. The simulations we have termed micro-behavioral, on the other hand, incorporate social psychological considerations and tend to de-emphasize total system processes.

In business-related simulations, the "macro" approach typically involves modeling the marketing, production, and financial functions as well as the flow of materials, products, information, and profits along with associated decision processes. The decisions in such a large-scale simulation generally are not associated with an individual nor specified in detail. Examples of the large-scale approach include the Cyert and March model of price and output behavior in the firm, the Bonini simulation of information and decision processes, and the Kaczka model of the behavior of work groups.

The Cyert and March (1963) simulation dealt with the output and price decisions of a business firm operating in an oligopoly market. The basic decision processes of the firm reflected the March and Simon (1958) concepts of "satisficing."

The firm in the model makes three basic decisions during each time period. First, the price to be charged for the product is determined. Second, the number of units to be produced in the next time period is decided. Finally, the firm decides on the amount of sales effort and the amount allocated to sales promotion.

The decisions are made subsequent to a comparison of past performance with goals. In effect, decisions are made on the basis of past results. Goals are adjusted according to a lagged relationship with performance. If problems exist, the firm may implement a search for alternatives to solve the problem. The firm operates under a type of management by exception since search is avoided if all appears to be going well.

The experiment on the Cyert and March model is implemented through the use of a number of runs, each with random variations in the values of the model parameters. The results are analyzed by regression techniques to determine which parameters exert the strongest influence over the performance of the firm. In summary, the Cyert and March model presents empirically based behavioral processes that are relevant to the determination of the price and output decisions of the business firm.

Bonini's work incorporated the simulation of the information and decision process in a hypothetical business firm. His model was an attempt to synthesize some of the relevant theory from several disciplines--economics, accounting, marketing, organization theory, and behavioral science. His model of the business firm included the traditional functions of production and marketing along with an executive group to oversee the operations. The objective of the simulation was to study the effects of certain environmental, informational, and organizational factors upon the performance of the firm.

The decision processes in the Bonini model were heavily influenced by the work of March and Simon (1958), and Cyert and March (1963), concerning the concepts of "satisficing" rather than "maximizing." The model was distinctive because of its emphasis on the behavioral aspects of the organization. In particular, Bonini incorporated the concept of an "index of pressure," which is a function of performance relative to goals.

> When an organization is failing to perform up to expectations, there is a tendency for pressure to build up within an organization, and this pressure generally results in attempts to achieve better performance. (Bonini, 1963, p. 19)

The study was basically an experimental simulation that investigated the effects of changes in the external environment, the information system, and the decision system. Among other findings, one major conclusion was that firms with relatively stable environments were slow to take advantage of profit opportunities, while firms faced with highly variable environments generally, after considerable search, ended up with higher sales and/or lower costs.

An important conclusion generated by the study was the point contrasting <u>a priori</u> versus <u>a posteriori</u> theorizing. He emphasized how it was often easy, after the fact, to explain how a mechanism would work, but emphasized that such explanations should not mean that the results were necessarily trivial or obvious beforehand.

Although the Bonini simulation was not intended to be applicable to any particular company's problems, it was important because of the demonstration of the capability to abstract selected behavioral aspects of the information systen and decision processes in the firm.

Eugene Kaczka has constructed a computer simulation model that concentrates on the behavioral aspects of the production sector of the business firm. His experiment addressed the question of whether a managerial climate which is employee oriented results in higher levels of performance than a task oriented climate. His research employed a factorial experiment on a complex model of a hypothetical industrial organization that was composed of four structural components: the market, the executive level, middle and lower management levels, and work groups.

As measured by both economic and socio-psychological criteria, he found performance to be significantly affected by managerial climate. His model demonstrated general support of the hypotheses of Likert (1967):

> Several of the dimensions of managerial climate, and interactions of these dimensions yielded higher levels of organizational performance under employee-orientation than were realized under task-orientation. The notable exception was low cost emphasis which yielded poorer performance.
>
> In summary, the findings indicate that the most efficient levels of performance result when concern for cost performance is wed with a concern for the employees of the organization. (Kaczka, 1966, p. 230-231)

The "micro" approach, on the other hand, has typically been concerned with the simulation of individual decision processes, but generally ignores the process by which the outcome of these decisions affects the total operation of the organization. Examples of the micro approach include the Smith simulation of the personnel selection decision process, the Clarkson simulation of the stock selection decision process, and the Gullahorn and Gullahorn simulation of George Homans' theory of exchange in interpersonal behavior.

Smith's (1968; Smith and Greenlaw, 1967) simulation dealt with a decision process in personnel selection. In particular, the simulation attempted to emulate the decision process of a personnel psychologist who utilized test scores and other data about individuals for selection and placement into various types of clerical-administrative positions. The simulation was designed to produce not only a specific employment recommentation, but also various interpretive comments about each applicant.

His model was proven capable of producing a strong correspondence between the human psychologist and the output of the computer simulation. In his experiment, he found a 94% level of agreement between the human decisions and the simulated psychological inferences.

His research suggested the possibility of utilizing computerized interpretive programs as prescriptive models for personnel selection. Also mentioned was the possibility of utilizing a similar model for computer-assisted instruction of industrial psychology students. In the long run, however, his major contribution lies in the fact that . . .

> Research of this type gives deeper insight into the manner in which people resolve problems. The methodology allows the researcher to map an

> equivalent thought process at a particular point in time and could permit the study of the effects of aging and experience on decision-making capabilities of individuals and groups. (Smith, 1968, p. 329)

Another research effort that involved the simulation of individual decision-making was the Clarkson model of the trust investment process. The principal objective of the study was to develop a behavioral, as opposed to normative, theory of trust investment. A trust investment office is charged with the responsibility of allocating a given investment amount among various stock investment alternatives. Clarkson's model was constructed by observing the decision logic of an investment officer and by incorporating that logic into a heuristic program for computer simulation. Clarkson's basic findings indicated that his model provided a reasonable prediction of both the actual portfolios as well as the decision processes by which selection was made.

One of the better known micro-models is HOMUNCULUS, the Gullahorns' simulation of interaction between two (or more) individuals (1964, 1969). HOMUNCULUS is not only a model of a social system but is also a micro-process because of the elaborate decision system of each individual in the model. Each individual is defined by a list structure representing personal attributes such as identity, values, attitudes, and a memory structure that may change with each interaction event. The decision that each individual makes is contingent upon his values, attitudes, and memory structure.

The model is based on George Homans' theory of social exchange, where two individuals act in face-to-face interaction and provide rewards and punishments to each other. The construction of the model requires the translation of five verbal propositions advanced by Homans (1961, pp. 53-111) into operational computer statements. The particular situation described by the model is a dyad, where one person requests help from another in a job related task. In the interaction event, both may benefit and both may pay a price in a sort of psychoeconomic exchange. The decision process that guides each individual's actions depends on the payoffs that his past interactions have elicited.

The input is composed of the personalities and past histories, defined by attributes assigned to the two individuals. The output data consists of the verbal responses of the two individuals as they proceed through a sequence of interaction events.

HOMUNCULUS has also been used to investigate triads (1964) and has found that, for individuals who were initially strangers, an isolate and a dyad results. For triads who are initially friends, the results are similar to the dyadic interaction.

The primary value of the Gullahorns' work is the fact that a social science theory, formerly expressed only verbally, was proven tractable to expression by a computer program which demonstrated the internal consistency of the theory.

The Nature And Purpose Of This Experiment

Currently, the Gullahorns are undertaking a project whose long-term objective is to integrate a "microprocess" individual decision-making model (similar to their HOMUNCULUS model) into a "macroprocess" that models the functions of a large-scale firm. The interfaces between the microprocesses and macroprocesses of the system will occur at the decision nodes. When the need for a decision is specified by the macrosystem, the inputs to the decision node will become the inputs (or stimuli) to the microsystem. The microsystem will emulate the decision process of an individual and will emit a decision (to the macrosystem) after being operated on by the socio-psychological attributes of that individual.

> The current simulation endeavor provides the challenging opportunity to advance. . .by building a model of an organization in which individual values, decisions, and behavior produce system results; and in turn, organization values, adaption, and integration feed back to influence individual's values and behavior (Gullahorns, 1970, p. 1).

As an intermediate step in this endeavor, this experiment involves a simplistic firm with a relatively simplified decision process in order to concentrate on the feasibility of integrating a macro and micro process into the same model.

In essence, the model is designed to be complex enough to produce realism in terms of output, but simple enough to be manageable. Considering time constraints and considering the state of the art, the experiment, therefore, is designed to meet three limited objectives:

1. To provide a means of incorporating and analyzing complex organizational relationships and selected communication and individual behavior factors that may, in combination, impinge on the performance of the organization.
2. To provide experimental control in order to isolate specific causal relationships.
3. To provide a means of evaluating the integration of micro- and macro-processes into a single model.

In summary, the research is a planned experiment on a hypothetical business firm, performed by computer simulation, to investigate the conditions under which selected personality variables and communication links can affect the productivity of the firm. The experiment is intended to be an exploration into the use of computer simulation for explication of behavioral theory.

CHAPTER 2

STRUCTURE OF THE MODEL

The model developed for this research is a simplified representation of the operations of a hypothetical business firm that manufactures and markets a line of products. The model utilizes a "fixed-time" interval (of one month) of timekeeping and transcends a total time of 100 months for each run. The model was written in FORTRAN IV and computations were performed on a Control Data Corporation Model 6500 computer.

Nominal demand for each of the firm's products is exogenously defined and may be described by a unique product life cycle (see Subroutine SLSGEN). Demand, of course, is influenced by pricing and promotion policies, sales effort, and random factors.

Since the model assumes that the firm is a well established existing organization with a history, initial conditions (primarily attributes of the existing product line) must be assigned to simulate the history of the firm. A program which was used for random generation of initial conditions is shown in Appendix IV (PROGRAM IC).

The model also assumes a given and constant production capacity function over the length of the run. Therefore, capital investment decisions are not considered. The manpower system is also assumed to be constant (both in a qualitative and quantitative sense), and the flow of manpower is not considered.[1]

The Organization

The firm in the model is composed of a chief executive officer, an accounting department, a production function, and a marketing function. Figure 2-1 shows a breakdown of these functions. This chart is a representation of the formal structure of the firm. The elements in the chart are restricted to only those elements of the firm which are actually incorporated into the model. It is recognized that a firm, which exists in the real world, even a small business, will be considerably more complex than the organization reflected by the chart.

A general summary of the organization activities is shown in figure 2-2. This chart specifies the primary responsibilities, decisions, and actions that are assigned to each position and department in the firm.

Each of the individuals and/or departments in the model receives specific types of information and makes an explicit set of decisions or performs a specific set of actions. Figure 2-3 is a summary of the information-decision flow processes in the model, listed according to position.

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[1]For a Capital Investment simulation, see Cleveland, (1967). For a Manpower Planning simulation, see Weber, (1970).

Program PAJAMA

Program PAJAMA is the executive program that implements and controls each replication.[2] After the values for the block initial conditions are read in, a loop is then established for each run with the values for the experimental variables defined by a zero-one generating algorithm. For each subsequent run, initial conditions are then reset.

The program also calls each of the subroutines that perform the dynamics of the simulation. An overall flow chart showing the executive program and subroutines is shown in Figure 2-4.

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[2]See Chapter 3 for definition of replication and run.

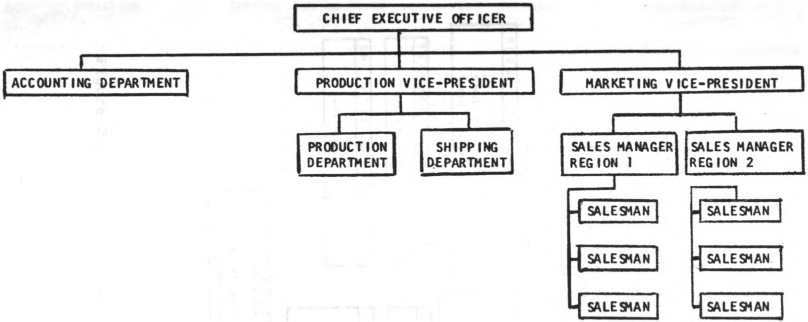

Figure 2-1

ORGANIZATION CHART

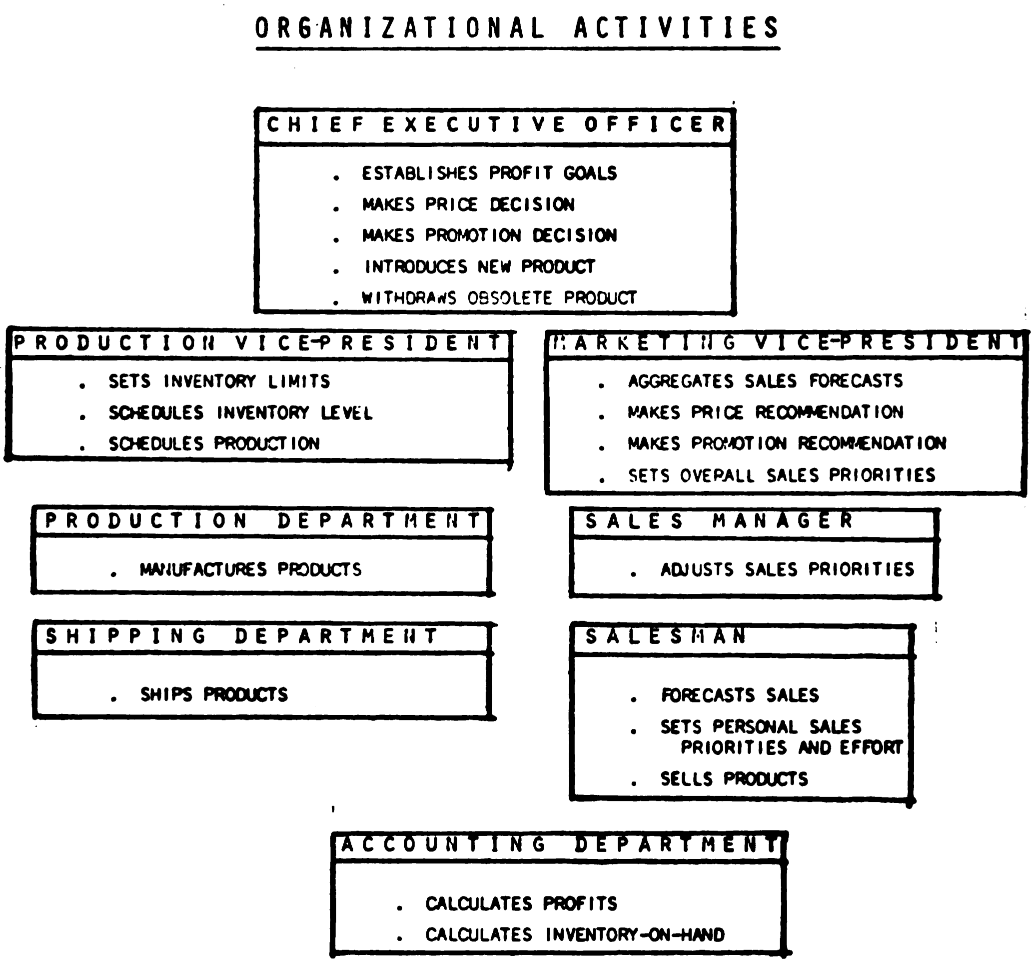

Figure 2-2. Organizational Activities

POSITION	INFORMATION RECEIVED AND USED	DECISIONS AND ACTIONS	INFORMATION TRANSMITTED
Chief Executive Officer	1. Past profit goal Actual profits, last period (from Accounting Department)	1. Establish profit goals (EXECUTIVE)	1. Profit goals
	2. Relative success of recent price and promotion decisions Projected profit Recommendations from Marketing Manager	2. Make price decision Make promotion decision (EXECUTIVE)	2. Price; Promotion
	3. Aggregate sales in relation to plant capacity Aggregate sales trend	3. Introduce new product (NEWPRO)	3. New product introduction
	4. Aggregate sales in relation to plant capacity Sales trend Product profitability Product share	4. Withdraw obsolete product (NEWPRO)	4. Obsolete product withdrawal

Figure 2-3

Information and Decision Flow

Production Vice-President	1. Previous period's sales Past limits	1. Set inventory limits (INVENT)	1. Upper inventory limit Lower inventory limit
	2. Inventory limits Present inventory level (from Accounting Dept.)	2. Schedule inventory level (INVENT)	2. Inventory schedule Pressure on Sales Dept.
	3. Sales forecast (from) Marketing Vice-President Present inventory Scheduled inventory	3. Schedule production (GENPRO)	3. Production schedule
Marketing Vice-President	1. Product sales forecast (from each salesman)	1. Aggregate sales forecast (FCAST)	1. Aggregate sales forecast
	2. Previous and current forecasts Sales in relation to previous forecast	2. Make price and promotion recommendation (PRREC)	2. Price and promotion recommendation Pressure on Sales Dept.
	3. Relative pressures	3. Set overall sales priorities (SLSMEN)	3. Ranking of sales priorities

Figure 2-3 (continued)

Sales Manager	1. Sales priorities (from Marketing V. P.) Influence of salesmen	1. Adjust sales priorities	1. Adjusted priority ranking
Salesman	1. Previous sales and trend	1. Forecast sales (FCAST)	1. Sales forecast
	2. Ranking on basis of response to marginal effort Priority ranking (From Sales Manager) Ranking on basis of gross volume	2. Set personal sales Priorities (SLSMEN)	2. Sales priority
	3. Pressure on each product Opportunity to participate	3. Set personal effort (SLSMEN)	3. Sales effort
	4. Age of product Price Promotion Effort Random Variation	4. Sells products (SLSGEN)	4. Actual sales
Production Department	1. Production schedule (from Production Vice-President) Random deviation	1. Manufacture products (GENPRO)	1. Production output

Figure 2-3 (continued)

Shipping Department	1. Orders (from salesmen) Inventory	1. Shipping activity (SLSGEN)	1. Product shipment
Accounting Department	1. Cost of production Inventory holding costs Promotion costs Fixed cost allocation Revenues	1. Calculate profits (BOOK)	1. Profit
	2. Sales Previous inventory Actual production	2. Calculate inventory-on-hand (BOOK)	2. Inventory level

Figure 2-3 (continued)

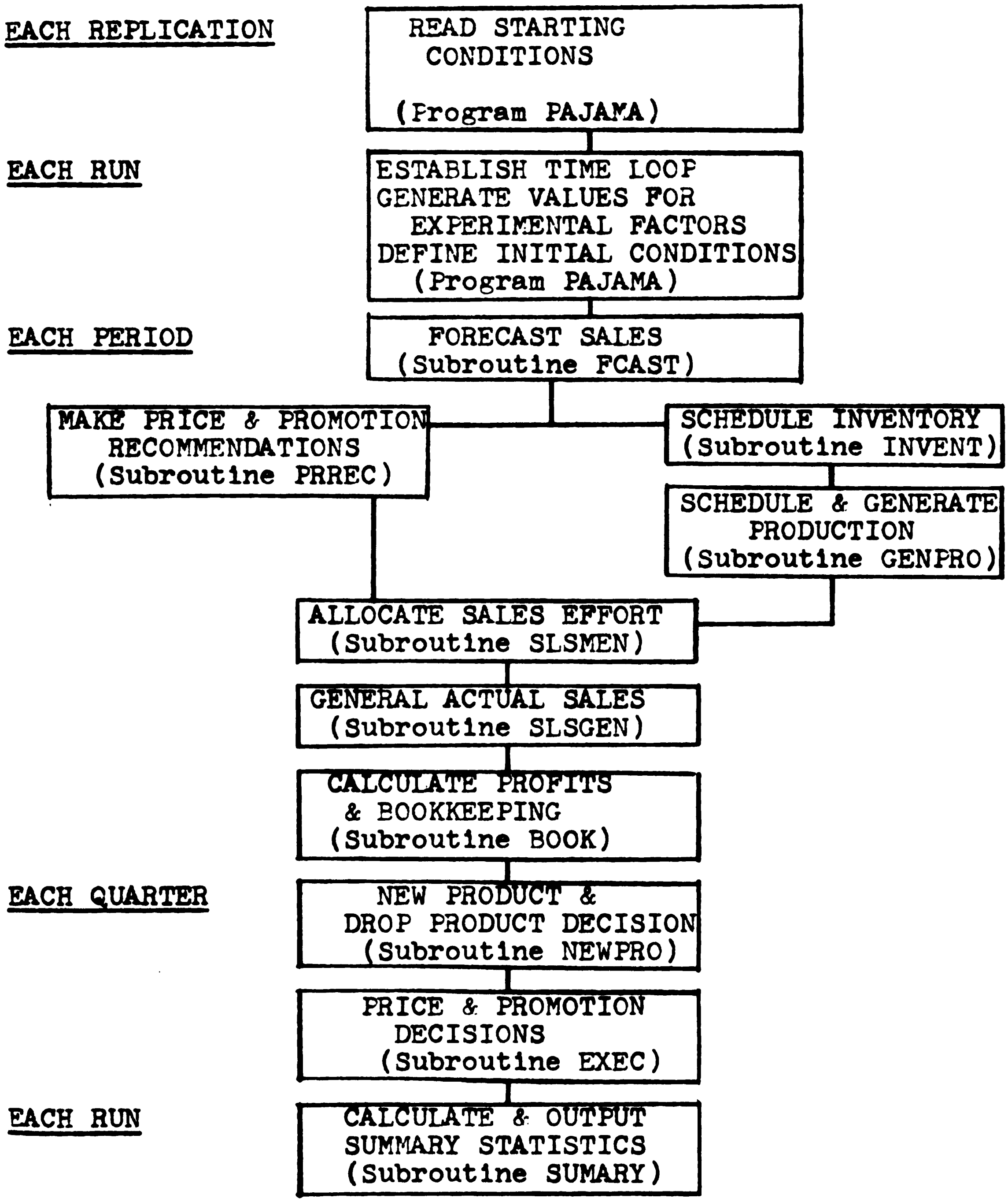

Figure 2-4. Overall Flow Chart

Subroutine FCAST

The objective of this subroutine is to provide a mechanism by which each salesman is able to forecast the next-period sales for each product in his territory. The forecast is based on the sales of the last period, adjusted for a trend factor.

The forecasting algorithm is based on the double exponential smoothing method (Clark and Schkade, 1969, pp. 705-6; Brown, 1963, pp. 128-132). The double exponential method is used because of the capability to correct for trend.

The steps in computing a double-smoothed forecast are:

- Calculate new smoothed average

  SAVE(K,L) = ALP1 * ORDERS(K,L) + (1-ALP1) * PSAVE(K,L)

  where: SAVE = New smoothed average
  ALP1 = Smoothing constant
  ORDERS = Current orders
  PSAVE = Previous smoothed average

- Calculate change in smoothed averages

  CHANGE = SAVE(K,L) - PSAVE(K,L)

- Forecast change in orders

  DELOR(K,L) = ALP1 * CHANGE + (1-ALP1) * DELOR(K,L)

  where: DELOR = Smoothed change in orders

- Compute forecast of orders for next period

  FORC(K,L) = SAVE(K,L) + (1-ALP1) * DELOR(K,L)/ALP1

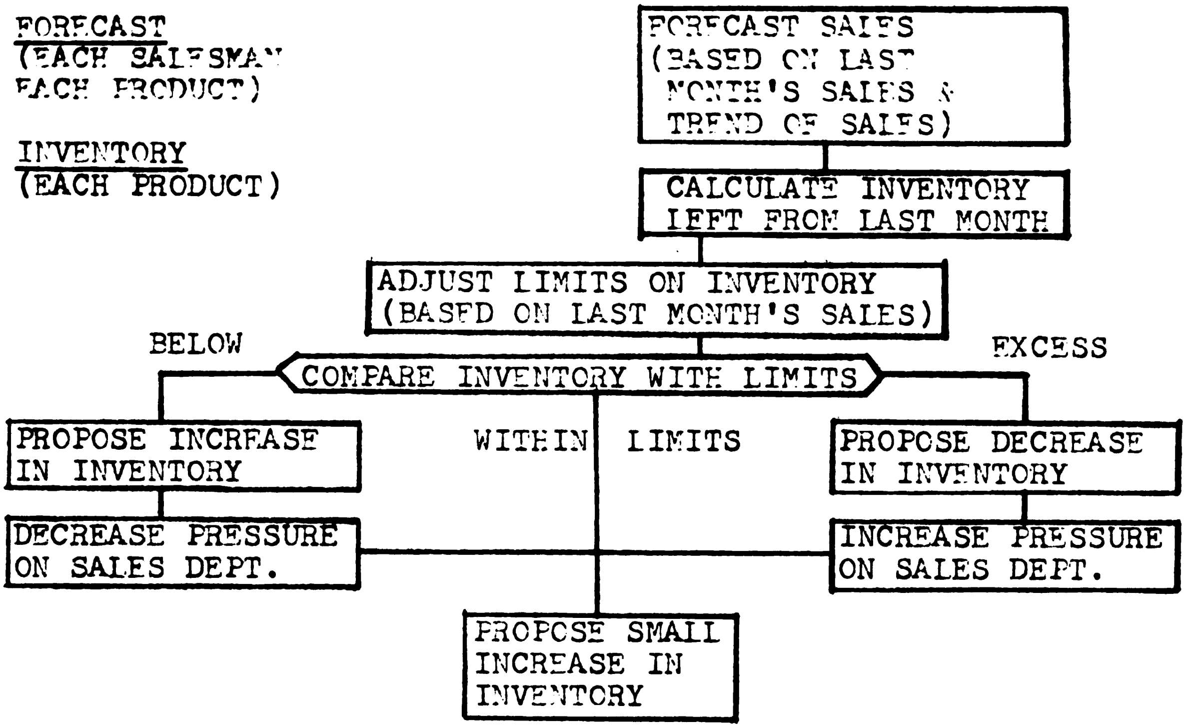

Figure 2-5. Subroutines FCAST and INVENT

Subroutine INVENT

The level of inventory to be scheduled for the end of the next period is determined by the Production Vice-President. The objective of this subroutine is to provide a mechanism for establishing the scheduled inventory level. The logic used in this subroutine is adapted from the Cyert and March (1963, pp. 149-236) general model of price and output determination.

Two limits are pertinent in the scheduling of inventory; UINL, the upper inventory level limit, and RINL, the lower (or "runout") inventory level limit. The upper limit is a level that, when exceeded, leads to excessive cost of maintaining unneeded inventory. The lower limit, when breeched, leads to excessive opportunity costs because of lost sales. The limits are a lagged function of sales--rising as sales rise, falling as sales fall.

UINL(K) = ALP7 * UINL(K) + (1-ALP7) * 0.3 * TSAL(K)

RINL(K) = ALP7 * RINL(K) + (1-ALP7) * 0.1 * TSAL(K)

where: UINL = Upper inventory limit.

ALP7 = Smoothing constant.

TSAL = Monthly sales.

RINL = Runout inventory limit.

Subsequent to adjusting the limits to reflect the most recent sales information, the current inventory level is compared with the limits. If current inventory level is in excess of the upper limit, a decreased level of inventory (for next month) is scheduled, pressure on the Sales Department is increased to sell the excess inventory, and the inventory limits are decreased.

If current inventory is below the lower limit, an increased level of inventory (for next month) is scheduled, pressure on the Sales Department is decreased, and inventory limits are raised.

If current inventory is within limits, a small increase in the level of inventory is scheduled.

This logic, defined by Cyert and March, (1963, p. 151) is a form of adaptive behavior in the face of incomplete information:

Each firm makes decisions on the basis of feedback

> from past results. The firms adjust goals. . . on the basis of such feedback.

In investigating the production planning procedures of a number of real firms, Wilson (1969, p. 152) found strong support for the Cyert and March model:

> We have been using. . .a technique, which is heuristic rather than a mathematical model, working with upper and lower bounds. . .on inventory. . . The problem is based on trying to keep inventory between a maximum level and a minimum level. . . .

Subroutine GENPRO

The objective of subroutine GENPRO is to provide a mechanism for scheduling and generating the actual production of each product.

The amount of production to be scheduled depends on the forecast, inventory-on-hand, and scheduled inventory:

SCHED = TFORC(K) - INV(K) + SCINL(K)

where: SCHED = Production schedule, in units

TFORC = Sales forecast

INV = Current inventory

SCINL = Scheduled inventory level

Actual production for each product is randomly generated in the model from a normal distribution with mean equal to the scheduled production, and a standard deviation equal to 2½% of the scheduled production.

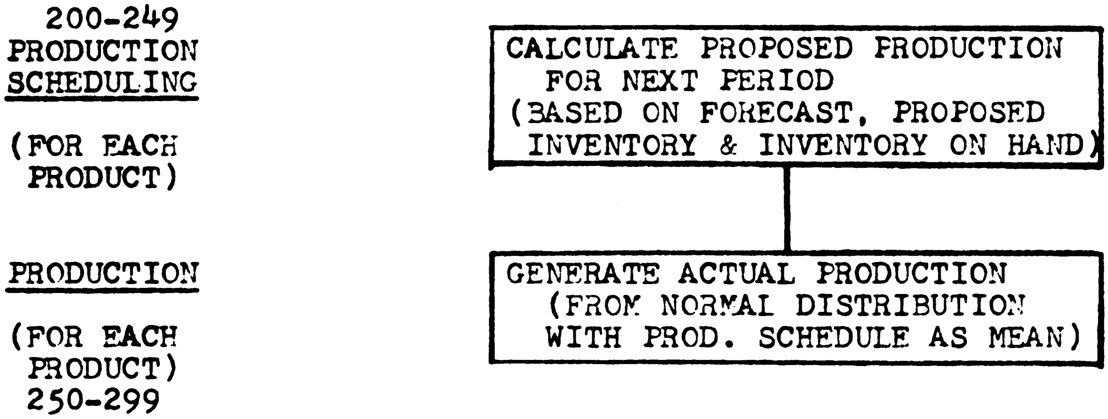

Figure 2-6. Flow Chart: Subroutine GENPRO

Subroutine PRREC

In subroutine PRREC, the marketing vice president makes recommendations to the executive committee regarding price and promotion decisions. The logic underlying this section of the model is based on the work of Cyert and March (1963) and Kaczka (1966).

From the marketing vice-president's viewpoint, his goal is to accomplish the sales forecasts that have previously been made, (subroutine FCAST). His decisions depend on a comparison of current forecast with previous forecast, and the actual performance of sales in relation to the previous forecast.

> The behavior he exhibits is, thus, dependent upon whether or not the sales goal of the previous forecast was met. If this forecast is higher than the previous one and the previous forecast was realized, then the situation is viewed as favorable. The pressure for sales effectiveness is decreased...., and he recommends that the promotion percentage be maintained. If the previous forecast was not met, he increases sales effectiveness pressure and may recommend either a price cut or an increase in promotion percentage. Under the condition where the current forecast is lower than the previous and the

> previous forecast was met, he is inclined to feel that the new goal can be met with little difficulty. As a result, he maintains the pressure on his salesmen and maintains the promotion percentage. However, if the previous forecast was not met, he reacts with a request for increase in sales promotion and (increases) the current pressure on salesmen.
>
> In brief, the marketing vice-president's main functions are the development of sales forecasts which serve as sales goals, the direction of sales goals, the direction of salesmen to realize these goals and the recommendation of the price and promotion strategies which he feels are needed to achieve the sales goal. (Kaczka, 1966, pp. 153-54).

The actual decisions regarding changes in price and promotion are made quarterly by the chief executive officer (see subroutine EXEC). The recommendation of the marketing vice-president is a primary factor that is considered in the decision process.

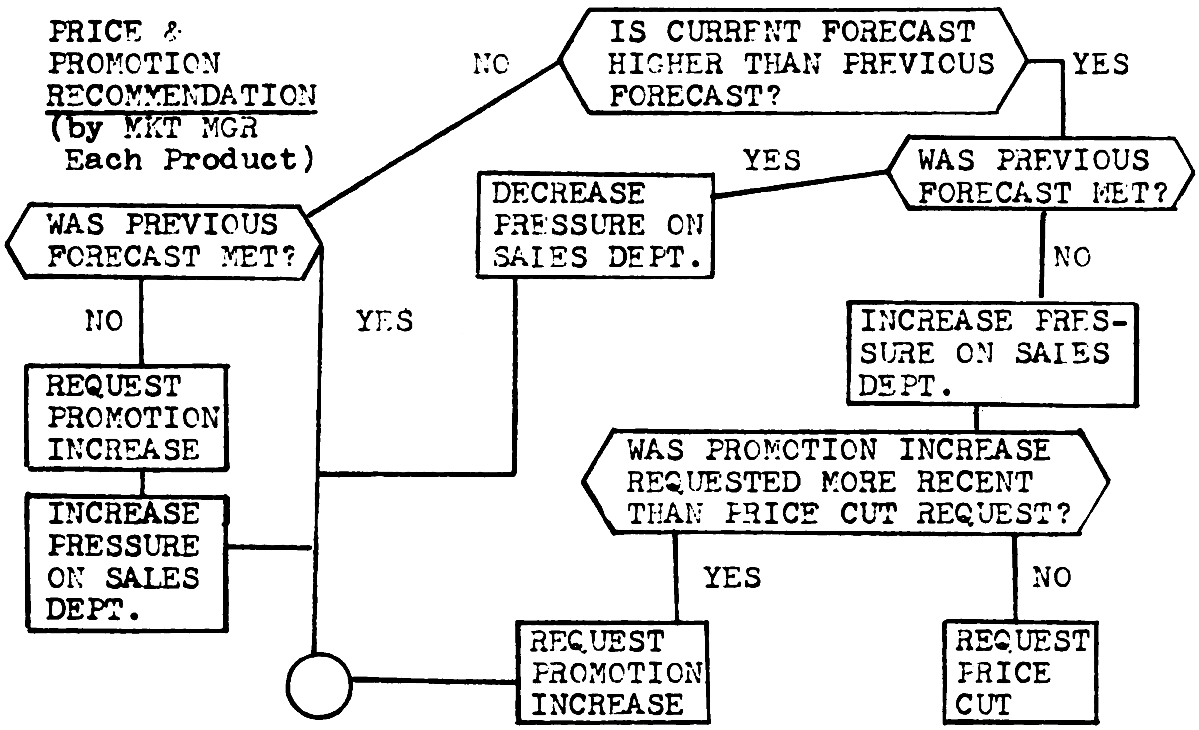

Figure 2-7. Flow Chart: Subroutine PRREC

Subroutine SLSMEN

Subroutine SLSMEN is the primary representation of the individual salesmen in the organization and their work performance. The behavior of the salesmen, as structured in this model, is primarily based on the theoretical framework established in Chapter 1.

The particular decision that is considered is the problem of allocating of sales effort among the different products.

> . . . the objective of many sales force management activities is really to achieve a desired allocation of effort, . . . (Simon and Freimer, 1970, p. 173).

The implementation of the sales effort allocation process is summarized by the flow diagram shown in Figure 2-8. A more detailed flow diagram is contained in Appendix I. The subroutine involves the following sequence of events:[3]

1. The marketing vice-president, on a monthly basis, evaluates each product in the company line in order to determine the relative priority of each product. The relative priority, in turn, is used as an input in allocating sales effort among the different products.

    The basic information utilized by the marketing vice-president is the "index of pressure" that is an attribute of each product. Each product begins its

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[3]The paragraph numbers in this section correspond to the box numbers in the flow diagram in Figure 2-8.

life cycle with a nominal pressure index of 1.0, but pressure may be adjusted due to the inventory position (subroutine INVENT), sales in relation to forecast (subroutine FRREC), or profitability in relation to profit goals (subroutine EXEC). Pressure varies between a maximum value of 1.2 and a minimum value of 0.8.

The output of the marketing vice president's decision process is a priority ranking of the firm's products. In effect, products are ranked according to relative pressure, with the product under highest pressure assigned the first rank. The information (priority ranking) is then transmitted to the sales force through the regional sales manager.

2. Meanwhile, each salesman is undergoing a similar evaluation process regarding the relative behavior of the product line in his sales territory. The basis for the salesman's evaluation is his perception of the marginal response of the market to the marginal effort that he expends on each product. In effect, he attempts to evaluate how much sales have increased as a result of additional effort expended on "pushing" each product.

The output of the salesman's evaluation process is a priority ranking, based on marginal response to marginal effort. He attempts to rank the products on the basis of those products which he expects to

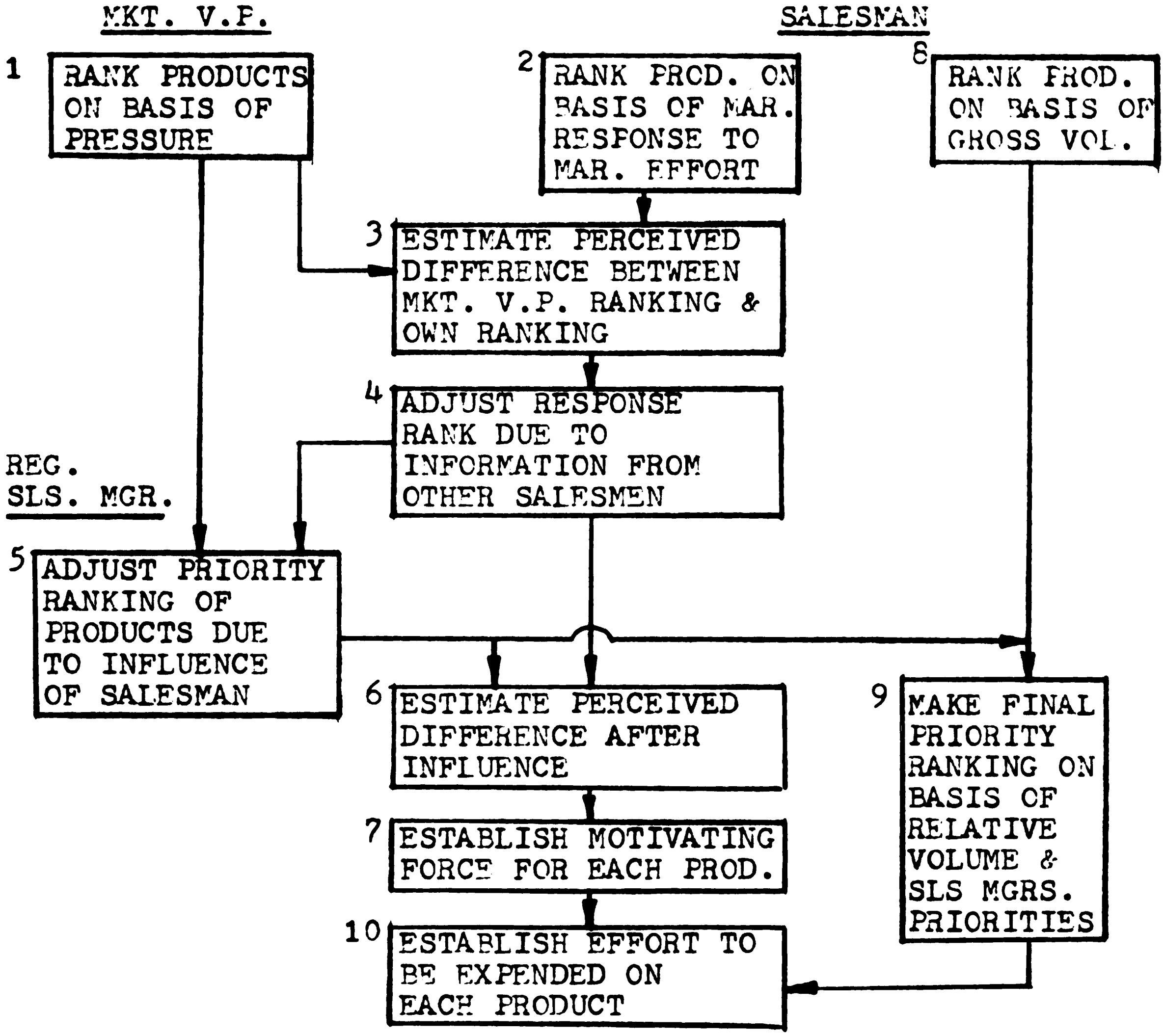


Figure 2-8. Sales Effort Allocation Process

respond best to any additional effort. This evaluation and ranking process is the mechanism by which each salesman "learns" about the unique peculiarities of his sales territory, and how his territory will uniquely respond to sales effort.

3. After receiving the priority ranking from the marketing vice president, each salesman compares this ranking to his own ranking regarding the marginal response of the market. The disparity in priority

rankings then becomes a base upon which the salesman can evaluate his ability to influence his supervisor, the regional sales manager.

4. The salesman may be provided with the opportunity to communicate with other salesmen in his sales territory. In doing so, the salesmen exchange information regarding the estimated response of the different products. Each salesman then modifies his response ranking because of the new information. He considers the evaluations of the other salesmen and adjusts his ranking accordingly.

   The information regarding the estimate of potential market response is then transmitted to the regional sales manager in an attempt to influence his final priority ranking.

5. If the sales manager encourages and permits influence in decision-making, he then considers the information from the salesmen in establishing final priorities. The sales manager combines three sources of information in the decision process: the ranking from the marketing vice president, the unit contribution to margin of each product (". . .an approach to allocation of effort based on contribution margin would seem fruitful" [Simon and Freimer, 1970, p. 173]) and the information furnished by each salesman. His final priority ranking is then transmitted back to each salesman.

6. When the priority ranking is received from the sales manager, each salesman then compares the ranking with the suggested ranking (response rank) that he had initially transmitted to the sales manager. He is thus able to estimate the difference between his ranking and the sales manager's ranking <u>after</u> his attempt to influence.
7. The salesman is then able to perceive if there has been any change in priorities received from management due to his (the salesman's) attempt to influence the decision-making. If a change in priorities has occurred, the salesman concludes that he has, in fact, exerted influence in the decision process.

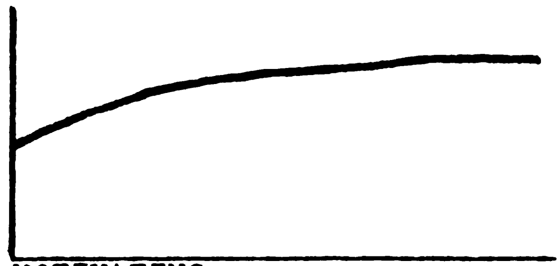
If the salesman has a high need for independence, he derives intrinsic satisfaction from the opportunity to participate in the priority setting process:

> The amount of influence of subordinates in decision making. . .affect(s) the speed and efficiency with which the decision is carried out . . . .it is clear that the effects of participation in decision-making are not confined to the nature of the decision, but also extend to the probability that the decision will be effectively implemented (Vroom, p. 227-228).

In effect, a salesman's motivating force to carry out an assignment tends to be enhanced by the opportunity to exert influence in the decision process.

In the model, the salesman is motivated by perceived participation with a negatively accelerating relationship between effort and motivation.[4]

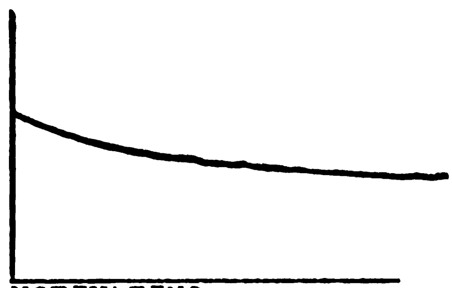
EFFORT



MOTIVATING FORCE = f (perceived participation)

It is also assumed that, for a salesman with a high need for independence, a lack of perceived participation will result in a negatively motivating force:

EFFORT



MOTIVATING FORCE = f (perceived participation)

The motivating force to sell each product is also dependent on the index of the pressure exerted on each individual product.

8. Since the salesman is paid by commission, he tends to emphasize those products that are high volume "movers." He ranks the products with the product of highest gross volume given the first ranking.

9. The salesman's final priority ranking that governs his allocation of effort among the different products

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[4] See previous discussion Chapter 1 regarding relationship between motivation and performance.

is a combination of his own "volume" ranking and the priority that is received from the sales manager.

In the model, the allocation process assumes that a given amount of total effort is to be distributed among the different products. The product given the highest priority is assigned an allocation index number of 1.2, with lower ranking products assigned progressively lower index numbers, until the lowest ranking product is assigned the number 0.8. The mean allocation index number of all the products is 1.0. The salesman thus decides the relative allocation of his time among the full range of products.

10. Finally, the effort that each salesman expends on each product is a combination of his final priority ranking (the allocation index number) and his motivating force:

EFFORT = MOTIVATING FORCE X ALLOCATION RANK

<u>Subroutine SALESGEN</u>

During each time period, the demand for each product is defined by an exogenous function that calculates the orders as a function of the age of the product, price, promotion, effort by the salesman, and a random component.

<u>The Product Life Cycle</u>.

The demand for a particular product can be expected to change over time. For many products the variation in lifetime sales may reveal a typical pattern of development known in marketing literature as the "product life-cycle." According to Kotler (1967, p. 291), five stages in the growth and decline of sales of this kind of product can be distinguished (Figure 1):

Stage 1. (Introduction.) The product is put on the market: awareness and acceptance are minimal.

Stage 2. (Growth.) The product begins to make rapid sales gains because of the cumulative effect of introductory promotion, distribution, and word-of-mouth influence.

Stage 3. (Maturity.) Sales growth continues but at a declining rate because of the diminishing number of potential customers who remain unaware of the product or who have taken no action.

Stage 4. (Saturation.) Sales reach and remain on a plateau marked by the level of replacement demand.

Stage 5. (Decline.) Sales begin to diminish absolutely as the product is gradually edged out by better products or substitutes.

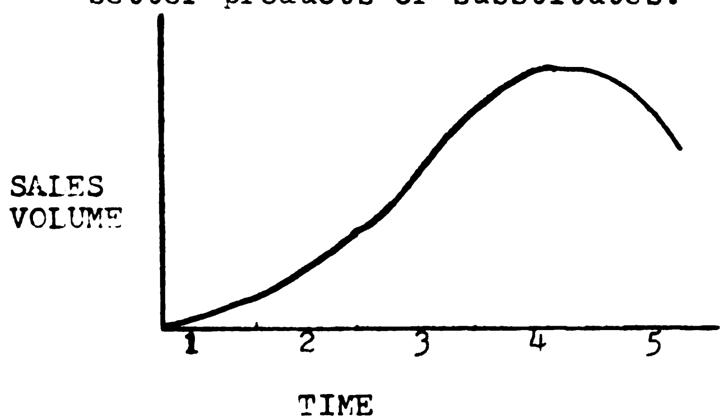


Figure 2-9. Stages in the Product Life Cycle

The validity of the product life-cycle concept is well established in marketing literature. Cox (1967), sampled 754 ethical drug products introduced in the United States in the years 1955 to 1960 and concluded the following: "Product life cycles not only can be determined; they are particularly useful as marketing models." Polli and Cook, (1969) attempted to empirically verify the product life cycle as a descriptive model of sales behavior for 140 categories of non-durable consumer products. These product categories included health and personal care, food, and tobacco products. They found strong <u>theoretical</u> support for the concept in Rogers' (1962) theory of the diffusion and adoption of innovations:

> "Essentially, the concept implies that a product finds initial resistance of some new ways of behaving, and is purchased by only a limited segment of the buying population. Later, as the product's performance and value are known and communicated, a larger segment of buyers adopts and sales begin to increase at a faster pace. Eventually, the rate of growth decreases as the proportion of adopters get closer and closer to a maximum, with most sales representing repeat purchases. The rate of adoption remains constant throughout the maturity phase and diminishes in the declining phase. The link between Rogers' theory and the life cycle concept becomes obvious if one considers that the logistic curve usually employed to represent the life cycle is the cumulative equivalent of the normal density function, which is precisely the shape of Rogers' adoption function." (Polli and Cook, 1969, p. 386)

Based on <u>empirical</u> evidence, they further concluded:

> "It is clearly a good model of sales behavior in certain market situations - especially so in the case of different product forms competing for essentially the same market segment within a general class of products." (Polli and Cook, 1969, p. 400)

In the model, a hypothetical sequence of demand that approximates the life-cycle, is generated through the use of a Weibull (1951) distribution:

DEM = KON*AA*ITIME*(exp(-AA*ITIME^2))

where: DEM Nominal Demand during time period t.

KON,AA Constants

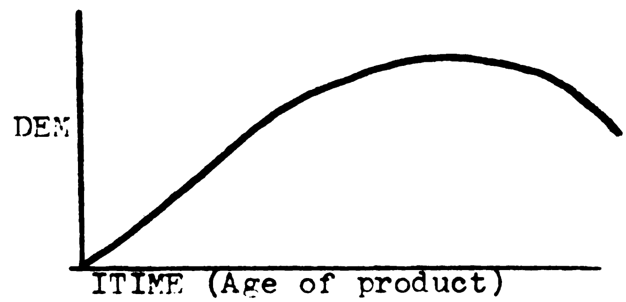


Figure 2-10. Hypothetical Weibull Distribution

For each time period, ITIME, a nominal demand, DEM, can be generated from the Weibull equation. Random fluctuations in sales (for each time period), can be simulated by sampling from a normal distribution with mean DEM, in order to obtain an adjusted value for sales. The nominal demand (DEM) thus reflects the age and the current life-cycle stage of the product. For each product, unique values of the constants of KON and AA are randomly generated by the initial condition program IC. Since the values of these parameters define the shape of the life-cycle curve, the underlying nominal demand is uniquely and exogenously defined over the life of the product. Nominal demand for each product is thus generated during each time period from a Weibull equation (with unique values of KON and AA) that includes the age of the product (ITIME(K)) as a parameter.

Price and Promotion

The effect of pricing on the demand for each product is represented by the equation:

$$M_{price} = (PRICE)^{PREL}/(20)^{PREL}$$

where:

M_{price}	=	Index for the level of sales due to the price elasticity factor
PRICE	=	Price of the product
P_{REL}	=	Price elasticity
$(20)^{PREL}$	=	Normalizing factor, of representing initial condition of PRICE = 20.

Price elasticity is randomly generated for each product by the subroutine GENPR. Thus, the response of the market to changes in price is assumed to be exogenously defined. Promotion is assumed to be an aggregate marketing expenditure that includes advertising, publicity, field promotion, etc., but excludes personal selling effort. The response of the market to promotion expenditures is determined exogenously for each product, in a manner similar to the price response:

$$M_{PROM} = (PROM)^{PMEL}/(1000)^{PMEL}$$

where:

M_{PROM}	=	Index for the level of sales due to the promotion elasticity factor.
PROM	=	Promotion expenditure
PMEL	=	Promotion elasticity
$(1000)^{PMEL}$	=	Normalizing factor, representing initial conditions of PROM = 1000.

Promotion elasticity is also randomly generated for each product (by subroutine GENPM). Thus, the response of the market to changes in promotion expenditure is also exogenously defined. Price and promotion policies, therefore, influence nominal demand according to the following relationship:

$$(\text{Adjusted Demand}) = (\text{Nominal Demand}) * M_{PRICE} * M_{PROM}$$

The logic underlying the use of elasticities to define an aggregate marketing response function is discussed by Urban (1969, p. 41)

> It can be expected that the consumer's willingness to buy a product at a given price will depend on his attitude toward the product's characteristics and appeals. This implies a marketing mix effect between price and advertising. . .an aggregate sales response function will be postulated. The function should include three basic marketing variables: advertising, price, and distribution. . . In unlogged form the formulation would be:
>
> $$X_{j1} = aP_{j1}^{EPI} A_{j1}^{-EAI} D_{j1}^{ED1} ,$$
>
> X_{j1} is industry sales of Product j,
>
> a is scale constant,
>
> P_{j1} is average price level of all brands in product group j,
>
> A_{j1} is total advertising of all brands in product group j,
>
> D_{j1} is total distribution level for all brands in product group j
>
> EP1 is industry price elasticity for Product j,
>
> EA1 is industry advertising elasticity for Product j,
>
> ED1 is industry distribution elasticity for Product j.
>
> This function captures marketing mix effects and allows nonlinearity in response to marketing variables. The nonlinearity is reflected in the parameters EP1, EA1, AND ED1. For example, if $0 < EA1 < 1$, the marginal sales response to advertising would be constantly decreasing as advertising increases. . . In general, EA1 and ED1 should be expected to fall between zero and plus one. The price parameter EP1 should be negative because as price increases, sales should decrease. The parameters EA1, ED1, and EP1 are elasticities and reflect the proportionate changes in the product group's sales

resulting from a proportionate change in one variable.
Equation 1 reflects marketing mix effects since the sales response of one variable depends on other variables as established, for example, by differentiating Equation 1 with respect to price. The marginal response to price changes (dX_{ij}/dP_{ij}) depends on the level of advertising and distribution.

In this model, for purposes of simplification, advertising and distribution have been aggregated into the promotion expenditure. Also, interdependencies, (complementarity and substitutability) with competitors' products and other products of the firm are assumed to be zero.

Similar uses of elasticities as a means of defining market response have been employed in simulations by Bonini (1963), Kaczka (1966), and Kotler (1965).

Random Deviation from Nominal Demand

Any other factors which may have an effect on demand are assumed to occur randomly and are therefore not explicitly defined in the model. The aggregate effect of these factors is assumed to be contained in a random error adjustment to demand. A percentage deviation from nominal demand is generated from subroutine RNDUM. This random adjustment to nominal demand is calculated by the equation:

NOISE = SIG1 * ERR * DEM

where:

NOISE = Random deviation (in units) from nominal demand.

ERR = Percentage deviation (returned from subroutine RNDUM) from nominal demand.

DEM = Nominal demand.

SIG1 = Scaling factor.

The scaling factor, SIG1, controls the stability of the demand function. For increasing values of SIG1, the effect of random deviation from nominal demand is increased, and the market becomes more volatile. The value of NOISE is additive to nominal demand.

Effort of the Salesman.

In the model, the response of the market to the effort of the salesman is approached in much the same way as promotion elasticity. Effort is represented by an index number which is utilized to characterize the relative personal selling emphasis that a salesman places on a particular product. An effort index larger than one means that a salesman spends a larger proportional amount of time "pushing" that particular product. Conversely, an effort index of less than one means that a salesman spends a less than proportional amount of time on that product.

The effect of a salesman's effort on the demand for each product is represented by the equation:

$$M_{EFF} = (EFF)^{EFEL}/(1.0)^{EFEL}$$

where: M_{EFF} = Index for the level of sales due to the effort elasticity factor.

EFF = Index of relative effort expended by a particular salesman.

EFEL = Effort elasticity.

$(1.0)^{EFEL}$ = Normalizing factor representing normal conditions of EFF = 1.0.

An "elasticity of effort" concept is not new. Lambert and Kniffin (1970, p. 3,4, & 8) used this idea to model a market response to personal selling effort:

> The response of the market to alternative levels of selling effort can be measured and expressed . . . Sales volume is probably the most easily utilized measure of market reaction . . . it may be very illuminating to examine the magnitude by which sales volume changes in relation to varying increases and decreases in the level of selling effort . . .
>
> Conceptually any measure of market reaction can be coupled with each measure of selling effort for purposes of constructing response functions. . an exponential expression was found to provide the best fit. . . . The equation that approximated the behavior of medical x-ray film sales in relation to number of salesmen became:

$$SV_i = a \cdot PM_i^{b1} \cdot P_i^{-b2} \cdot S_i^{b3}$$

where:

	SV_i	=	Sales volume of medical x-ray film in $District_i$.
	a	=	Constant.
	PM_i	=	Product mix being sold in $District_i$.
	P_i	=	Prevailing selling price in $District_i$.
	S_i	=	Number of salesmen in $District_i$.
	b1, b2, b3	=	Exponents.

Final Sales

The adjusted demand (orders) is compared with the amount available from inventory and production. If orders exceed the amount available, then sales equal the amount available (no backorders allowed). If orders are equal to or less than the amount available, then sales equal orders.

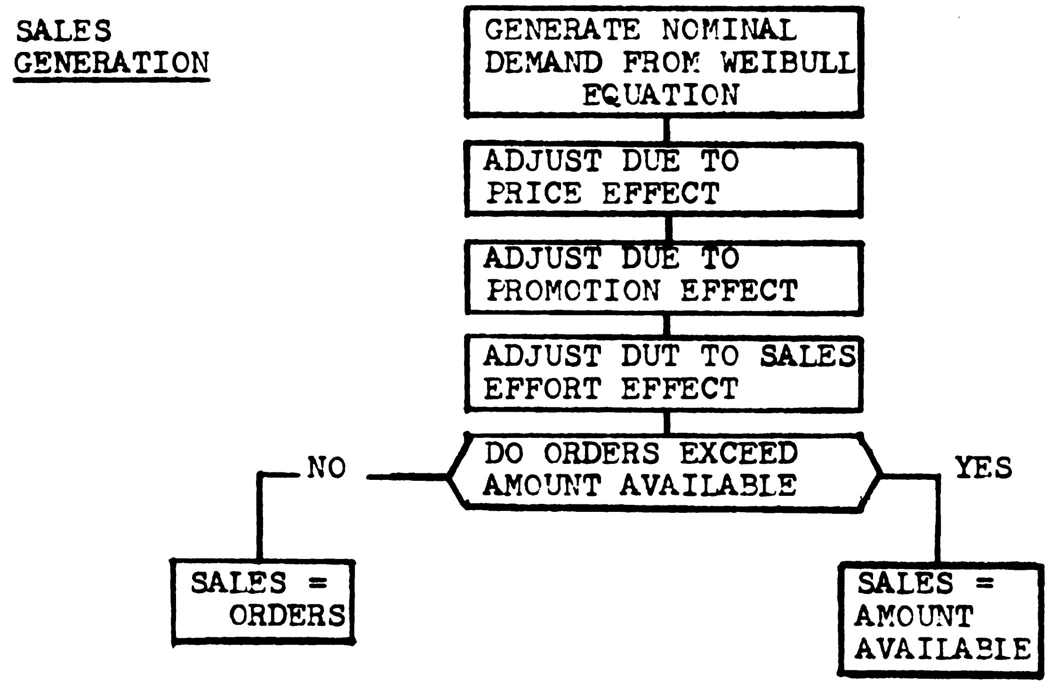


Figure 2-11. Flow Chart: Subroutine SLSGEN

Subroutine BOOK

The purpose of subroutine BOOK is to calculate profits, collect summary statistics, and adjust model parameters if a product is dropped.

Profit Calculation

The basic profit calculation for each product is:

PROF(K) = REV(K) - COSTS(K)

where:

PROF	=	Profit
REV	=	Revenue
COSTS	=	Total Costs
K	=	Product Number K.

Revenue is calculated thus:

REV(K) = PRICE(K) * TSAL(K)

where:

PRICE	=	Unit Price
TSAL	=	Sales in units

Costs for each product are composed of inventory holding costs, production cost, promotion expenditure, and fixed cost allocation. For simplification, all costs in the firm are assumed to be aggregated into one of these catagories.

Inventory holding cost is calculated thus:

INHCOS(K) = STDIC * (Average Inventory)

INHCOS(K) = STDIC * (INV(K) + PREINV(K))/2

where: INHCOS = Inventory holding cost

STDIC = Standard cost of holding one unit of inventory

INV = Current inventory level

PREINV = Inventory level in previous period

The production cost for each product, in each period, is a function of the age of the product. It is assumed that a "learning curve" effect occurs, and, because of learning, the unit cost of producing one additional unit is less than the unit cost of producing the previous unit:

> The. . .learning curve (concept). . .has evolved from experience in airframe manufacture, which found that the number of manhours spent in building a plane declined at a rate over a wide range of production (Hirschmann, 1964).

The functional form of the learning curve is assumed to be exponential (Andress, 1954):

$$U(i) = U(1) * i^{b}$$

where: U(i) = Cost to produce the i^{th} unit

U(1) = Cost to produce the first unit

b = Learning parameter

For each product, the total cumulative cost (of all units produced to date) can be calculated from the approximation (Teichroew, 1964, p. 30).

$$T(n) = U(k)n^{b+1}/(b+1)$$

where: $T(n)$ = Total cost of all units produced to date

$U(1)$ = Cost to produce the first unit

n = Number of units produced to date

b = Learning parameter

This formula is used in the model to calculate direct production costs for each time period. The cumulative production cost is computed and then the cumulative production cost for the previous period is subtracted. Setup cost is then included in cost of production:

$$COSTPR(K) = (CUMCST(K)_t - CUMCST(K)_{t-1}) + SETUP$$

where: COSTPR = Total cost of production

CUMCST = Cumulative direct product cost

SETUP = Setup costs

The average unit cost for each product in inventory is then computed:[5]

AVCOIN(K) = (COSTPR(K) + AVCOIN(K) * PREINV(K))/ (ACTPRO(K) + PREINV(K))

[5]The method of inventory valuation is average cost (Anthony, 1964). The value of each unit in inventory is equal to the value of the previous inventory, plus the value of production added to inventory, divided by the total number of units in inventory.

where: AVCOIN = Average unit cost of inventory

COSTPR = Total cost of production

PREINV = Previous inventory level

ACTPRO = Actual production

Fixed cost allocation is calculated on a percentage of total production basis:

(Fixed cost allocation) = FCOS * (ACTPRO(K)/TPROD)

where: FCOS = Total fixed costs

ACTPRO = Actual production of product K (units)

TPROD = Total production (in units) of all products

Total cost of sales are then computed:

COSTS(K) = (TSAL(K) * AVCOIN (K) + PROM(K) + INHCOS(K) + FCOS(ACTPRO(K)/TPROD)

where: COSTS = Total cost of sales

TSAL = Sales (units)

AVCOIN = Average unit cost on inventory

PROM = Promotion expenditure

INHCOS = Inventory holding costs

Adjust Parameters and Summary Statistics

If a product is scheduled to be withdrawn from the market, and all inventory of that product has been disposed, a housekeeping operation to adjust the parameters of each product is performed. Summary statistics are then accumulated for analysis at the end of the run.

Subroutine NEWPRO

The purpose of subroutine NEWPRO is to provide a mechanism in the model by which new products may be introduced into the market and obsolete products withdrawn from the market. Since the major focus of this experiment is not directed towards the product planning process, the decision processes involved in this routine are simplified and merely fulfill the objective of defining a means of moving products into and out of the market.

Just as new products should be introduced to infuse new blood into a product line, so should obsolete products (because of fashion or technology) be withdrawn. The need for selective elimination of products is well recognized in the literature (Alexander, 1964; Kotler, 1965; Levitt, 1965).

> Profits can be enhanced by eliminating certain costs associated with products in the later stages of their life. . .the proper performance of the (withdrawal) program should result in increased profitability. . . since resources will be assigned to more productive uses . . . (Rothe, 1970, p. 45).

Profits typically are reduced or disappear in the declining stages of a product's life cycle. At some point, it becomes marginally profitable to transfer resources from dying products to newer endeavors. After studying over 2000 companies, Booz, Allen, and Hamilton (1960) concluded: "Sooner or later every product is preempted by another or else degenerates into profitless price competition."

Rothe (1970), in surveying 174 companies found a number of factors to be important in the product elimination decision. Among them were:

1. A minimum sales volume

2. A minimum market share percentage

3. Comparison of market share with previous years

4. Profitability

These factors are not explicitly considered in the model because of the potential of confounding with the primary experimental variables. In the model, the product deletion decision occurs when a product's nominal demand has declined to a point of less than 50% of the past maximum nominal demand. "A possible policy with respect to timing may be to let one product almost complete its life cycle before taking on another." (Simon and Freimer, 1970, p. 93)

Subsequent to the decision to drop a product, further production scheduled for that product is canceled, but sales continue until remaining inventory is depleted.

In the model, when a new product is withdrawn from the market, a new product is introduced to replace the obsolete product. It is assumed that the full research and development process has transpired, less attractive potential products have been discarded, and a steady supply of approved new products is readily available. Each new product has successfully completed the stages of screening, economic analysis, product development, market testing, commercialization, risk analysis, etc. Each new product and the market to receive that product is therefore assumed to be developed and ready for introduction. The degree of acceptance of the product by the market is defined exogenously (and specified by the generation of values for the variables KON and AA). Cross elasticity effects with existing products are assumed to be zero.

Although not explicitly handled in this model, the subject of new product decision process has been examined elsewhere (Freimer and Simon, 1970; Kotler, 1968; Pessemier, 1969) and would appear to be a fertile field for exploration with computer simulation. An experimental model designed to study the factors controlling the product deletion process would also appear to be a potentially fruitful line of investigation.

Subroutine EXEC

At quarterly intervals, the chief executive officer makes strategic decisions regarding pricing and promotion for each product. In general, pricing and promotion decisions are a response to a comparison of profits with profit goals. The logic in subroutine EXEC is adapted from the Cyert and March (1963), and Kaczka (1966) models.

The profit goal is established as a lagged function of past profit. As profits rise or fall, the profit goal follows a similar trend. Thus, profit goals are continually changing, reflecting the past history of actual profits.

The firm learns, over time, which strategies are most successful in achieving profit goals. When a profit goal is achieved, greater emphasis is given to the strategy employed. Conversely, when a profit goal is not achieved, less emphasis is given to the strategy employed and a search for a new strategy may be initiated.

If the price for a product changed at the beginning of the previous quarter, the chief executive officer reviews the effect of the price change on profit. If profits have improved as a result of the change, the price change rule is altered to further emphasize the direction of the previous price change. Conversely, if profits have not improved as a result of the price change, then the price change rule is revised in order to decrease (or possibly) reverse the direction of the previous price change.

Future prospects are then revised. If the projected profit exceeds the profit goal, then the requests for a price cut or promotion increase are evaluated and acted upon. If there are no requests for price or promotion changes, and price has not recently been changed, the price is revised in the best past direction.

If projected profits do not meet the profit goal, then price and promotion requests are denied, and a search routine is entered. There are four possible actions which may be taken:

1. Increase sales pressure.
2. Increase sales promotion.
3. Decrease sales promotion.
4. Decrease profit goal.

These strategies are employed, each in turn, until a successful strategy is found. (As a last resort, the profit goal is decreased.) If projected profits still do not meet the profit goal, and price was recently successfully raised (or unsuccessfully lowered) then price is increased.

In summary, subroutine EXEC determines strategy for the future marketing of each product, based on the performance of that product in the past. At the end of each quarter, the performance history of each product is reviewed, and marketing strategy is revised based on the degree of success of past strategies.

Subroutine EXEC also computes a number of quarterly "housekeeping" statistics which are necessary for the operation of the model.

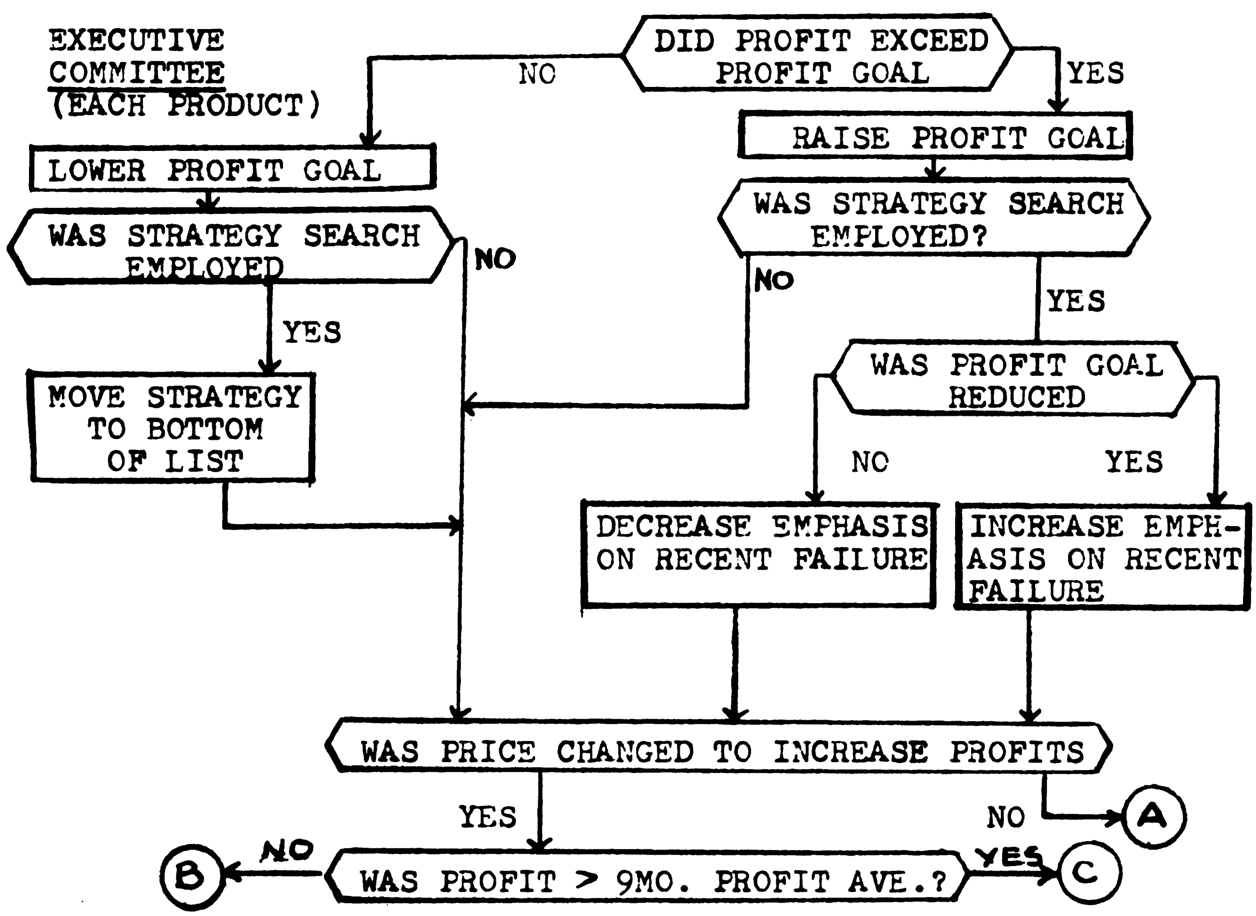
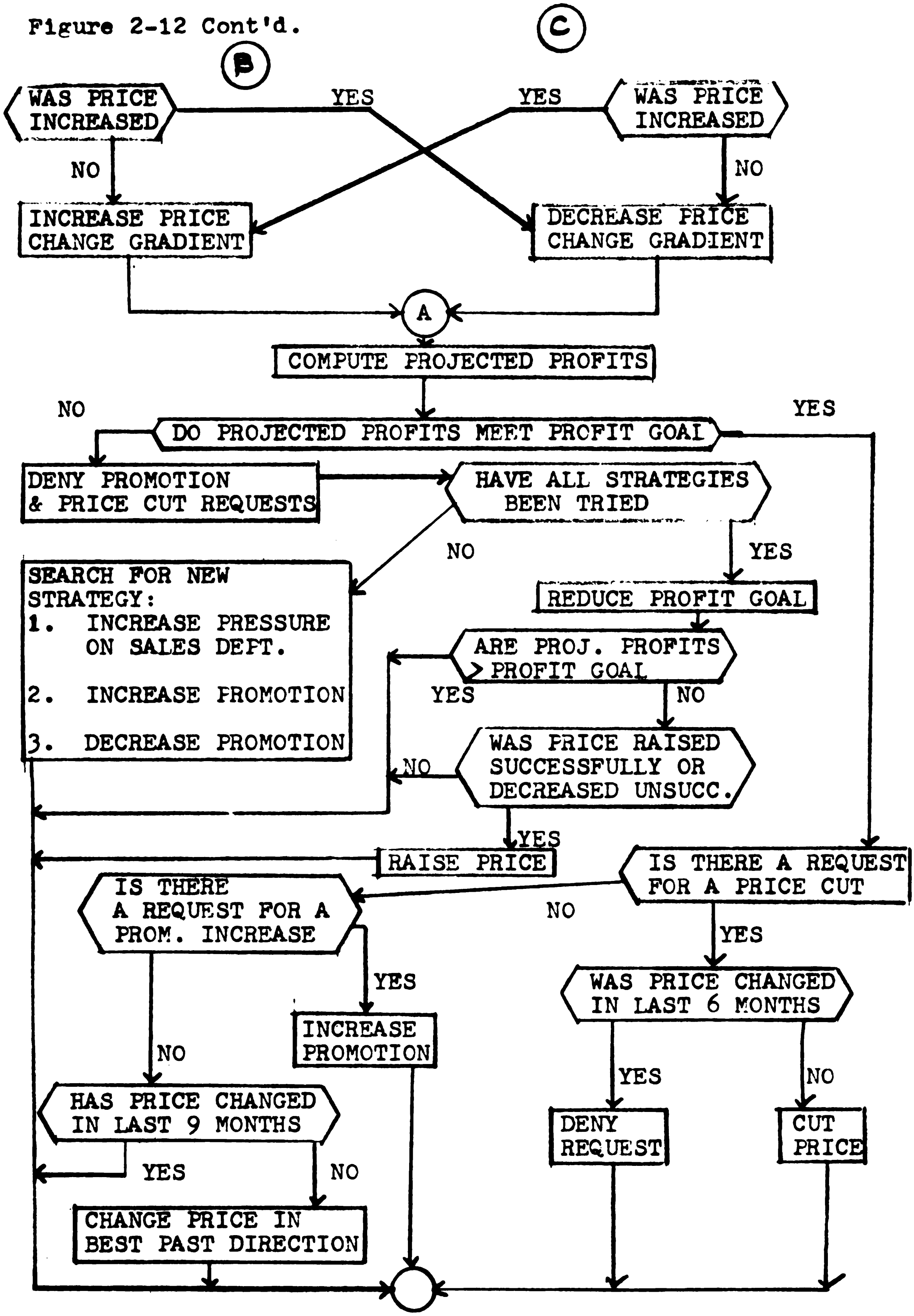


Figure 2-12. Flow Chart: Subroutine EXEC

Figure 2-12 Cont'd.



Utility Subroutines

FUNCTION RNDUM is a service routine for generating a random variate from a normal distribution with a mean of 0.0 and a standard deviation of 1.0

> Let r_1 and r_2 be two uniformly distributed independent random variates defined on the (0,1) interval, then
>
> $$X = (-2 \log_e r_1)^{1/2} \cos 2\pi r_2$$
>
> [is a] random variate from a standard normal distribution. This method produces exact results . . . . (Mc Millan and Gonzalez, 1968, p. 260; Naylor et al, 1966, p. 260)

The pseudo-random numbers are generated by the standard multiplicative method (Rotenberg, 1960) which has been tested by Clark (unpublished).

FUNCTION PRJPRO is a service routine that calculates the projected unit profit for a product. The routine is called from subroutine EXEC as a part of the pricing and promotion decision process.

The projected profit is estimated on the basis of price less estimated unit inventory costs, estimated unit production cost, estimated fixed cost allocation, and estimation promotion expense.

SUBROUTINE RANK is a service routine that provides a mechanism for assigning a rank to any entity based on the value of some designated attribute. The routine assigns the first rank to the entity with the smallest attribute value, and then assigns progressively higher ranks to entities with progressively larger attribute values.

The routine ranks on the basis of smallest attribute value assigned rank number one. If it is necessary to rank on the basis of largest attribute value first, then the attribute values must be multiplied by minus one before the ranking routine is called.

Summary

This chapter has described, in a general way, the content of the model. A more detailed description is provided in Appendix I, the detailed flow chart, and Appendix II, the computer program.

CHAPTER 3

EXPERIMENTAL DESIGN

A simulation is basically used to compare the consequences of alternate types and levels of independent variables. While it would be interesting to examine the sensitivity of the model to each parameter value and decision process, the fulfillment of that objective is obviously impossible.

> While, in principle, simulation can be used to investigate the effects of any factors, conditions, procedures, and interactions of which the investigator can conceive, in practice this results in factorial experiments whose dimensions dwarf the most powerful computer and the most lavish budget, so that the experimental designs actually used are rather modest (Conway, et al., 1959, p. 104).

The current experiment, therefore is limited to an investigation of the impact of a selected set of environmental, communication, and personality variables on selected dependent variables.

The experiment was conducted by making changes in the model and analyzing the effects of the changes on the performance of the firm. As in any experiment, it is useful to focus on the terms _factor_ and _response_. The changes to be made to the model, the independent variables, are classified as _factors_, or as experimental variables. The performance criteria, the dependent variables, or the output to be generated by the model, are classified as the response variable.

The primary response variable that was selected for analysis is the profitability of the firm (see subroutine BOOK for details of profit calculation). As noted in the introduction, it is recognized that profit is not the single determinant of a firm's performance and effectiveness; nevertheless, in a free enterprise society, profit remains the primary factor upon which the performance of most business firms is judged. The particular statistic generated by the model is the mean profit per period for each run.

Another response variable generated by the model is the mean index of pressure exerted on each product, for each time period, over the length of the run. Also generated is the standard deviation in profit for each run and the standard deviation in the mean index of pressure. These secondary criterion variables are useful in drawing conclusions regarding the effect of the experimental factors on the primary response variable, profit.

Several techniques of analyzing the experimental data were considered. Cyert and March (1963), for example, used regression analysis to test the sensitivity of parameters in their general model of price and output behavior. Regression analysis is well suited to experiments where the factors are quantitative, rather than qualitative. In this experiment, most factors are qualitative, in that the "levels" represent alternative decision processes rather than different values of the same variable.

> A factor is quantitative if its levels are numbers which are expected to have a meaningful relationship with the responses. Otherwise, a factor is qualitative . . . machines, operators, and days of the week are all considered qualitative factors. . weather conditions in the form of temperature and/or humidity would be a quantitative factor (Naylor, et al., 1966, p. 324).

Another analysis technique receiving recent attention has been spectral analysis. This technique measures the behavior of the variance of a variable within a time series.

> . . .as one becomes more sophisticated in the analysis of computer simulation data, he may be interested in analyzing more than expected values and variances. "When one studies a stochastic process, he is interested in the average level of activity, deviations from this level, and how long these deviations last, once they occur." Spectral analysis provides us with this kind of information. "Spectral analysis studies the salient time properties of a process and presents them in an easily interpretable fashion for descriptive and comparative purposes" (Naylor, et al., 1966, p. 331; quoting Fishman and Kiviat, 1965).

In this experiment, the time series of the response variables is summarized by a single measure. Thus, since the focus of the present research is on a summary variable rather than on a detailed study of the time-dependent behavior patterns, spectral analysis does not appear to be necessary.

If the purpose of the current experiment had been to make a quantitative, rather than qualitative, evaluation of the effects of the experimental variables, then further analysis using a multiple ranking (Beckhofer, et al., 1954) or multiple comparison (Tukey, 1959, or Dunette, 1955) technique would have been useful. In this experiment, however, the information provided by the analysis of variance appears sufficient to make qualitative judgments regarding the effects of the factors.

Through analysis of variance, it is possible to determine whether differences between means arose due to chance or if they constitute real effects generated by factor variations. The objective of analysis of variance is to explain the relationship between the response variable and the controlled experimental variables. In this technique, the variations in the observations around their grand mean are segregated into those attributable to the main effects, the interaction effects, and unexplained variations. This technique is employed to segregate the total variations in the data into components representing the experimental error, the controlled experimental variables and their combined actions. For test of significance, an F-ratio test relating the mean squared residual deviation to the mean squared deviations for each effect is used.

In this investigation, a complete 2^6 factorial experimental design was selected in order to explore both main effects and interactions among six factors that were represented at two levels, a "standard" level and an "alternate" level.

The first category of factors selected for study involves two environmental characteristics (so-called because they are specified exogenously to the firm and thus beyond the firm's control). Factor A, stability of demand, controls the random fluctuations of demand in the model (see subroutine SLSGEN for details regarding the structuring of random fluctuations). At the standard level, demand is considered to be stable (i.e., the standard deviation of the NOISE generating distribution is 2.5% of nominal demand; SIGI = 0.025). At the alternate level, demand is considered to be volatile (i.e., the standard deviation of the NOISE generating distribution is 10% of nominal demand; SIGI = 0.10).

The selection of the degree of random variability in demand as an experimental variable provides an indirect test of stability in the model. This factor is a test to ascertain whether the model behaves reasonably under different conditions in the external environment of the firm. In effect, the model should not be expected to "blow up" and proceed to infinity due to relatively minor changes in the firm's external environment.

The other environmental characteristic, factor B, market response to salesmen effort, controls the marginal response of demand to marginal changes in effort by the salesman (see Subroutine SLSGEN). At the standard level, the response of all products to marginal effort is uniform, (i.e., the value of effort elasticity is a uniform 1.0). At the alternate level the response of the market is different for each product, and the returns to marginal units of effort will be different for each product, (i.e., the value of effort elasticity is randomly generated and is not equal to 1.0). This factor provides a mechanism for contrasting the effect of a "false" information input to the decision process verses a "true" information input. At the standard level, when elasticity of effort is uniform between products, there is no potential differential response to marginal sales effort. At the alternate level however, elasticity of effort is different for each product and each product displays a unique response characteristic to marginal sales effort.

The second category of experimental variables involves the presence or absence of selected communication links. Factor C specifies the presence or absence of knowledge of the current inventory position by the marketing vice president. At the standard level, knowledge of current inventory is absent. At the alternate level, knowledge of the current inventory level is present and is used by the marketing vice president in setting priorities among different products.

Factor D specifies the communication link between salesmen within a given sales territory. At the standard level, no communication between salesmen exists and each salesman must rely only upon his own perceptions regarding the potential response of different products. At the alternate level, each salesman communicates with other salesmen in the same sales region and perceptions about market response are "pooled."

The third category of experimental variables is concerned with personality characteristics of individuals in the firm. Factor E specifies the personality attribute of the regional sales manager. At the standard level, the sales manager is defined as authoritarian. He neither encourages nor allows participation in the decision process regarding the setting of priorities among different products. At the alternative level, however, the sales manager is defined as equalitarian. He encourages participation in decision making and considers information received from salesmen in setting priorities among products (see Chapter 1 for development of the theoretical framework underlying the selection of this factor).

Factor F specifies the personality type of the individual salesman. At the standard level, the salesman is defined as having low need for independence. He derives no satisfaction from an opportunity to influence superior decision making. At the alternate level, however, the salesman is defined as having a high need for independence. He derives intrinsic satisfaction from the opportunity to influence decision making and is highly motivated by the opportunity to participate (also see subroutine SLSMEN description for development of theoretical framework underlying classification of salesmen personality types).

It is recognized that personality types in a real firm will be distributed along a continuum. In the model, however, personality types are classified as "polar" for purposes of controlled experimental variation.

The selected experimental variables and concomitant specification of levels are summarized in Table 3-1.

Table 3-1. Experimental Variables

Factor	Alternative States: Standard	Alternative States: Alternative
A. Environmental Characteristics		
1. Stability of Demand	Stable	Volatile
2. Mkt. Response To Sales Effort	Uniform Elasticity	Non-Uniform Elasticity
B. Communication Links		
1. Inventory Position	No Knowledge By Sales	Knowledge By Sales
2. Regional Salesmen Intercommunication	No Info. Exchange	Information Exchange
C. Personality		
1. Sales Mgr.	Authoritarian	Equalitarian
2. Salesmen	Low Need For Independence	High Need For Independence

Factorial experiments involve the simultaneous investigation of the effects of a number of different independent variables. Since, in this experiment, six factors (each varied at two levels) were selected for study, the experiment is described as a 2^6 factorial experiment. The total number of design points in the full factorial design is the product of the number of levels for each factor. Sixty-four runs were therefore required, each with a unique combination of the six factors, in order to make up one complete replicate of the study. The total experiment consisted of six replications, each of which contained sixty-four runs.

Within a replication, the initial conditions for each run were idential, while between replications, a different set of starting conditions was employed. (See appendix IV for Program IC; random generation of initial conditions.)

The starting conditions are controlled within each replication in order to increase precision and therefore may be regarded as "blocks." In experimental design, blocks are used to reduce the unexplained variation in the observations.

> [This practice] sharpens the contrast between [computer runs] by reducing residual variation. Differences can be detected, their statistical significance tested, and their economic significance assessed with much smaller sample sizes than would otherwise be required (Conway, 1963, p. 53).

In order to reduce the effect of any bias that may have been attributable to initial conditions, the first ten periods in each run were allowed to elapse before any response variables were measured.

Within each replication, the values of the experimental variables for each run were assigned by a zero-one generating algorithm (Gonzalez and McMillan, 1971, p. 161).

CHAPTER 4

DESCRIPTION OF RESULTS

This chapter describes the results of the experiment with the model of the firm. Results are reported in terms of the effects of the changes in the experimental variables on the response variables. The complete output of the analysis of variance program is shown in Appendix V. Table 4-1 summarizes results of special interest.

The results of changes to each factor will be presented separately, starting with the main effects and proceeding through the interaction effects. The description of results will focus on the primary response variable, profit.

Table 4-1. Summary of Analysis of Variance

AVERAGE FIRM	MEAN PROFIT PER PERIOD	=	63.025

EFFECTS OF EXPERIMENTAL VARIABLES

Factor	Mean Increment In Profit (From Std. to Alt. Levels)
A: Demand Stability	-1.204
B: Market Response	+3.321 ***
C: Inv. Comm. Link	-0.099

Table 4-1 (cont'd.)

Factor	Mean Increment in Profit (From Std. to Alt. Levels)
D. Salesmen Comm. Link	-0.152
E. Participation	+5.246***
F. N. Independence	+1.734**
B-E: Mkt. Response-Participation	+2.053**
E-F: Part. - N. Ind.	+3.260***

**Significant at .05 Level
*** Significant at .01 Level

The behavior of the "average" firm is also summarized in Table 4-1. The values listed in this table are the overall means of the response variables for all runs and all replications.

The values of the response variables for the "average" firm are the standard of comparison upon which the effects of the various changes in the model are evaluated. Conclusions regarding the effect of each experimental variable are derived from examination of the value of the "mean invrement" (from the average firm) and the approximate level of significant of the F statistic. The F-ratio tests for statistical significance were conducted to determine which of the null hypotheses could be accepted or rejected.

Results of the firms under different conditions varied considerably from the "average" firm. The object of the analysis was to determine which changes resulted in behavior that was significantly different from the average. The null hypotheses are that none of the changes to the experimental variables produces a change in the response variables. Rejection of any or all of these null hypotheses implies that the specific factor (or combination of factors) exerts a significant effect to alter the response of the model.[1]

In terms of the notation, the null hypotheses were:

Factor A: A(2)=A(1)

Factor B: B(2)=B(1)

etc.

Interaction AB: AB(22) + AB(11) = AB(21) + AB(12)

etc.

where: A(2) = Mean of the response variable where factor A is at the alternative level.

A (1) = Mean of the response variable where factor A is at the standard level.

and: AB(22) = Mean of the response variable where both factors A and B are at the alternate level.

AB(11) = Mean of the response variable where both factors A and B are at the standard level,

AB(21) = Mean of the response variable where factor A is at the alternate level and factor B is at the standard level.

AB(12) = Mean of the response variable where

---

[1]This conclusion is subject, of course, to the probability of making an incorrect inference, i.e. Type I and Type II errors (see Clarke and Schade, 1969).

factor A is at the standard level and
factor B is at the alternate level.

A numerical measure for each main effect was calculated by the analysis of variance program (A. O. V., 1966). An effect is measured as the average difference between the observations at the standard level and the observations at the alternate level. In mathematical terms, the main effect of factor A is defined as:

$$A = A(2) - A(1)$$

where: A = Main effect of factor A.

In the analysis of variance output, the main effect is expressed as a "mean increment", or, the difference between the mean of the runs with the factor at one level and the overall means of all runs.

Interaction effects are defined mathematically as:

$$AB(ab) = 1/2\,(AB(22) - AB(21) - AB(12) + AB(11))$$

where: $AB(ab)$ = Interaction effect of factors A and B.

In the analysis of variance output, the interaction effect is also expressed as a "mean increment", or, the difference between the means with the factors at the same level and the overall mean of all runs.

Following are the findings resulting from the analysis of variance. The limitations on the findings of this study, which are a caveat for this research, are explicitly underlined in a later section of this chapter.

Factor A: Stability of Demand

Factor A controls the stability of nominal demand. At the standard level, demand is regarded as relatively stable, i.e. random fluctuations in the demand function are relatively minor. At the alternate level, however, demand is regarded as relatively volatile, i.e. random fluctuations in the demand function are substantially higher.

The results indicate that profit was slightly reduced at the alternate level; the mean increment in profit when fluctuations in demand increased from the standard to the alternate level was -1.204.[2] Revenue was also slightly decreased at the alternate level, with a mean increment of 528.

The results therefore indicate that profits and revenue fell slightly in the more volatile market.

Main Effect -- Factor B: Market Response

Factor B controls the market response to personal sales effort. At the standard level, the market elasticity of effort is set at 1.0 for each product. At the alternate level, the market elasticity of effort is randomly generated and assumes a value between 0.0 and 2.0. This factor is a useful approach to specifying whether information is actually present or absent in the market.

If a product has a large elasticity of effort attribute, it responds well to marginal increments of effort by the

---

[2]Approximate significance probability of F statistic = 0.136.

salesman. On the other hand, a product with a low elasticity of effort will have a sluggish response to marginal effort. In general, it is much to the salesman's benefit to direct his marginal effort toward those products with a high elasticity of effort, and away from those products with low elasticity of effort. The salesman, however, has no way of knowing precise elasticity values. He is able to achieve a rough estimate, however, by continually "testing" the market on a trial and error basis. In effect, he is continually undertaking a process of "search" to determine which products respond best to marginal sales effort. He is continually attempting to rank the products in his line on the basis of marginal response to marginal effort. He seeks to find which products will produce the best "payoff" as a result of his sales efforts. The validity of his estimate is of course disturbed by any other elements that may perturb the demand function.

In this model, factor B is a means of specifying whether such information is present or not. In the standard case, where the value of elasticity is always 1.0, all of the products respond identically to marginal effort. There is no true basis for differentiating between the products on the basis of response even though the salesman may attempt to do so. Any evaluation of response by the salesman in such a case results in a false signal, attributable to random factors alone, since no true differential response characteristic exists. When factor B is at the alternate level, however, and elasticity is not equal to 1.0, then true information is considered to be present and a relatively correct signal results.

Factor B, therefore, is a mechanism for specifying market response such that "false" information and a false signal result when factor B is at the standard level, and "true" information is present when factor B is at the alternate level.

This factor is included for the purpose of evaluating the effect of valid vs. invalid information in the performance of the firm. The results show that when factor B was at the alternate level, a significant improvement in profits was produced. The mean increment in profit of factor B at the alternate level was an increase of 3.188.

The results clearly demonstrate that when unique information about the market actually did exist, the firm was able to make use of the information for an improvement in profit performance. The particular mechanism by which the firm took advantage of the information is best shown through examination of the interaction effects.

Interaction Effect -- BE: Market Response and Participation

The interaction of factors B and E at the alternate level produced a significant improvement in profits. Recall that factor E controls participation in decision making. At the standard level, the regional sales manager is defined as authoritarian and no participation is allowed. At the alternate level, the regional sales manager is defined as equalitarian and the participation of salesmen in the decision making process is encouraged.

When factors B and E interact, the feedback of "true" information from the salesmen to the regional sales manager is accomplished. When valid information is considered by the sales manager in the allocation of effort decision, higher profits resulted. Conversely, if the information is "false", or when participation is not allowed, a lower level of profits resulted.

Main Effect -- Factor C: Inventory Link

Factor C controls a communication link between the production function and the marketing function. At the standard level, no communication exists and the marketing vice-president has no knowledge of the inventory position. At the alternate level, the communication link is present, and the marketing vice-president has knowledge of the inventory position.

At the alternate level, if the remaining inventory at the end of a period is not within acceptable limits, the marketing vice-president makes the appropriate change in the index of pressure, which may result in a change in a product's relative priority. The objective of the communication link, therefore, is to provide information regarding the inventory position to the marketing function so that marketing can hopefully make improved priority decisions, resulting in higher profit.

The results, however, showed an effect of factor C on profitability that was somewhat unexpected: when the communication link was "open", profit was unchanged rather than being improved. The mean index of pressure was significantly increased at the alternate level. A tenative deduction regarding the cause of this somewhat surprising result is deferred until the discussion in Chapter 5.

Main Effect -- Factor D: Salesmen Intercommunication

Factor D controls the presence or absence of a communication link between salesmen within a region regarding response characteristics of the market. At the standard level, salesmen do not communicate. At the alternate level, salesmen exchange information regarding marginal response of the market to marginal sales effort. The results indicate that factor D had no significant effect on the firm's profitability.

Main Effect -- Factor E: Participation in Decision Making

Factor E controls whether salesmen participate in the decision process of allocating sales effort among the product line. At the standard level, the regional sales manager is defined as authoritarian and he refuses to accept participation in decision making. At the alternate level, the regional sales manager is defined as equalitarian and he provides the opportunity for salesmen to participate. The salesmen participate by transmitting their perceptions regarding the response characteristics of the market.

The results clearly demonstrate that factor E, at the alternate level, had a definite positive effect on profits. The mean increment in profit with factor E at the alternate level was 5.30146.

Interaction Effect--Factors BE: Market Response and Participation

The interaction effect of factors B (response function) and E (participation) was significant. When "true" information was available, and the firm used that information in the effort allocation decision process, the mean increment of profits was an improvement of 2.13949.

Main Effect--Factor F: Need for Independence

Factor F controls the definition of the salesmen personality types. At the standard level, the salesman is defined as having low need for independence and deriving no intrinsic satisfaction from the opportunity to participate. He possesses low instrumentality for the outcome of perceived influence in decision making. At the alternate level, the salesman is defined as having high need for independence and deriving satisfaction and motivation from perceived influence in decision making.

Profit was significantly improved with salesmen with a high need for independence. The mean increment in profit with factor B at the alternate level was a positive 1.74. For purposes of drawing conclusions, however, the most relevant aspect of factor E was its interaction effect.

Interaction Effect--Factors EF: Participation and Need for Independence

The interaction of factor F, need for independence, with factor E, participation, resulted in significant profit improvement. When both factors were at the alternate level, the mean increment in profit was 3.182.

This interaction effect clearly shows that participation was strongly moderated by the need for independence factor.

Summary of Results

The factor exerting the strongest effect on the firms profitability was Factor E, participation, especially in interaction with factor B, market response, and factor F, need for independence. The encouragement of participation in the sales effort allocation decision, in conjunction with valid market information or need for independence on the part of the salesman, had significant positive effects on profitability.

Factor A, market stability, caused a slight decrease in profitability and revenue under conditions of a more volatile market. Factors C and D, the inventory link and salesmen communication link, respectively, caused no significant changes in profitability. These results are summarized in Table 4-2.

Table 4-2 Summary of Results

Factor	Result
A: (Demand Stability) Stable ⇒ Volatile	• Profit slightly decreased • Revenue decreased • Promotion decreased
C: (Inventory Communication Link) No-Knowledge ⇒ Knowledge	• No change in profit • Revenue decreased
D: (Salesmen Communication Link) No-Link ⇒ Link	• No change in profit
E: (Participation)	
B-E: (Participation-Market Response) Non-Participation: Non-Valid Info ⇒ Participation: Valid Info	• Profit increased
E-F: (Participation-Need For Independence) Low N.-Ind.: No Participation ⇒ High N-Ind.: Participation	• Profit increased

The Problem of Realism in Simulation

In discussions regarding the relative value of simulation, one dominant advantage is clearly evident: the capability to attain a high degree of experimental control at relatively low cost. For theory testing purposes, this advantage is manifested by the potential ability to systematically vary and control conditions which, in the real world, may be unwittingly confounded with other factors.

> The unique advantage of simulation is that not just closely identical but absolutely identical conditions can be maintained through repeated experimental runs. (McMillan and Gonzalez, 1968, p. 492)

However, the advantage of control is not attained without cost. Concomitant with control is the persistent problem of insuring that the simulation model is an acceptable representation of reality. Although a simulation is able to control potential confounding variables, it is impossible for the simulation to exactly replicate real life.[3] Thus the problem that typically confronts any model builder is the question of validity: Is the model a realistic representation of the real world?

Cohen and Cyert (1961) have differentiated between models for synthesis and models for analysis. Models for analysis assume knowledge of the overall performance of the system. The objective of this type of model is to discover the manner in which the separate system elements function in

---

[3] Nor in most cases really desirable because of the need for parsimony.

order to generate the known overall performance. In contrast, models for synthesis assume knowledge of how the basic elements operate. The objective of this type of simulation is to determine the effect of the elements on the performance of the whole system.

> The methods for validating these two types of models are different. Validation of models for synthesis takes place principally at the level of the model's basic elements. If essential characteristics of the elements are judged to be true representations of real life and if the results of simulations are plausible, then one tends to consider the model valid. This, in turn, generates greater confidence that the results of simulations can be used as reasonable predictions of what might happen in the analogous real life situation. . . .
>
> Models for analysis, on the other hand, are validated in reverse direction. Given information on how the total system performs. . . a model is constructed which hypothesizes how the elements of the system operate. If the model is plausible and able to predict, within acceptable limits, the performance of the whole system. . . then the model is accepted as a reasonable explanation of how the elements of the system operate. (Saltzman, 1965, pp. 4-5.)

One basic test for validity would therefore be to compare the output of the model with that of a real world organization. This approach is patently impossible, however, in the present research, because the model simulates a hypothetical organization. No validity testing procedure has been suggested for surmounting this problem.

Since this experiment would be classified as a model for synthesis, however, rather than a model for analysis, a different validation approach is necessary. The focus here is on validation of the model elements, not on empirical validation. Rather than comparing a simulated time series of output behavior against an actual time series of behavior, validation must rely instead on the judicious selection of the internal components of the model.

The validation approach in this experiment will be similar to the technique employed by Bonini (1963, p. 22):

> The first question to be asked about our model would properly be, "Does the model correspond to the real world?" In other words, "Do the information and decision systems reasonably represent real-world situations?"
>
> We would not expect, of course, the model to be an exact replication of the real world--all models are simplifications to some degree. . . . We do believe, however, that the model is a reasonable representation of real-world behavior. We cannot, of course, completely validate this belief, but what we can and will do is set forth the major ingredients of our decision rules for separate examination. We will attempt to justify these rules by relating them to existing theory in the scientific literature of economics, accounting, or the behavioral sciences, or to the literature on business practice.
>
> In many cases, we have recourse to "rule-of-thumb" decision rules. . . .validity here essentially depends upon the correspondence of these rules to some aspects of business behavior. . . .
>
> Other decision rules rest upon accumulated knowledge of economics or the behavioral sciences. We shall not attempt to justify these concepts but will merely relate our constructs to the appropriate literature.

Validation therefore depends on the care that is exercised to clearly indicate the structural variables and relationships in the model, and most importantly, their theoretical and empirical foundations.

It should be clearly recognized that this approach to validation does not categorically insure that the model is isomorphic with reality. This test, in fact, may be interpreted as a null test. If a model failed, it would be suspect; on the other hand, one that has valid elements and produces reasonable output cannot be categorically guaranteed as representing reality. In view of the limited objective of this experiment, and because the organization is hypothetical, an effort to justify the elements of the model appears to be the only reasonable method of attempting to incorporate realism. The value of this experiment, therefore, will lie in its ability to contribute to the understanding of the structure and internal consistency of behavioral theory, rather than its ability to reproduce and predict the actual behavior of a real firm.

In this approach to validation the relation between simulation methods and survey methods becomes extremely important:

> . . .the computer model compliments field research and experimental techniques, it does not replace them. The working hypotheses contained in the model must still be developed and verified empirically and deductively, and the more familiar research techniques will continue to be important here. (Meinhart, 1966, p. 304.)

The limitations of this experiment should be considered when the findings, implications, and conclusions are examined. While the model is complex, certainly not all aspects of a business firm are considered. The emphasis has been on the marketing sector, and only on selected decisions within the marketing function. Behavioral characteristics of individuals have been defined to only a limited extent. The sensitivity of the model to many parameters has not been tested and interaction effects with variables that have not been included in the experiment could possibly be significant.

It is believed, however, that despite the limitation cited above, computer simulation can lead to further insight regarding behavioral theory and may also provide additional insight into the world of reality.

CHAPTER 5

SUMMARY AND CONCLUSIONS

This chapter attempts to derive conclusions and implications regarding the effects of the experimental variables on the profitability of the firm. Recall from Chapter 3 that the experimental variables were separated into three categories: environmental factors, communication factors, and personality factors. The following discussion will analyze the reasons why changes in the experimental variables produced the results described in Chapter 4, and will attempt to relate the findings to the empirical and theoretical concepts upon which the model was founded.

Effects of Demand Stability

When factor A was at the alternate level, indicating a volatile demand function, overall revenue and profits were slightly reduced. This result was somewhat in conflict with Bonini, who found that a volatile demand function led to an increased level of profits. He explained his result as follows:

> . . .in a highly variable environment an occasional crisis is caused within the firm by chance alone (that is, by factors outside the control of the firm). Such crises cause the firm to initiate search for better alternatives, generally ending in finding higher sales or lower costs. (Bonini, 1963, p. 136)

In this model, however, an effect was present which tended to counteract the mechanism deduced by Bonini.

Profits in this model were sensitive to the capability of the salesmen to estimate the marginal response of the market to marginal changes in selling effort. Any factor which tended to diminish the validity of the salesmen's estimate of marginal response therefore also tended to reduce the firm's profitability. If the salesman's perception of marginal response was impaired, then the company's ability to make a better sales allocation decision was also impaired, and decreased profits resulted.

Factor A, at the alternate level, represents a stronger influence of demand factors exogenous to the firm's sphere of control. The stronger influence of such extraneous factors tended to interfere with each salesman's capability of estimating marginal response, and profits were accordingly reduced. The strength of this effect completely overshadows the contrary effect found by Bonini.

No direct evidence is present that the effect found by Bonini was also found in this model. One result, however, leads indirectly to the conclusion that the "Bonini effect" was indeed present. In a limited post experimental run, the average level of promotion was found to be higher when factor A was at the alternate level (see Table 5-1), indirectly indicating that "search" was more frequently implemented. Although promotion was higher at the alternate level, revenue and profits were lower, indicating that the interference to the process of estimating marginal response was the predominate effect.

Table 5-1. Variation of Promotion Expenditures with Factor A

Level of Factor A	Mean Promotion Expenditure
1	6345
2	6361*

*significant at 0.15 level

In summary, the results present indirect, albeit inconclusive, evidence that the effect found by Bonini may be present, but strong evidence of the effect of the interference of a volatile market with the process of predicting marginal response to marginal sales effort.

Effect of Inventory Communication Link

Since the results of factor C, the inventory communication link, were counter to prior expectations, a post-experiment investigation was conducted in an attempt to discover the structural mechanism that would explain why profits were not improved when the inventory communication link was open. Recall from Chapter 2 (Subroutine INVENT), that upper and lower limits on inventory levels are established as a lagged function of total sales. In the event these limits are "breeched"[1] by unexpected demand for a particular product, an adaptive mechanism is initiated. First, the pressure on

[1] In effect, a "breech" means the end-of-month inventory is outside the previously established upper or lower limit.

that product is adjusted (if factor C is at the alternate level). Second, the limits on inventory levels are also adjusted as a self-correcting mechanism. The scheduled level of inventory is also adjusted.

A subsequent trial run was made for the purpose of discovering if subroutine INVENT behaved differently at the different levels of factor C. One of the first observations was concerned with the timing of the "breeches" of the inventory limits.

Preliminary indications in the trial investigation demonstrated that the breeches of the lower limit typically occurred at the beginning and the growth stages of the product's life cycle, while breeches of the upper limit typically occurred at the maturity and declining phases of the life cycle. It was also noted that the number of breeches of the lower limit were typically more numerous when factor C was at the standard level than when factor C was at the alternate level. This behavior led to the tentative explanation for higher profits at the standard level as shown in Figure 5-1.

With factor C at the standard level, pressure is <u>not</u> lowered in the event of a lower limit breech, thus, sales tend to be higher, which, in turn causes more lower limit breeches. Conversely, when Factor C is at the alternate level, pressure is lowered in the event of a lower limit breech, which tends to limit sales because of a lower index of pressure. In general, a higher level of sales of a product tends to increase profits because of a decreasing ratio of fixed cost to total sales and also because of a slight "learning effect", which tends to slightly decrease unit variable costs as cumulative sales volume rises.

The question should be considered: If lower limit breeches cause increased sales at the growing stages of the product life cycle, should not the upper limit breeches at the declining stage of the life cycle cause a counter and offsetting effect? In the maturity and declining stages, the pattern is for upper limit breeches to occur, which would cause an increase in sales when C was at the alternate level.

This phenomenon does, in fact, occur. With C at the standard level, sales tend to be lower in the declining stages. The loss in sales, however, is not sufficient to overcome the prior increase in sales that was experienced in the growth stage. The net effect is that, over the total life of the product, sales are higher when C is at the standard level, causing a concomitant increase in profits.

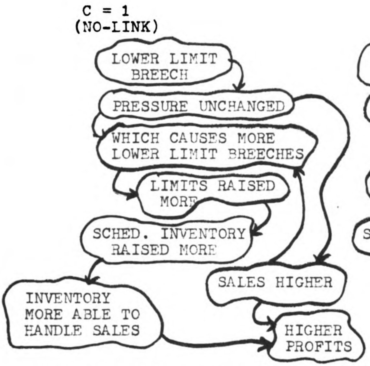


Figure 5-1. Effect of Inventory Communication Link

As shown in Table 5-2, REV-1 is the mean revenue for the <u>first 10 periods</u> of a product's life. Note that revenue is higher when C=1. Higher revenue (at C=1) continues through the growth stages of the product's life. REV-2 is the mean revenue for a product's declining stage only. Note that in the declining stage, when C=1, the mean revenue is lower. TOTAL REVENUE, the mean revenue over the total product life, is higher at the standard level.

These statistics can be interpreted as follows: When C=1, revenues tend to be higher in the growth stage, but lower in the declining stage. When C=2, revenues tend to be lower in the growth stage, but higher in the declining stage. The net total difference in revenues between the standard and alternate levels, however, is such that total revenues are higher at the standard level. The conclusion, therefore, is that the differences in revenues at the growth stage is the predominant effect, and has sufficient influence on profits.

In summary, two counter-balancing effects[2] occur as a result of factor C. On the one hand, the inventory communication link does cause lower inventory costs. On the other hand, the communication link has an inhibiting effect (because of decreased pressure) on sales during the crucial growth stages of the product's life cycle. The unexpected net result of these counter-current effects is that factor C has no significant effects on the profitability of the firm.

Effect of Salesmen Intercommunication

Somewhat surprisingly, factor D, the communication link between salesmen within a region, failed to have a significant effect on profits. It was expected that the presence of the communication link would significantly improve the quality of information. A reexamination of the communication link mechanism as conceptualized in the model is necessary in order to explain this result.

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[2]It is worth noting that Bonini also found counter-balancing effects: With a "loose" Industrial Engineering Dept., profits were expected to be higher because of higher costs. Costs were, in fact, found to be higher, but sales rose to counterbalance the increase in costs.

Table 5-2. Effects of Standard and Alternate Levels of Factor C

		REV-1	REV-2	TOTAL REV.	INV. HOLDING COST
C =	1 (Standard)	14069	71975	116417	4431
	2 (Alternate)	13688	73118	115955	4406
	Mean Increment	-190	571	-230	-12

Each salesman undertakes a "search" process for the purpose of evaluating how each product will respond to marginal effort. The result of his "search" is a ranking of the products on the basis of high marginal response to marginal effort. His search and ranking, of course, are subject to error from other extraneous factors that might affect demand. It was expected that communication with other salesmen would tend to reduce this error, but the results generally did not support this expectation.

It is proposed that the reason the communication link did not reduce error is that the difference between the salesmen's rankings was negligible in the first place. Therefore, communication regarding the relative rankings generally served no useful purpose. In general, the communication was an attempt to "pool" information when, in fact, there really was no substantive difference between the information possessed by each salesman.

There was, however, an exception. In the cases where factors A and B were at the alternate level, profit was slightly improved when the communication link was present (see Table 5-3).

Table 5-3. Profit Under Different Conditions of Factor D

FACTOR			
A	B	D	PROFIT
2	2	1	59.086
2	2	2	59.351

This result, although not statistically significant, was in keeping with expectation. With factor A at the alternate level, the market was subject to a higher degree of random changes in demand. With factor B at the alternate level, the information to be transmitted was truly valid.[3] Therefore, the pooling of information between the salesmen appeared to result in a reduction of random error, improving the quality of information. The differences between the salesmen's error, however, were not sufficiently large to produce a statistically significant improvement in profits.

It should be noted that, for reasons of simplicity, the motivational effects of group intercommunication are not

[3]See previous discussion under factor B.

explicitly modeled in this experiment. Likert (1967) proposes that face-to-face group communication, aside from the informational transfer effects, also results in favorable attitudes and higher motivation to produce. It would seem reasonable to assume that the effects of group intercommunication, like participation in decision-making, can be segregated into an information transfer component and a socio-psychological (ego-involvement) component, but not the socio-psychological component, was explicitly considered.

The failure of the factor to produce a significant improvement in performance, therefore, may be explained by the absence of motivational effects in this model, and also by the fact that an improvement in the transfer of information is not possible under the particular conditions of information structure proscribed by this model.

Effects of Participation

The effect of participation, factor F, cannot be adequately discussed except in conjunction with factor B, market response, and factor F, need for independence. The interaction effects of these variables provide an excellent means of demonstrating the partialling of the effects of participation into a result due to "decision quality" and a result due to "ego-involvement."

When acting in conjunction with factor B, factor F produces an improvement in profits due to "decision quality," because of the improvement in the quality of information that is utilized as an input to the effort allocation decision. When factor B is at the alternate level, the elasticity of effort varies between products. The potential exists for an improvement in performance if more effort is directed toward those products with a high elasticity of effort, and it is the responsibility of the salesman to "search" for those products which will give a high marginal response to marginal effort. The results clearly show that when valid information actually does exist, and when the regional sales manager does consider the information in making the allocation decision, profits significantly improve because the sales manager is in possession of information needed to make a higher "quality" decision. With the interaction of factors B and E, the improvement in decision-making is due entirely to an improvement in the quality of information that is required for the decision.

The interaction of factors E and F, however, deals with the motivational aspects of the process of participation. In the model, a salesman with low need for independence attaches no instrumentality to the opportunity to participate. A salesman with high need for independence, however, attaches high instrumentality to the opportunity to influence decision making. In the model the results clearly demonstrate that salesmen with high need for independence, when allowed to participate in decision making, are motivated to higher levels of effort which significantly improve the profit performance of the firm. The salesman becomes "ego involved" in the decision, and exerts significant supportive effort to assure that the decision is correct. The results also show that this effect may occur even though no concomitant improvement in information and decision quality is present.

The value of the conclusions derived from these results lies in the fact that the model clearly demonstrates that, from a structural standpoint, participation in decision making can be partialled into a decision quality effect and an ego involvement effect. (Fig. 5-2) With the decision quality effect, the improvement in performance occurs because the decision-maker has improved information upon which he can base his decision. With the ego-involvement effect, the improvement comes about because the participant becomes involved in the decision making process, and strives to insure desired results from his recommendation. This simulation has modeled structural mechanism which segregates the two effects into independent components: the decision quality effect can exist independently of the ego-involvement effect, and vice versa. In other words, the two effects can act concurrently to improve performance.

In summary, the experiment has demonstrated structural mechanisms by which participation in decision making can act independently to improve performance. The conclusions derived from the experiment serve to demonstrate the consistency and sufficiency of Vroom's conceptualization of the effects of participation and lead to further confidence in his theory.

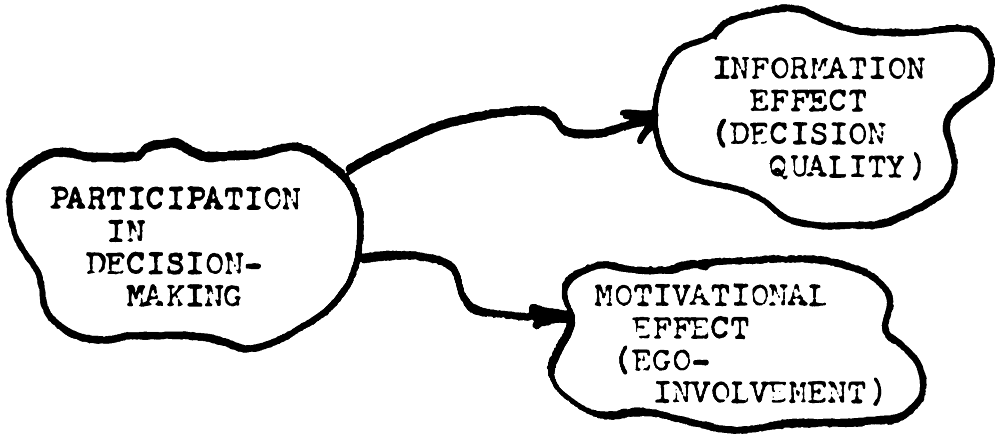

Figure 5-2. The Effects of Participation

<u>Future Research</u>

The model suggests a number of directions in which future research projects could be developed. In the marketing area, the model could serve as a framework upon which experiments might be constructed that focus on the product introduction process, the product deletion process, or the behavioral process of allocation of sales effort. An experiment that developed the application of smoothing-type forecasting techniques (especially adaptive smoothing) to life-cycle type products might also be appropriate.

Another area of future interest might deal with a more formal examination and delineation of the counterbalancing effects found in this experiment.

Without a doubt, this experiment has been distinctly limited in scope--dealing with only a few of the myriad of variables that might form the basis of interest for such an experimental approach. The work of Joan Woodward (1965), for example, regarding the juxtaposition of technical and behavioral aspects of the work environment might provide useful focus for a computer simulation experiment. Alternate ways of developing attributes of individuals might be considered, especially various aspects of need-achievement, need-affiliation, and need-power.

Finally, the original objective of the research was to provide a step toward the melding of the "macro" and "micro" simulation approaches into one model. This model has served to provide a framework (i.e., the "macro" portion) for such an integration, but requires considerable in-depth development of the micro decision processes if such an objective is to be completely accomplished. The challenge of the micro-process development--perhaps the integration of a HOMUNCULUS type of decision system--will hopefully provide stimulation for fruitful future research.

Summary

This chapter has described the major mechanism which produced the experimental results. Two factors, stability of demand and the inventory communication link, were found to have little effect on profitability, primarily because of counterbalancing mechanisms that tended to result in opposing effects. The intercommunication of salesmen was also found to be insignificant because of the lack of substantive information transfer. The strongest effect on profitability was caused by participation in the sales-effort allocation decision, especially when considered in conjunction with valid market information and salesmen characterized by a high need for independence.

The model has demonstrated a structure which explicated the partialling of the effects of participation into an information transfer component and an ego involvement component, each independent of the other.

The experiment has provided an initial step toward the integration of "macro" and "micro" type simulations, as well as demonstrated the viability of simulation as a means of explicating the structural mechanism under lying behavioral theory. Above all, the experiment has provided a demonstration of the usefulness of computer simulation as a vehicle for the exploration of behavioral theory. It is believed that the conclusions drawn from the experiment, when tempered by the limitations cited in Chapter 4, are useful in demonstrating the tractability of the dynamic modeling of behavior in organizations.

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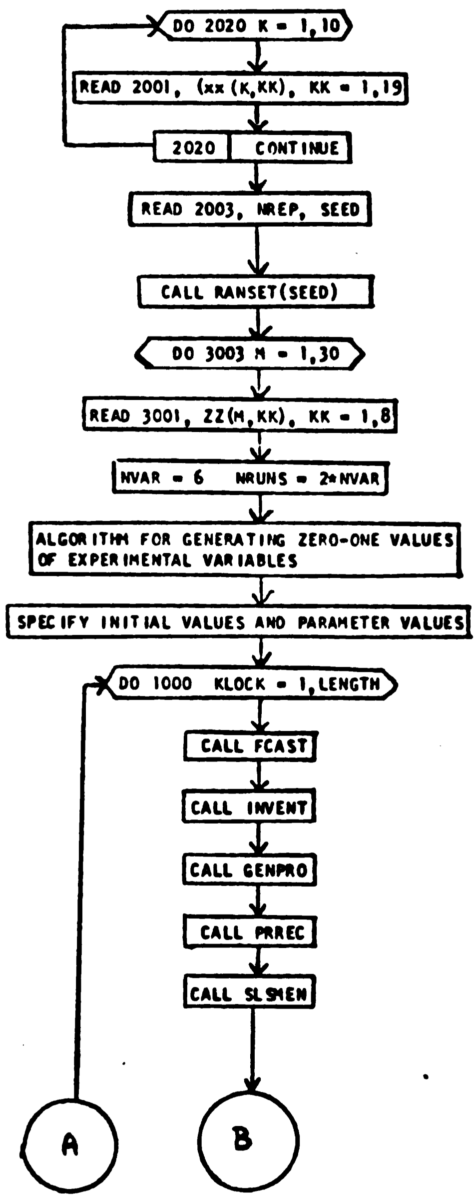
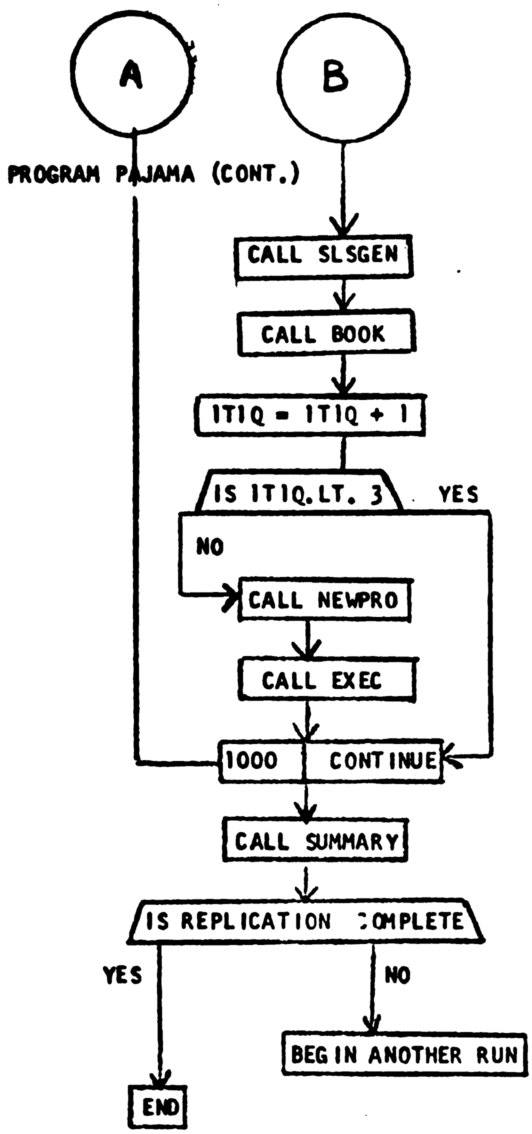
APPENDIX I

Detailed Flow Chart

PROGRAM PAJAMA

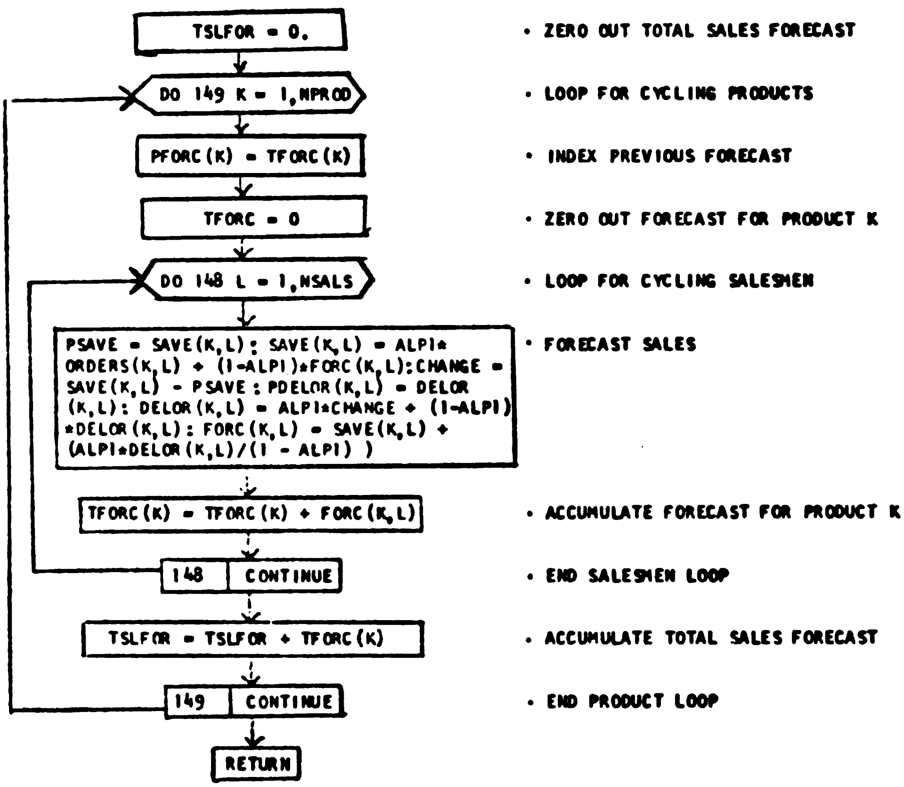


- LOOP FOR EXISTING PRODUCTS
- ASSIGN ATTRIBUTES OF EXISTING PRODUCTS
- END LOOP
- READ REPLICATION NUMBER AND RANDOM NUMBER SEED
- SET INITIAL RANDOM NUMBER
- LOOP FOR FUTURE PRODUCTS
- READ ATTRIBUTES OF FUTURE PRODUCTS
- SPECIFY NUMBER OF EXPERIMENTAL VARIABLES AND NUMBER OF RUNS
- MAIN TIMEKEEPING LOOP FOR EACH RUN
- CALL FORECAST ROUTINE
- CALL INVENTORY ROUTINE
- CALL PRODUCTION ROUTINE
- CALL PRICE & PROMOTION RECOMMENDATION ROUTINE
- CALL SALES EFFORT DECISION ROUTINE

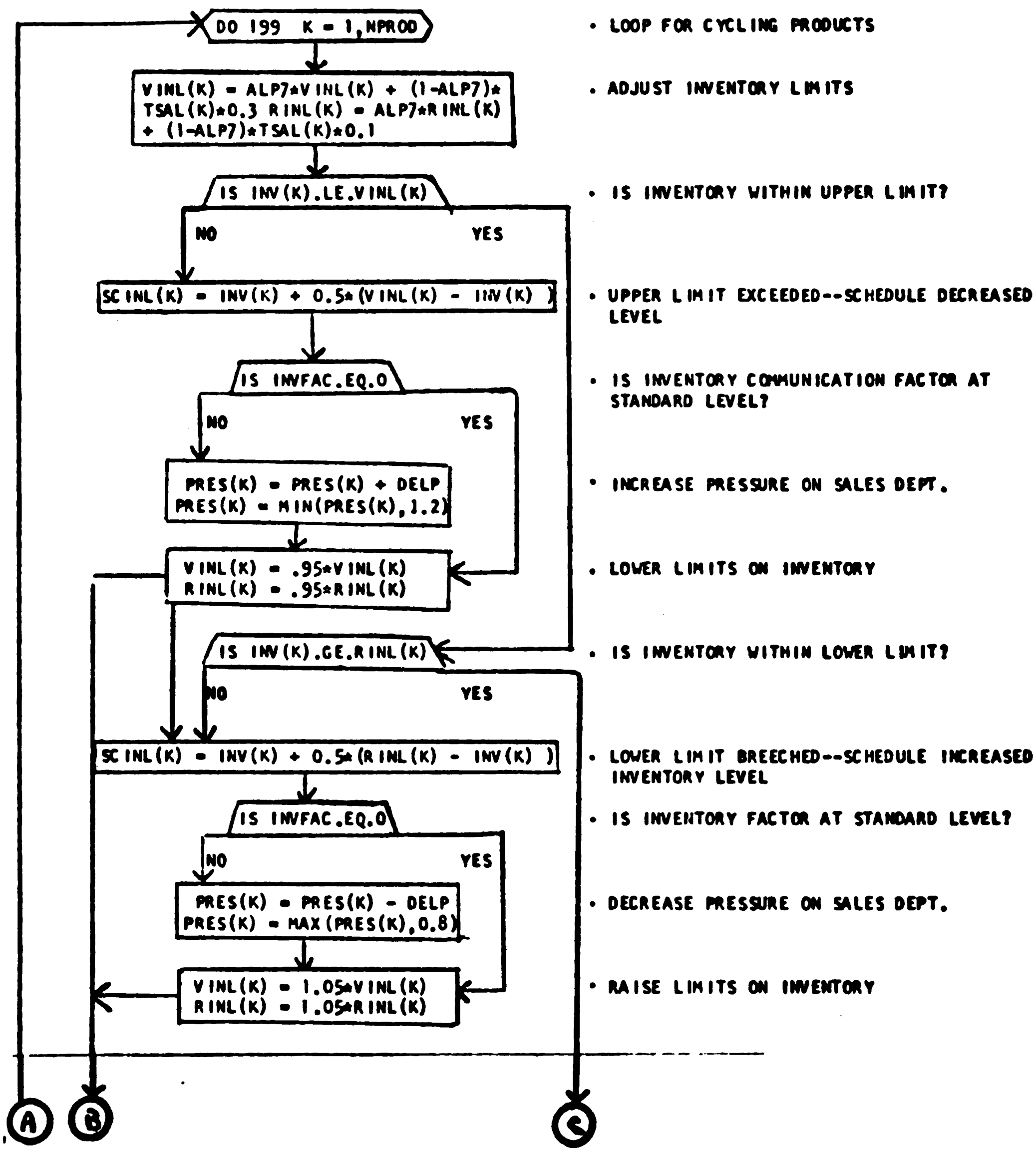


- CALL SALES GENERATING ROUTINE
- CALL BOOKKEEPING ROUTINE
- ADVANCE TIME-IN-QUARTER COUNTER
- DOES QUARTER HAVE TIME LEFT
- CALL NEW-PRODUCT ROUTINE
- CALL EXECUTIVE DECISION ROUTINE
- END MAIN TIMEKEEPING LOOP
- CALL OUTPUT ROUTINE

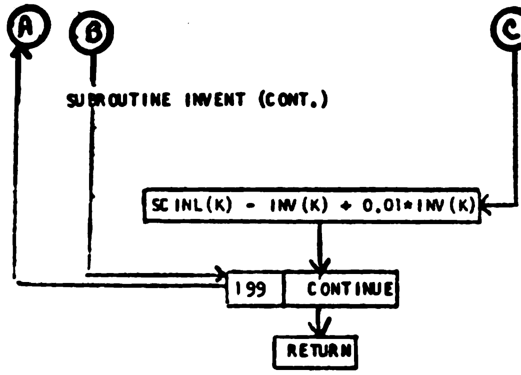
SUBROUTINE FCAST



SUBROUTINE INVENT

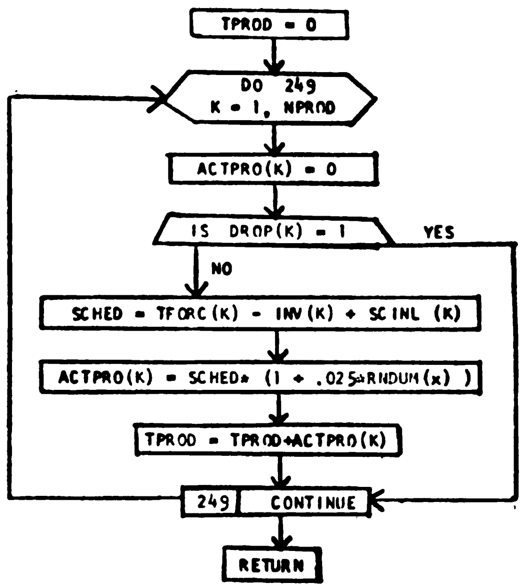


SUBROUTINE INVENT (CONT.)



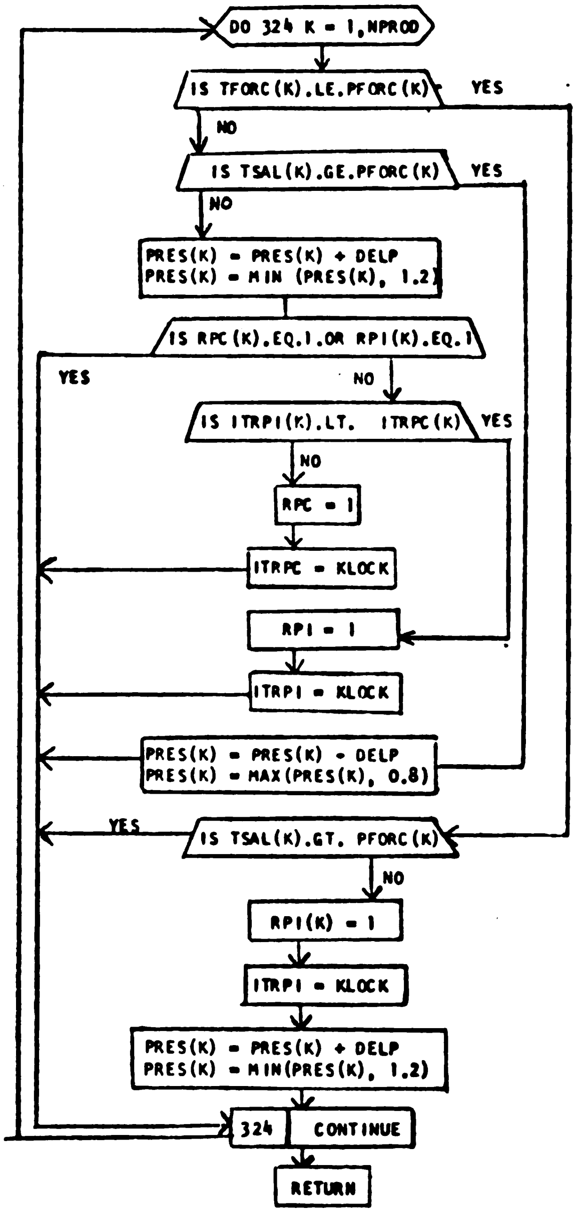
- NEITHER LIMIT BREECHED--SCHEDULE SLIGHT INCREASE IN INVENTORY
- END PRODUCT LOOP

SUBROUTINE GENPRO



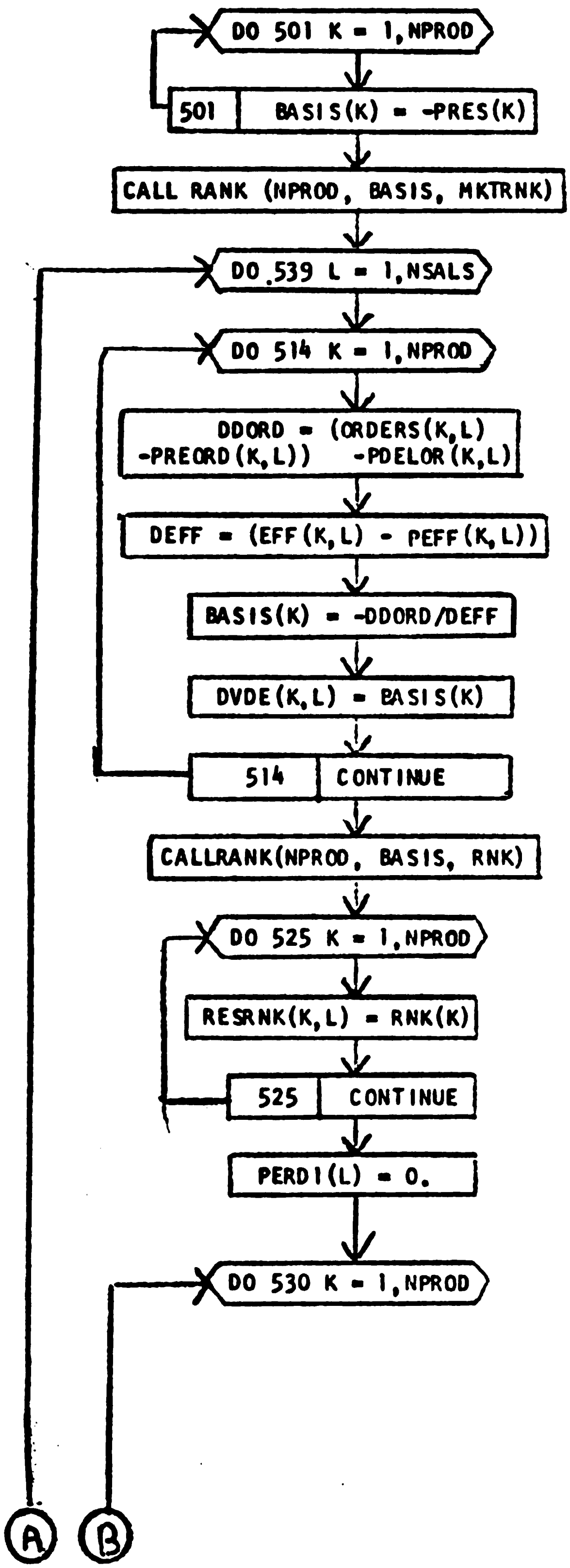
- ZERO OUT TOTAL PRODUCTION
- LOOP FOR CYCLING PRODUCTS
- ZERO OUT ACTUAL PRODUCTION
- HAS PRODUCT K BEEN DROPPED
- SCHEDULE PRODUCTION
- GENERATE RANDOM ERROR AND ACTUAL PRODUCTION
- ACCUMULATE TOTAL PRODUCTION
- END OF LOOP

SUBROUTINE PRREC

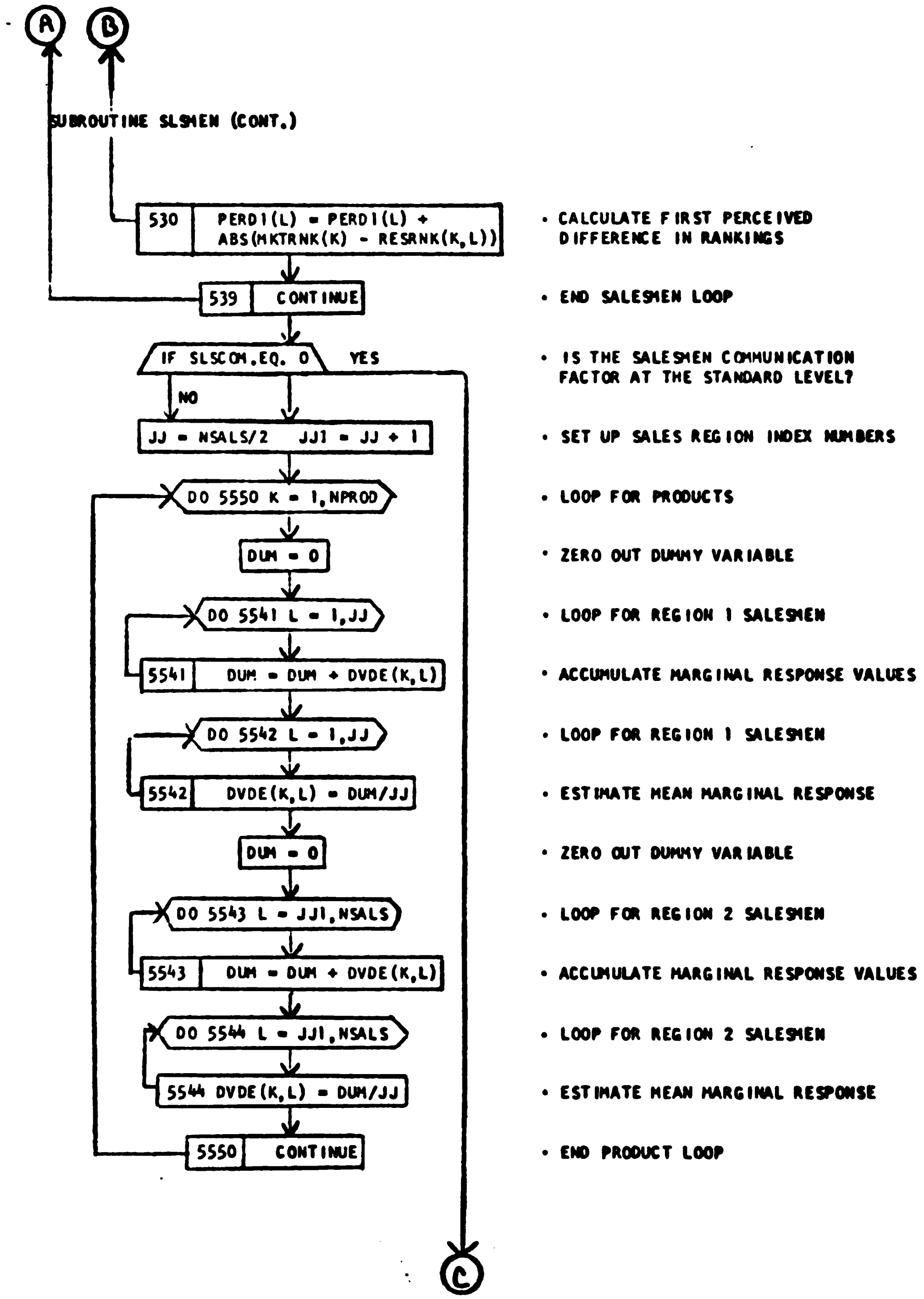


- LOOP FOR PRODUCTS
- IS PREVIOUS FORECAST HIGHER THAN CURRENT FORECAST?
- CURRENT FORECAST HIGHER--WAS PREVIOUS FORECAST MET?
- INCREASE PRESSURE ON SALES DEPT.
- HAS A REQUEST FOR PROMOTION INCREASE OR PRICE DECREASE BEEN MADE THIS QUARTER?
- WAS PROMOTION INCREASE REQUESTED MORE RECENT THAN PRICE CUT REQUEST?
- REQUEST PRICE CUT
- STORE TIME OF PRICE CUT REQUEST
- REQUEST PROMOTION INCREASE
- STORE TIME OF PROMOTION REQUEST
- DECREASE PRESSURE ON SALES DEPT.
- WAS PREVIOUS FORECAST MET?
- REQUEST PROMOTION INCREASE
- STORE TIME OF PROMOTION REQUEST
- INCREASE PRESSURE ON SALES DEPT.
- END PRODUCT LOOP

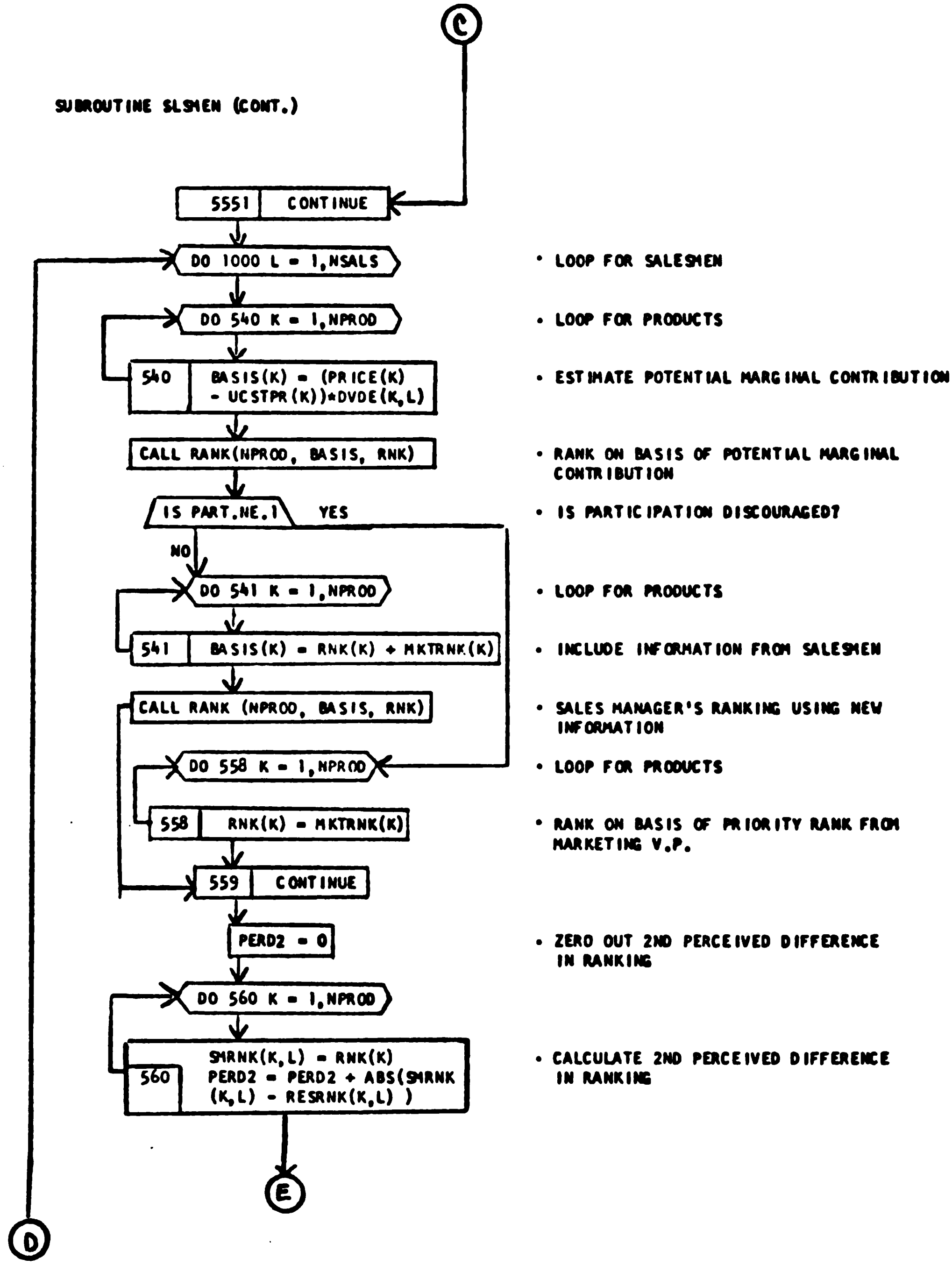
SUBROUTINE SLSMEN

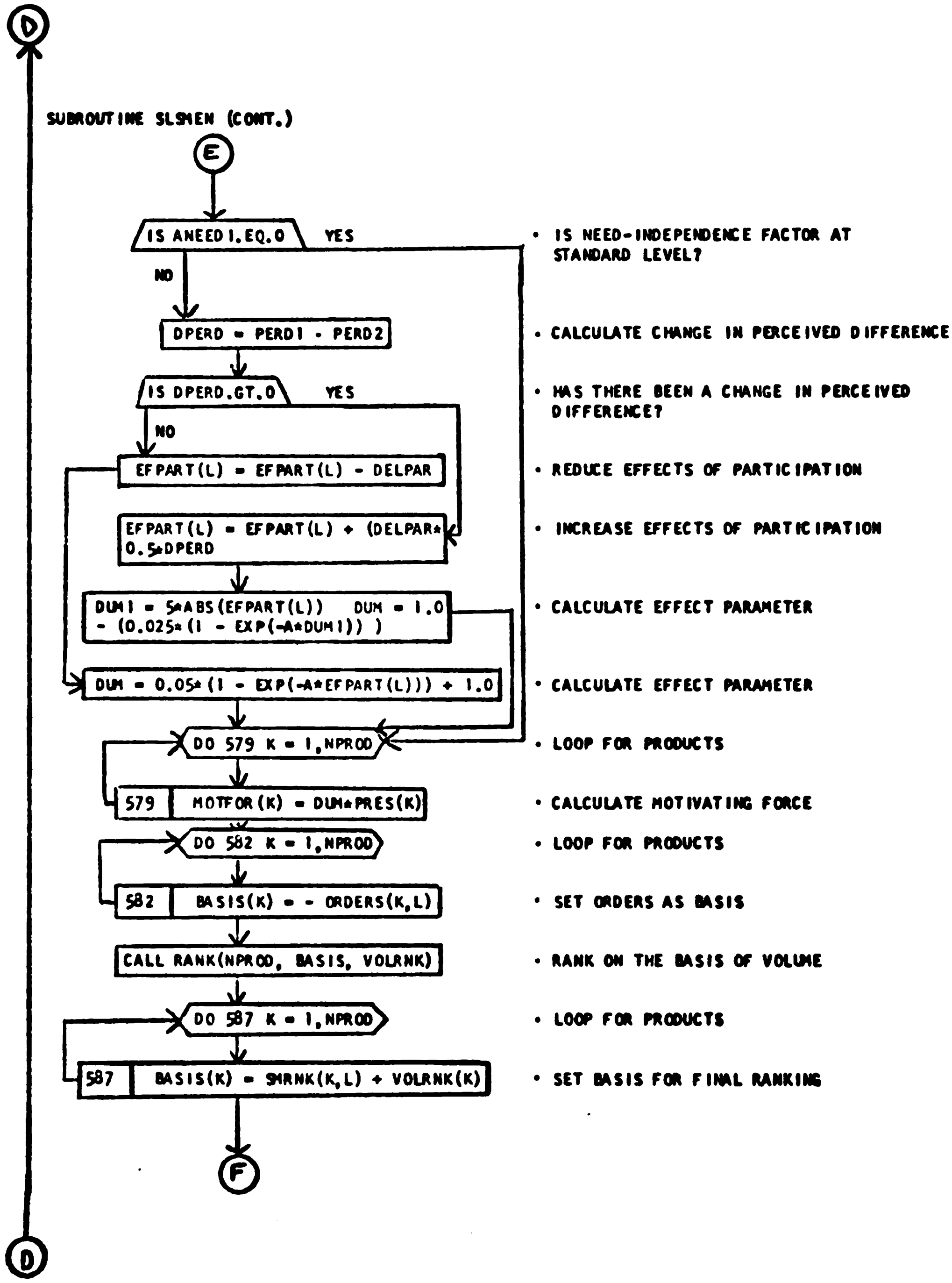


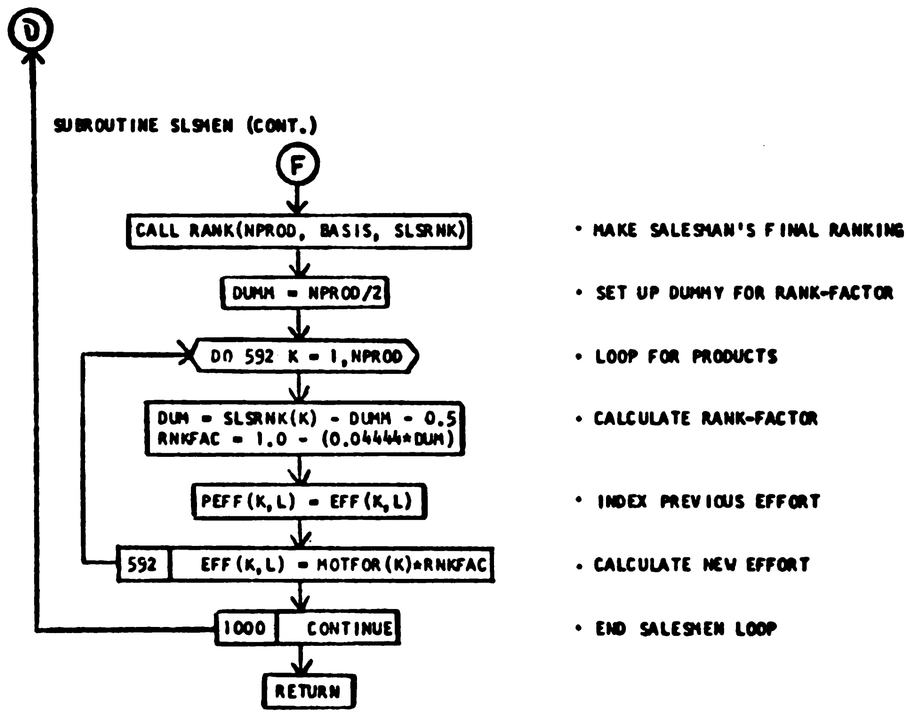
- LOOP FOR PRODUCTS
- ASSIGN PRESSURE AS RANKING BASIS
- RANK PRODUCTS ON THE BASIS OF PRESSURE
- LOOP FOR SALESMEN
- LOOP FOR PRODUCTS
- ESTIMATE MARGINAL RESPONSE OF ORDERS
- ESTIMATE MARGINAL EFFORT
- ESTIMATE MARGINAL RESPONSE TO MARGINAL EFFORT
- STORE MARGINAL RESPONSE
- END PRODUCT LOOP
- RANK PRODUCTS ON THE BASIS OF MARGINAL RESPONSE
- LOOP FOR PRODUCTS
- STORE RESPONSE RANK
- END PRODUCT LOOP
- ZERO OUT FIRST PERCEIVED DIFFERENCE IN RANKING
- LOOP FOR PRODUCTS


A
B
SUBROUTINE SLSMEN (CONT.)
530 PERDI(L) = PERDI(L) + ABS(MKTRNK(K) - RESRNK(K,L))
539 CONTINUE
IF SLSCOM.EQ. 0
YES
NO
JJ = NSALS/2 JJ1 = JJ + 1
DO 5550 K = 1,NPROD
DUM = 0
DO 5541 L = 1,JJ
5541 DUM = DUM + DVDE(K,L)
DO 5542 L = 1,JJ
5542 DVDE(K,L) = DUM/JJ
DUM = 0
DO 5543 L = JJ1,NSALS
5543 DUM = DUM + DVDE(K,L)
DO 5544 L = JJ1,NSALS
5544 DVDE(K,L) = DUM/JJ
5550 CONTINUE
C
• CALCULATE FIRST PERCEIVED DIFFERENCE IN RANKINGS
• END SALESMEN LOOP
• IS THE SALESMEN COMMUNICATION FACTOR AT THE STANDARD LEVEL?
• SET UP SALES REGION INDEX NUMBERS
• LOOP FOR PRODUCTS
• ZERO OUT DUMMY VARIABLE
• LOOP FOR REGION 1 SALESMEN
• ACCUMULATE MARGINAL RESPONSE VALUES
• LOOP FOR REGION 1 SALESMEN
• ESTIMATE MEAN MARGINAL RESPONSE
• ZERO OUT DUMMY VARIABLE
• LOOP FOR REGION 2 SALESMEN
• ACCUMULATE MARGINAL RESPONSE VALUES
• LOOP FOR REGION 2 SALESMEN
• ESTIMATE MEAN MARGINAL RESPONSE
• END PRODUCT LOOP

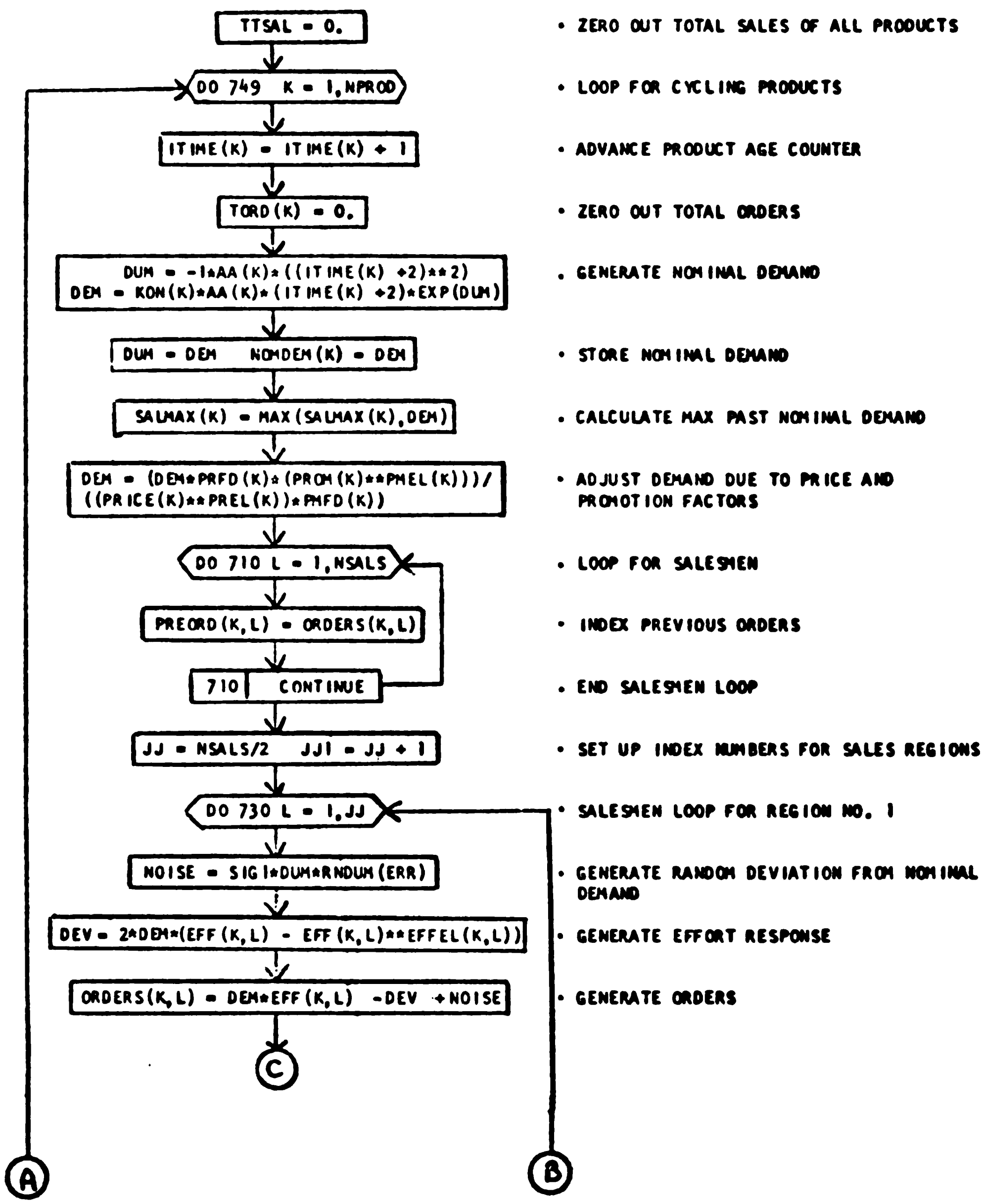
SUBROUTINE SLSMEN (CONT.)

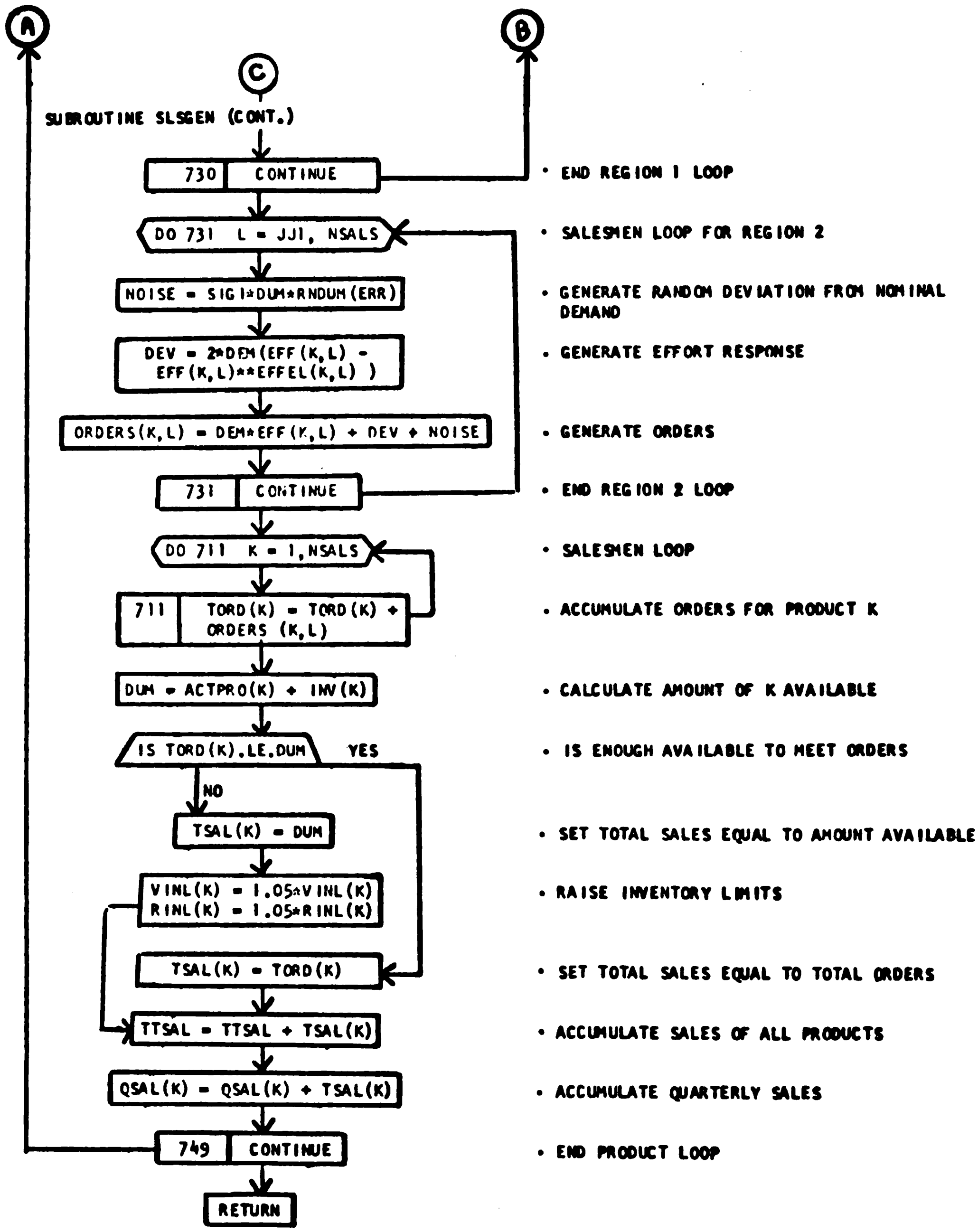



SUBROUTINE SLSMEN (CONT.)
E
IS ANEED1.EQ.0
YES
NO
DPERD = PERD1 - PERD2
IS DPERD.GT.0
YES
NO
EFPART(L) = EFPART(L) - DELPAR
EFPART(L) = EFPART(L) + (DELPAR*
0.5*DPERD
DUM1 = 5*ABS(EFPART(L)) DUM = 1.0
- (0.025*(1 - EXP(-A*DUM1)))
DUM = 0.05*(1 - EXP(-A*EFPART(L))) + 1.0
DO 579 K = 1,NPROD
579 MOTFOR(K) = DUM*PRES(K)
DO 582 K = 1,NPROD
582 BASIS(K) = - ORDERS(K,L)
CALL RANK(NPROD, BASIS, VOLRNK)
DO 587 K = 1,NPROD
587 BASIS(K) = SMRNK(K,L) + VOLRNK(K)
F
D
D
• IS NEED-INDEPENDENCE FACTOR AT STANDARD LEVEL?
• CALCULATE CHANGE IN PERCEIVED DIFFERENCE
• HAS THERE BEEN A CHANGE IN PERCEIVED DIFFERENCE?
• REDUCE EFFECTS OF PARTICIPATION
• INCREASE EFFECTS OF PARTICIPATION
• CALCULATE EFFECT PARAMETER
• CALCULATE EFFECT PARAMETER
• LOOP FOR PRODUCTS
• CALCULATE MOTIVATING FORCE
• LOOP FOR PRODUCTS
• SET ORDERS AS BASIS
• RANK ON THE BASIS OF VOLUME
• LOOP FOR PRODUCTS
• SET BASIS FOR FINAL RANKING


SUBROUTINE SLSMEN (CONT.)
F
D
CALL RANK(NPROD, BASIS, SLSRNK)
DUMM = NPROD/2
DO 592 K = 1,NPROD
DUM = SLSRNK(K) - DUMM - 0.5
RNKFAC = 1.0 - (0.04444*DUM)
PEFF(K,L) = EFF(K,L)
592
EFF(K,L) = MOTFOR(K)*RNKFAC
1000
CONTINUE
RETURN
• MAKE SALESMAN'S FINAL RANKING
• SET UP DUMMY FOR RANK-FACTOR
• LOOP FOR PRODUCTS
• CALCULATE RANK-FACTOR
• INDEX PREVIOUS EFFORT
• CALCULATE NEW EFFORT
• END SALESMEN LOOP

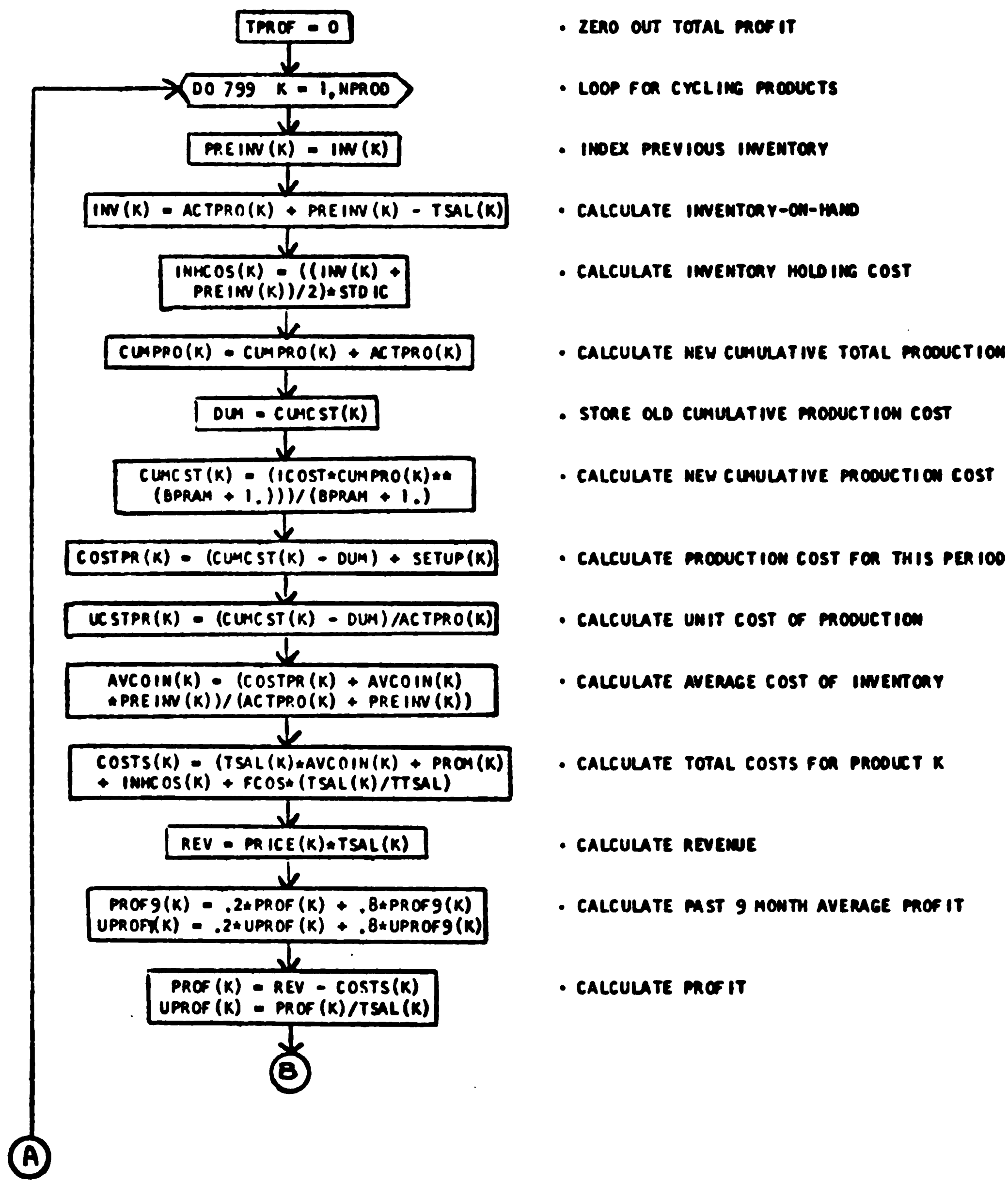
SUBROUTINE SLSGEN

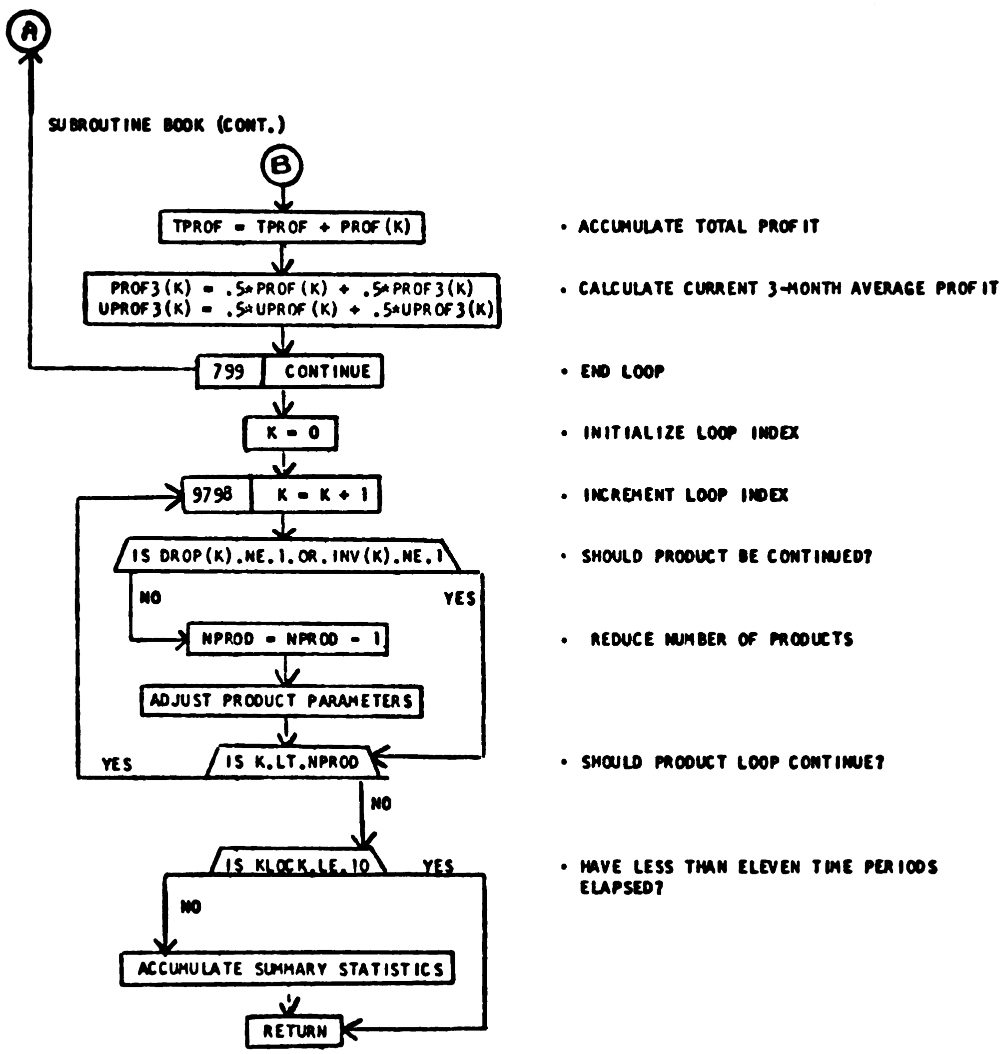




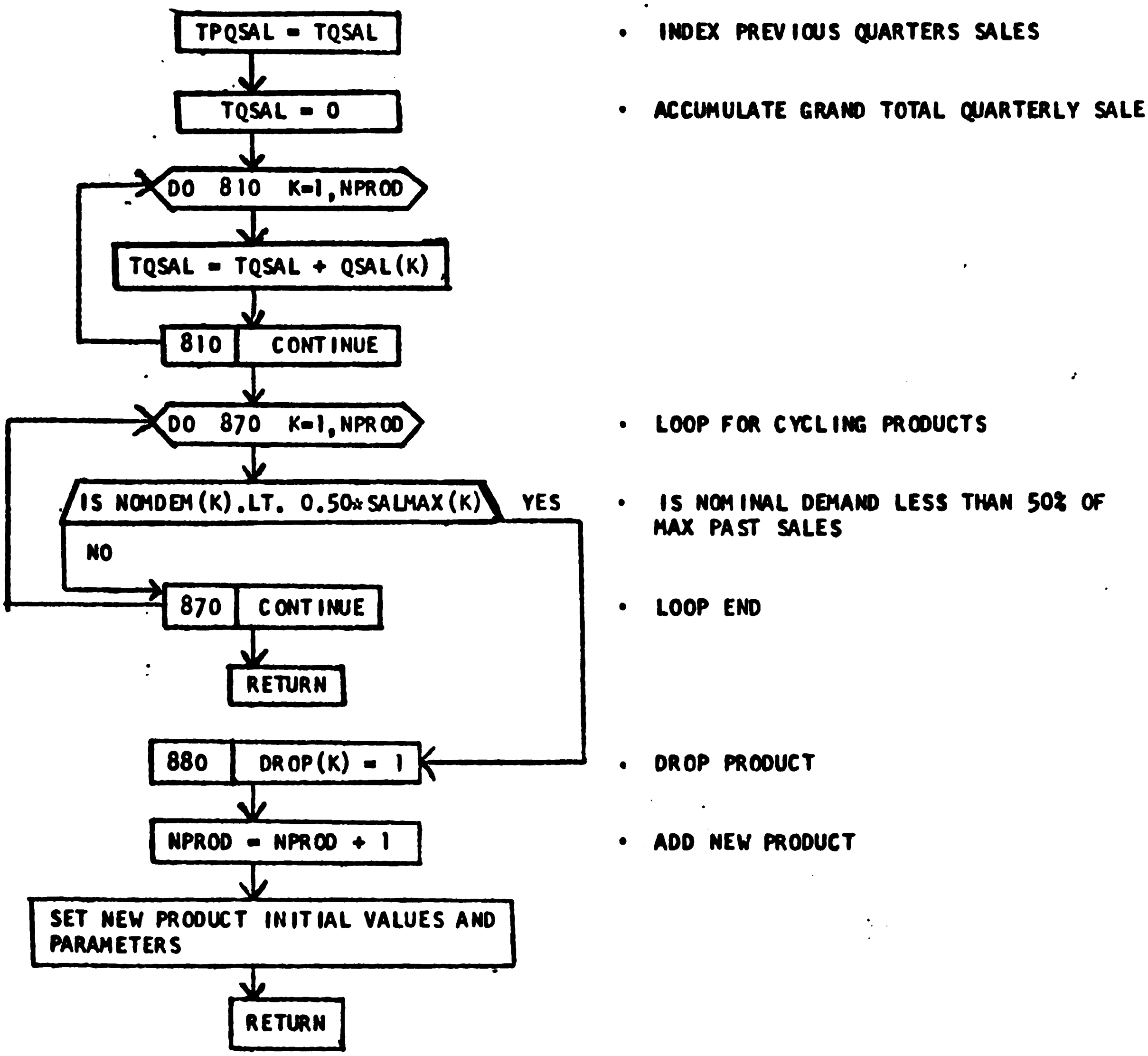
A
B
C
SUBROUTINE SLSGEN (CONT.)
730 CONTINUE
DO 731 L = JJ1, NSALS
NOISE = SIG1*DUM*RNDUM(ERR)
DEV = 2*DEM(EFF(K,L) - EFF(K,L)**EFFEL(K,L))
ORDERS(K,L) = DEM*EFF(K,L) + DEV + NOISE
731 CONTINUE
DO 711 K = 1,NSALS
711 TORD(K) = TORD(K) + ORDERS (K,L)
DUM = ACTPRO(K) + INV(K)
IS TORD(K).LE.DUM
YES
NO
TSAL(K) = DUM
VINL(K) = 1.05*VINL(K)
RINL(K) = 1.05*RINL(K)
TSAL(K) = TORD(K)
TTSAL = TTSAL + TSAL(K)
QSAL(K) = QSAL(K) + TSAL(K)
749 CONTINUE
RETURN
• END REGION 1 LOOP
• SALESMEN LOOP FOR REGION 2
• GENERATE RANDOM DEVIATION FROM NOMINAL DEMAND
• GENERATE EFFORT RESPONSE
• GENERATE ORDERS
• END REGION 2 LOOP
• SALESMEN LOOP
• ACCUMULATE ORDERS FOR PRODUCT K
• CALCULATE AMOUNT OF K AVAILABLE
• IS ENOUGH AVAILABLE TO MEET ORDERS
• SET TOTAL SALES EQUAL TO AMOUNT AVAILABLE
• RAISE INVENTORY LIMITS
• SET TOTAL SALES EQUAL TO TOTAL ORDERS
• ACCUMULATE SALES OF ALL PRODUCTS
• ACCUMULATE QUARTERLY SALES
• END PRODUCT LOOP

SUBROUTINE BOOK

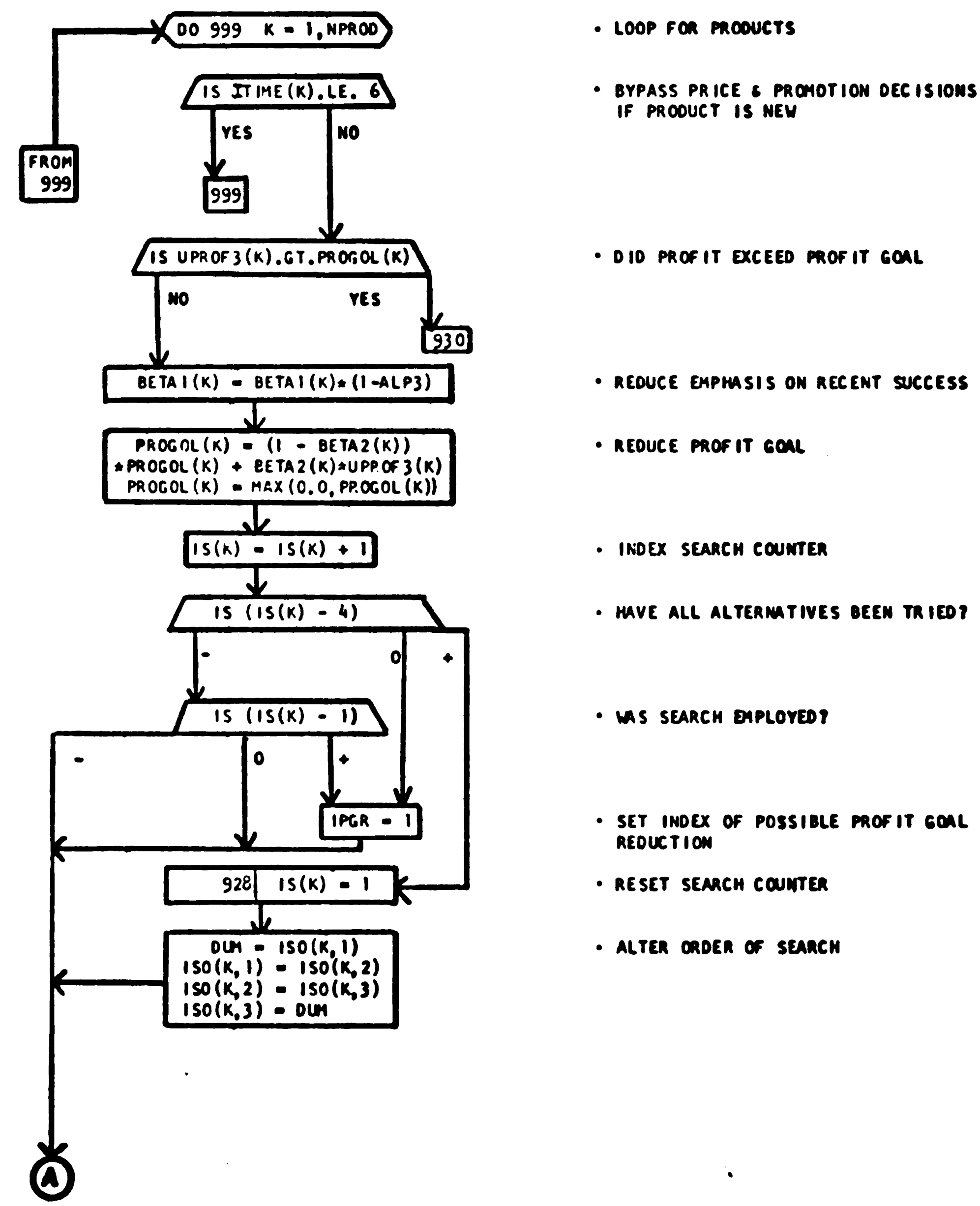


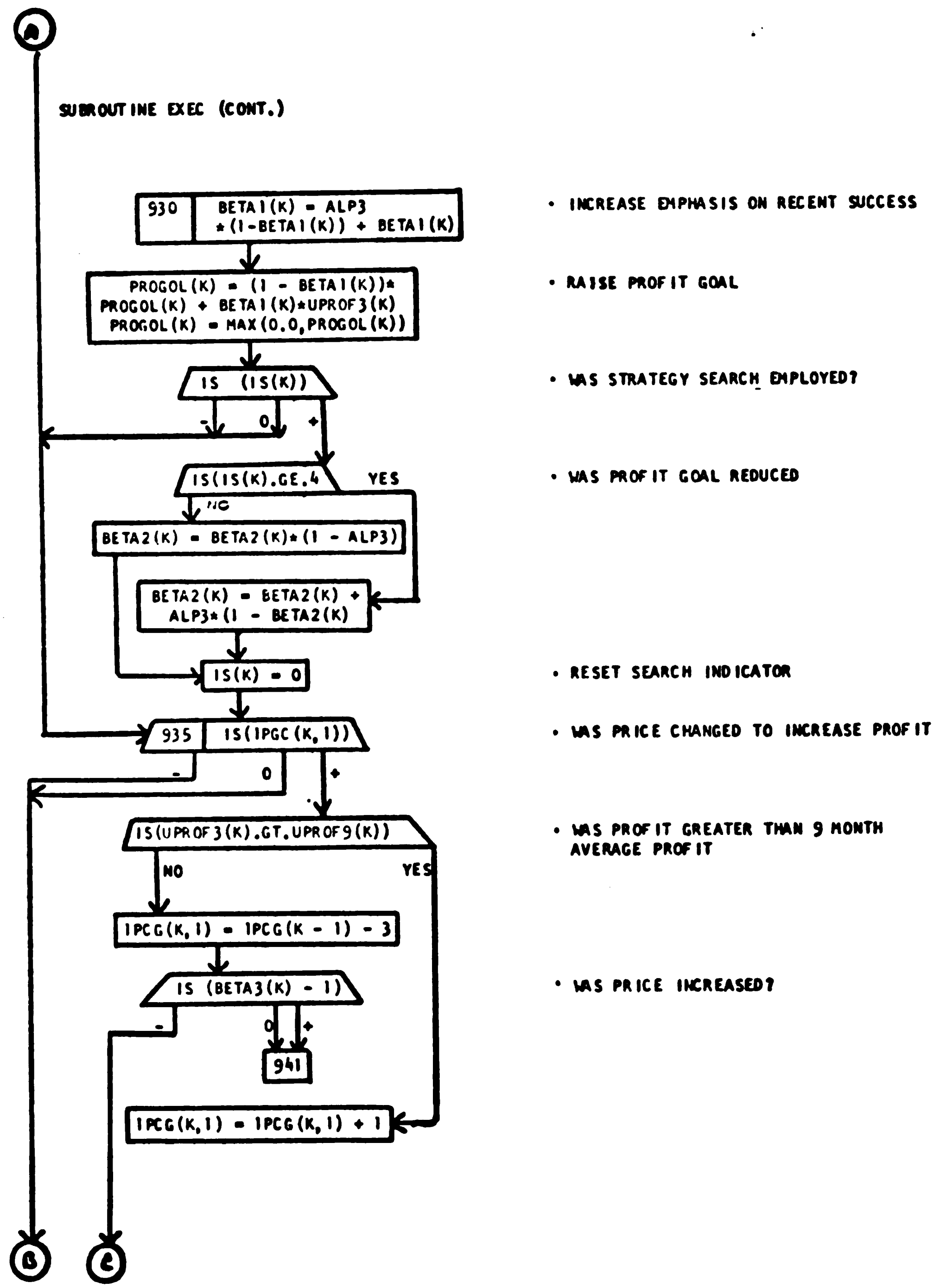

A
SUBROUTINE BOOK (CONT.)
B
TPROF = TPROF + PROF(K)
PROF3(K) = .5*PROF(K) + .5*PROF3(K)
UPROF3(K) = .5*UPROF(K) + .5*UPROF3(K)
799 CONTINUE
K = 0
9798 K = K + 1
IS DROP(K).NE.1.OR.INV(K).NE.1
NO
YES
NPROD = NPROD - 1
ADJUST PRODUCT PARAMETERS
YES
IS K.LT.NPROD
NO
IS KLOCK.LE.10
YES
NO
ACCUMULATE SUMMARY STATISTICS
RETURN
• ACCUMULATE TOTAL PROFIT
• CALCULATE CURRENT 3-MONTH AVERAGE PROFIT
• END LOOP
• INITIALIZE LOOP INDEX
• INCREMENT LOOP INDEX
• SHOULD PRODUCT BE CONTINUED?
• REDUCE NUMBER OF PRODUCTS
• SHOULD PRODUCT LOOP CONTINUE?
• HAVE LESS THAN ELEVEN TIME PERIODS ELAPSED?

SUBROUTINE NEWPRO

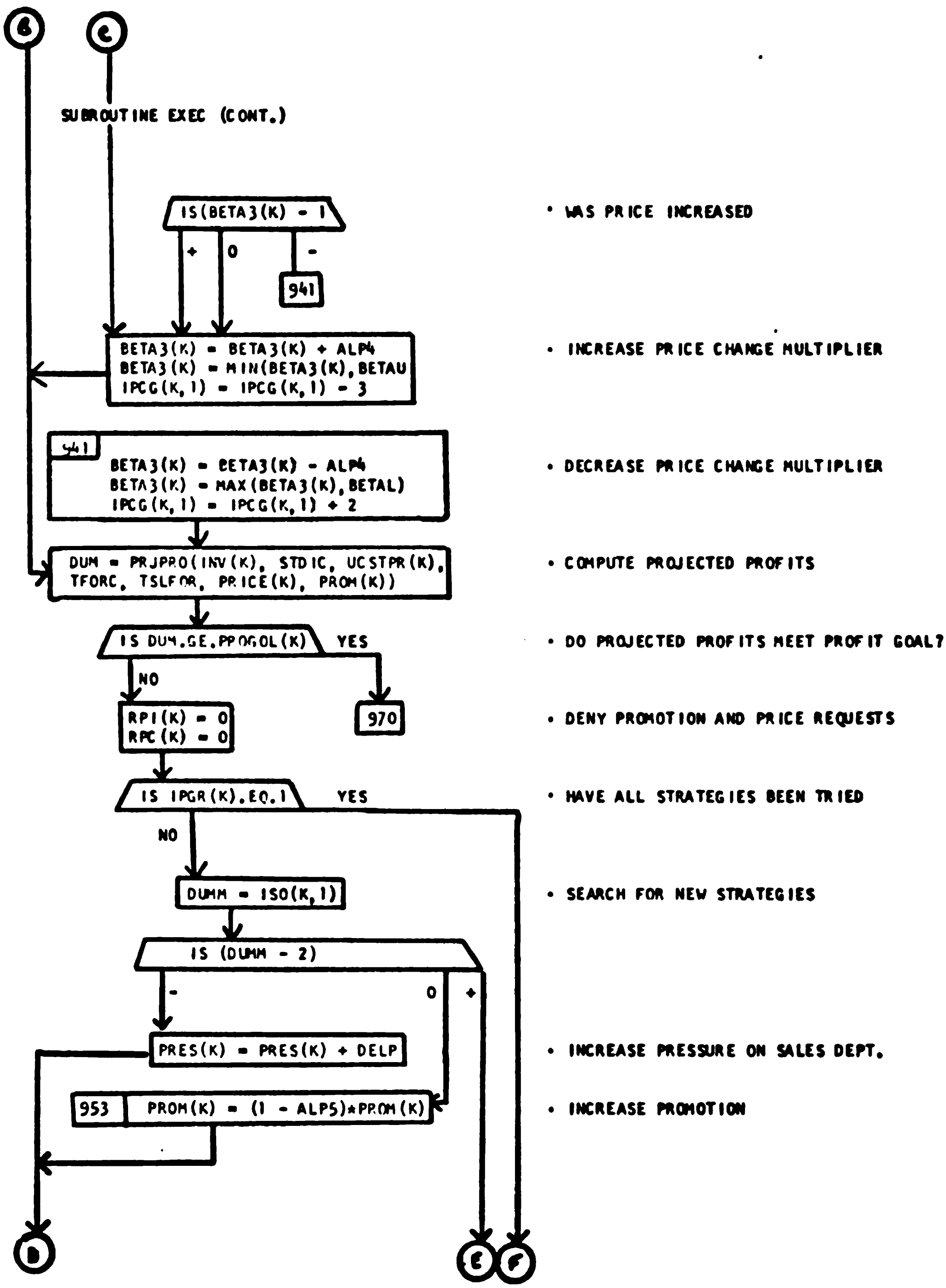


SUBROUTINE EXEC

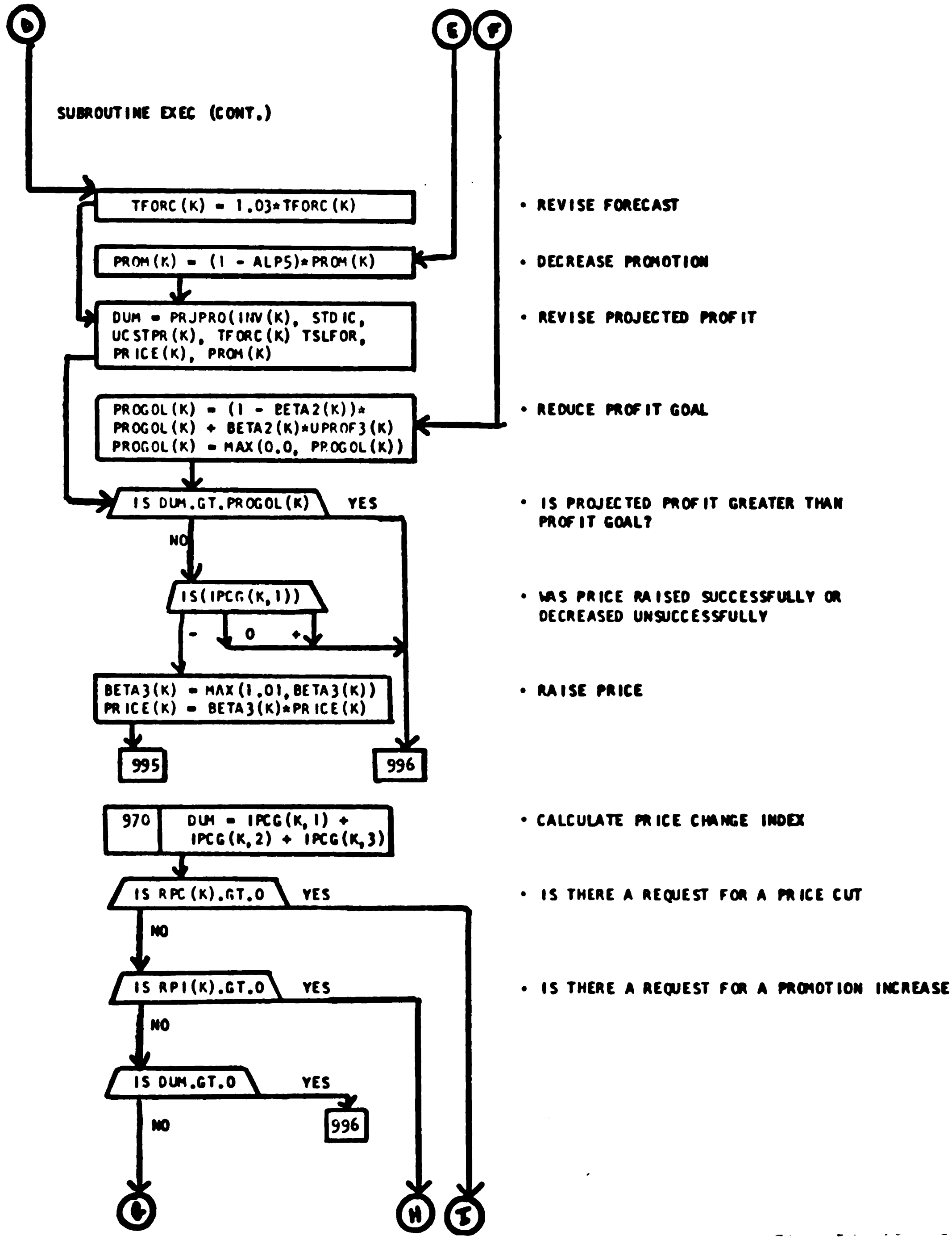


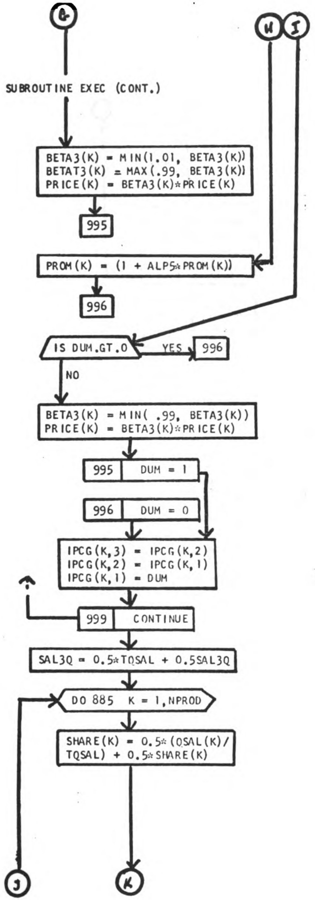


A
SUBROUTINE EXEC (CONT.)
930
BETA1(K) = ALP3 *(1-BETA1(K)) + BETA1(K)
• INCREASE EMPHASIS ON RECENT SUCCESS
PROGOL(K) = (1 - BETA1(K))* PROGOL(K) + BETA1(K)*UPROF3(K)
PROGOL(K) = MAX(0.0,PROGOL(K))
• RAISE PROFIT GOAL
IS (IS(K))
• WAS STRATEGY SEARCH EMPLOYED?
-
0
+
IS(IS(K).GE.4
YES
NO
• WAS PROFIT GOAL REDUCED
BETA2(K) = BETA2(K)*(1 - ALP3)
BETA2(K) = BETA2(K) + ALP3*(1 - BETA2(K)
IS(K) = 0
• RESET SEARCH INDICATOR
935
IS(IPGC(K,1))
• WAS PRICE CHANGED TO INCREASE PROFIT
IS(UPROF3(K).GT.UPROF9(K))
• WAS PROFIT GREATER THAN 9 MONTH AVERAGE PROFIT
NO
YES
IPCG(K,1) = IPCG(K - 1) - 3
IS (BETA3(K) - 1)
• WAS PRICE INCREASED?
941
IPCG(K,1) = IPCG(K,1) + 1
B
C

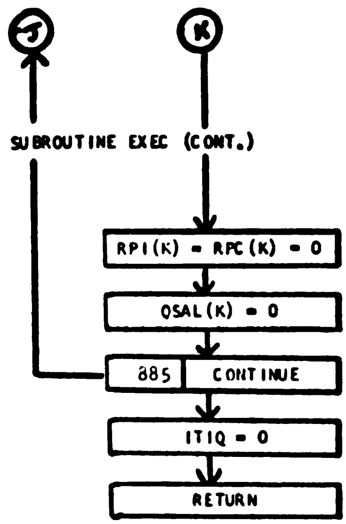


B
C
SUBROUTINE EXEC (CONT.)
IS(BETA3(K) - 1
+
0
-
941
BETA3(K) = BETA3(K) + ALP4
BETA3(K) = MIN(BETA3(K),BETAU
IPCG(K,1) = IPCG(K,1) - 3
941
BETA3(K) = BETA3(K) - ALP4
BETA3(K) = MAX(BETA3(K),BETAL)
IPCG(K,1) = IPCG(K,1) + 2
DUM = PRJPRO(INV(K), STDIC, UCSTPR(K),
TFORC, TSLFOR, PRICE(K), PROM(K))
IS DUM.GE.PPOGOL(K)
YES
NO
970
RPI(K) = 0
RPC(K) = 0
IS IPGR(K).EQ.1
YES
NO
DUMM = ISO(K,1)
IS (DUMM - 2)
-
0
+
PRES(K) = PRES(K) + DELP
953
PROM(K) = (1 - ALP5)*PROM(K)
D
E
F
• WAS PRICE INCREASED
• INCREASE PRICE CHANGE MULTIPLIER
• DECREASE PRICE CHANGE MULTIPLIER
• COMPUTE PROJECTED PROFITS
• DO PROJECTED PROFITS MEET PROFIT GOAL?
• DENY PROMOTION AND PRICE REQUESTS
• HAVE ALL STRATEGIES BEEN TRIED
• SEARCH FOR NEW STRATEGIES
• INCREASE PRESSURE ON SALES DEPT.
• INCREASE PROMOTION


SUBROUTINE EXEC (CONT.)
TFORC(K) = 1.03*TFORC(K)
PROM(K) = (1 - ALP5)*PROM(K)
DUM = PRJPRO(INV(K), STDIC, UCSTPR(K), TFORC(K) TSLFOR, PRICE(K), PROM(K)
PROGOL(K) = (1 - BETA2(K))* PROGOL(K) + BETA2(K)*UPROF3(K) PROGOL(K) = MAX(0.0, PROGOL(K))
IS DUM.GT.PROGOL(K)
YES
NO
IS(IPCG(K,1))
-
0
+
BETA3(K) = MAX(1.01, BETA3(K)) PRICE(K) = BETA3(K)*PRICE(K)
995
996
970
DUM = IPCG(K,1) + IPCG(K,2) + IPCG(K,3)
IS RPC(K).GT.0
YES
NO
IS RPI(K).GT.0
YES
NO
IS DUM.GT.0
YES
NO
996
• REVISE FORECAST
• DECREASE PROMOTION
• REVISE PROJECTED PROFIT
• REDUCE PROFIT GOAL
• IS PROJECTED PROFIT GREATER THAN PROFIT GOAL?
• WAS PRICE RAISED SUCCESSFULLY OR DECREASED UNSUCCESSFULLY
• RAISE PRICE
• CALCULATE PRICE CHANGE INDEX
• IS THERE A REQUEST FOR A PRICE CUT
• IS THERE A REQUEST FOR A PROMOTION INCREASE

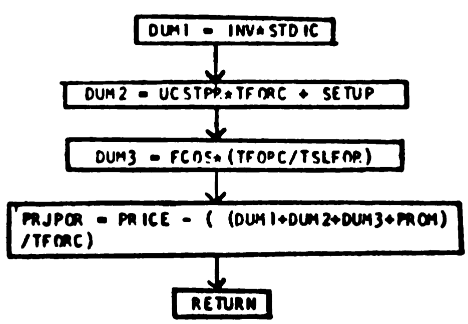


- CHANGE PRICE IN BEST PAST DIRECTION
- INCREASE PROMOTION
- HAS PRICE CHANGED IN LAST 9 MONTHS
- CUT PRICE
- UPDATE PRICE CHANGE INDEX (PRICE HAS BEEN CHANGED)
- UPDATE PRICE CHANGE INDEX (PRICE HAS NOT BEEN CHANGED)
- UPDATE PRICE CHANGE RECORD
- END OF PRODUCT LOOP
- CALCULATE 3-QUARTER SALES AVERAGE
- LOOP FOR CYCLING PRODUCTS
- CALCULATE 3-QUARTER AVERAGE SHARE OF TOTAL SALES



- ZERO OUT PRICE AND PROMOTION REQUESTS
- ZERO OUT QUARTER SALES
- END PRODUCT LOOP
- ZERO OUT TIME-IN-QUARTER

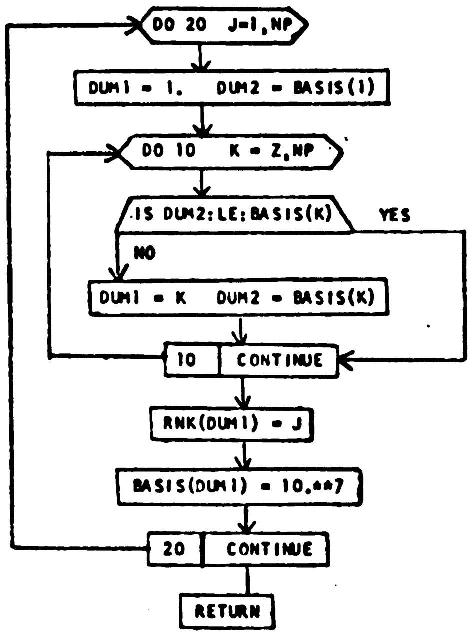
FUNCTION PRJPRO



- ESTIMATE TOTAL INVENTORY HOLDING COST
- ESTIMATE PRODUCTION COST
- ESTIMATE FIXED COST ALLOCATION
- ESTIMATE UNIT PROFIT

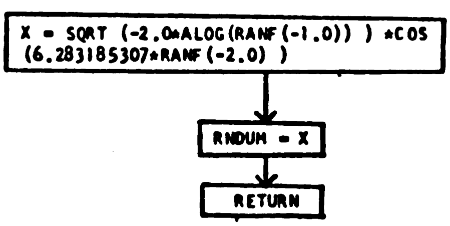
SUBROUTINE RANK

- C-RANK SMALLEST VALUE OF BASIS FIRST--LARGEST VALUE OF BASIS LAST



- LOOP FOR CYCLING PRODUCTS
- SET INITIAL VALUES OF DUMMY VARIABLES
- COMPARISON LOOP CONTROL
- COMPARE LOWEST NUMBER WITH NEXT VALUE OF BASIS
- LET DUM2 EQUAL NEW LOWEST VALUE
- END OF LOOP
- DEFINE RANK OF NEW LOWEST VALUE
- ASSIGN ARBITRARILY HIGH VALUE TO BASIS
- END OF LOOP

FUNCTION RNDUM



- GENERATE A RANDOM VARIABLE FROM A NORMAL DISTRIBUTION WITH MEAN OF ZERO AND STANDARD DEVIATION OF 1.0

APPENDIX II

Glossary of Variable Names

GLOSSARY OF VARIABLE NAMES

Subscripts

In general, the subscript K refers to a particular product, with
K 1, NPROD. (NPROD Number of products)

The subscript L refers to a particular salesman with
L 1, NSALS. (NSALS Number of salesmen)

Program PAJAMA

KLOCK	The timekeeping variable. The value of KLOCK is the particular month of the current run.
LENGTH	The length of the run. The number of time periods to be covered in the run.
ITIQ	Current time in quarter.

Subroutine FCAST

TSLFOR	Total sales forecast.
PFORC(K)	Previous month's forecast.
TFORC(K)	Forecast for product K.
PSAVE	Previous smoothed average.
SAVE(K, L)	Smoothed average.
ALP1	Smoothing constant used in forecasting.
ORDERS(K, L)	Orders received (units).
CHANGE	Change in smoothed average.
PDELOR(K, L)	Previous forecasted change in orders.
DELOR(K, L)	Forecasted change in orders from current month to next month.
FORC(K, L)	Forecast of sales.

Subroutine INVENT

UINL(K)	Upper limit on inventory level.
ALP7	Smoothing constant in setting inventory limits.
RINL(K)	Runout (lower) limit on inventory level.
TSAL(K)	Monthly sales.
INV(K)	Inventory level at end of month.
SCINL(K)	Scheduled level of inventory.
INVFAC	Experimental variable control (inventory communication link).
PRES(K)	Index of pressure on sales department.
DELP	Change constant for index of pressure.

Subroutine GENPRO

TPROD	Total monthly production.
ACTPRO(K)	Actual amount produced in current month.
DROP(K)	Index number indicating if a product is to be discontinued. If DROP(K) 1, the product will be deleted.
SCHED	Production scheduled for next month.
TFORC(K)	Forecasted sales.
INV(K)	Current level of inventory.
SCINV(K)	Scheduled level of inventory.

RNDUM(X)	Function for generating standardized normal random variate.

<u>Subroutine PRREC</u>

TFORC(K)	Forecasted sales.
PFORC(K)	Forecast of sales in previous month.
TSAL(K)	Monthly sales.
PRES(K)	Index of pressure on sales department.
DELP	Change constant for index of pressure.
RPC(K)	Request for price cut index.
PPI(K)	Request for promotion increase index.
ITRPI(K)	Month in which promotion increase was last requested.
ITRPC(K)	Month in which price cut was last requested.
KLOCK	"Clock time". Current month.

<u>Subroutine SLSMEN</u>

BASIS(K)	Dummy variable, used for listing values of attribute on which a ranking is made.
PRES(K)	Index of pressure on sales department.
MKTRNK(K)	Indicates a priority rank of each product.
DDORD	The marginal change in orders.
ORDERS(K, L)	Monthly orders.
PREORD(K, L)	Previous month's orders.
PDELOR(K, L)	Previous month's change in orders.
DEFF	The change in a salesman's effort.
EFF(K, L)	Salesman's effort index.
PEFF(K, L)	Previous month's effort index.
DVDE(K, L)	Marginal response variable.
RNK(K)	Dummy variable used to carry result of ranking subroutine back to calling program.
RESRNK(K, L)	Rank of marginal response of a product to marginal effort.
PERDI(L)	First perceived difference between salesman's ranking and sales manager's ranking.
SLSCOM	Experimental variable control (salesmen communication).
JJ, JJ1	Index numbers for separating sales regions.
PRICE(K)	Price.
UCSTPR(K)	Unit cost.
MKTRNK(K)	Priority ranking from marketing vice-president.
SMRNK(K, L)	Salesmanager's priority ranking of products.
PERD2	Second perceived difference.
DPERD	Change in perceived difference in rankings due to participation.
EFPART(L)	Index indicating a cumulative effect from participation.
DELPAR	Participation change constant.
DUM	Dummy variable.
MOTFOR(K)	Motivating force.
VOLRNK(K)	Ranking on basis of volume.
SLSRNK(K)	Final priority ranking of salesman.

RNKFAC	Index due to final salesman's ranking.

<u>Subroutine SLSGEN</u>

TTSAL	Total monthly sales of all products.
ITIME(K)	The age of product K.
TORD(K)	Monthly orders.
DUM	Dummy variable.
AA(K)	Wiebull equation parameter.
DEM	Nominal demand for product.
NOMDEM(K)	Nominal demand.
SALMAX(K)	Maximum past nominal demand.
KON(K)	Wiebull equation parameter.
PFRD(K)	Price factor divisor.
PROM(K)	Promotion expenditure.
PMEL(K)	Promotion elasticity.
PMFD(K)	Promotion factor division.
PREORD(K, L)	Previous month's orders.
ORDERS(K, L)	Current month's orders.
JJ, JJ1	Index numbers for sales regions.
DROP(K)	Drop index.
NOISE	Random variation in demand.
SIG1	Constant used in calculating random variation.
RNDUM(ERR)	Function for generating standardized normal variable.
EFF(K, L)	Selling effort.
EFFEL(K, L)	Elasticity of effort.
DEV	Adjustment due to effort response.
ACTPRO(K)	Actual production.
INV(K)	Current inventory level.
UINL(K)	Upper inventory limit.
RINL(K)	Runout (lower) inventory limit.
TSAL(K)	Total monthly sales.
QSAL(K)	Quarterly sales.

<u>Subroutine BOOK</u>

TPROF	Monthly profit.
PREINV(K)	Previous month's inventory level.
INV(K)	Current inventory level.
ACTPRO(K)	Actual production.
TSAL(K)	Monthly sales.
INHCOS(K)	Inventory holding costs.
STDIC	Standard cost for holding one unit of inventory.
CUMPRO(K)	Cumulative number of units produced over the life of the product.
CUMCST(F)	Cumulative total production costs over the life of the product.
BPRAM	Learning curve parameter.
ICOST	Initial cost of first unit produced.
COSTPR(K)	Monthly production cost.

UCSTPR(K)	Unit monthly production cost.
SETUP(K)	Setup cost.
AVCOIN(K)	Average cost of inventory.
COSTS(K)	Monthly total costs.
PROM(K)	Promotion expenditures.
FCOS	Monthly fixed costs.
TTSAL	Total monthly sales.
TPROD	Total monthly production.
REV	Revenue.
PRICE(K)	Price.
PROF9(K)	Nine month average profit.
PROF(K)	Monthly profit.
UPROF9(K)	Nine month average unit profit.
UPROF(K)	Unit profit.
TPROF	Total profit.
PROF3(K)	Three month average profit.
UPROF3(K)	Three month average unit profit.
DROP(K)	Index indicating if a product is to be dropped.
KLOCK	Current month.
SUMX	Sum of previous months.
SUMX2	$(SUMX)^2$
SUBP	Summation of pressure index values.
SUMPR	Average pressure value.
SUMXPR	Product of KLOCK and average pressure value.
SUMPR2	$(SUMPR)^2$
SUMY	Sum of total profit.
SUMXY	Product of KLOCK and total profit.
SUMY2	$(SUMY)^2$

<u>Subroutine NEWPRO</u>

ITIQ	Clock indicating current month in current quarter.
TPQSAL	Total previous quarter's sales.
TQSAL	Total current quarter's sales.
QSAL(K)	Quarterly sales.
SALMAX(K)	Maximum past nominal demand.
DEM(K)	Nominal demand.
DROP(K)	Index for dropping product.

<u>Subroutine EXEC</u>

ITIME(K)	Age of product.
UPROF3(K)	Three month average unit profit.
PROGOL(K)	Unit profit goal.
BETA1(K)	Smoothing constant used in profit goal equation.
ALP3	BETA1 change constant.
BETA2(K)	Smoothing constant used in profit goal equation.
IS(K)	Search counter.

IPGR(K)	Index of possible profit goal reduction.
ISO(K)	Order of search precedence.
IPCG(K, 1)	Index indicating if price has been changed at beginning of last quarter.
UPROF9(K)	Nine month average unit profit.
BETA3(K)	Price change multiplier.
ALP4	Change constant for price change multiplier.
BETALL	Upper limit on price change multiplier.
BETAL	Lower limit on price change multiplier.
PRJPRO(...)	Function used to calculate projected profit.
RPI(K)	Request for a promotion increase.
RPC(K)	Request for a price cut.
PRES(K)	Pressure on sales department.
DELP	Change constant for pressure index.
PROM(K)	Promotion expenditure.
ALP5	Change constant for changing promotion.
TFORC(K)	Monthly sales forecast.
IPCG(K, KK)	Index of past price change. KK 1, 3
PRICE(K)	Unit sales price.
SAL3Q	Three-quarter sales average.
TQSAL	Total quarterly sales.
SHARE(K)	Share of total quarterly sales.

APPENDIX III

Program PAJAMA

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```
              PAJAMA
      PROGRAM MAIN(INPUT,OUTPUT,PUNCH)
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/FCASTB/DELOR(15,6),ALP1,FORC(15,6)
      COMMON/FCASTC/SAVE(15,6)
      COMMON/FCASTD/TSLFOR
      COMMON/INVNTB/ALP7
      COMMON/INVNTC/INVFAC
      COMMON/GENPRB/SCHED,ERR
      COMMON/PRRECB/RPC(15),RPI(15),ITRPI(15),ITRPC(15)
      COMMON/SLSMNB/BASIS(15),MKTRNK(15),DDORD,DEFF,PEFF(15,6),
     1 RESRNK(15,6),RNK(15),PERD1(15),PART,SMRNK(15,6),PERD2,DPERD,
     2 EFPART(15),DELPAR,MOTFOR(15),VOLRNK(15),SLSRNK(15),RNKFAC
      COMMON/SLSMNC/DVDE(15,6)
      COMMON/SLS1/ANEEDI
      COMMON/SLS2/SLSCOM
      COMMON/SLSGNB/TORD(15),AA(15),DEM,KON(15),PRFD(15),PMEL(15),
     1 PREL(15),PMFD(15),NOISE,SIG1,LOSTSL(15)
      COMMON/SLSGNC/TTSAL
      COMMON/SLSGND/EFFEL(15,6)
      COMMON/SLSGNX/NOMDEM(15)
      COMMON/BOOKB/TPROF,PREINV(15),INHCOS(15),CUMPRO(15),
     1 CUMCST(15),ICOST,BPRAM,COSTPR(15),SETUP(15),AVCOIN(15),COSTS(15),
     2 FCOS,REV,PROF(15),UPROF(15),SUMX,SUMX2,SUMY,SUMY2,SUMXY
     3,UCSTPR(15)
      COMMON/BOOKC/STDIC
      COMMON/NEWPRB/ITIQ,TPQSAL,TQSAL,NOMCAP,SAL3Q,MXPROD,SHARE(15)
      COMMON/NEWPRC/EFELFAC
      COMMON/NEWPROX/BPRAMM(15)
      COMMON/NEWPRXX/NAME(15)
      COMMON/NEWPRZ/ZZ(30,8)
      COMMON/EXECUB/UPROF3(15),PROGOL(15),BETA1(15),ALP3,BETA2(15),
     1 IS(15),IPGR(15),ISO(15,3),UPROF9(15),BETA3(15),ALP4,BETAU,
     2 BETAL,ALP5,IPCG(15,3)
      COMMON/SUM1/I(6)
      COMMON/SUM2/SUMPR,SUMXPR,SUMPR2
      COMMON/SUM3/NREP
      DIMENSION XX(10,19)
 2001 FORMAT(3X,2F5.0,2F4.0,F2.0,F6.5,F6.0,F4.3,F4.2,F5.0,F6.0,
     +F7.0,F4.0,F5.2,/,3X,2(F9.2,F6.2),F5.3)
 2002 FORMAT(I3,2F6.0,2F5.2,F3.0,F7.5,F7.0,
     +F5.3,F5.2,F6.0,F7.0,F8.0,F4.0,F6.2,F9.2,
     +F6.2,F9.2,F6.2,F6.3)
 2003 FORMAT(1X,I2,F15.5)
 2010 FORMAT(////,1X,* K*,8X,*PREO*,5X,*EFEL2*,
     +8X,*AA*,8X,*PMEL*,5X,*SALMAX*,
     +9X,*CUMCST*,4X,*AVCOIN*,9X,*UPROF9*,9X,*UPROF3*,/,
     +6X,*ORD*,6X,*EFEL1*,3X,*ITIME*,11X,*KON*,6X,*PREL*,7X,*CUMPRO*,
     +7X,*SETUP*,10X,*PROF9*,10X,*PROF3*,7X,*BPRAMM*,//)
 2011 FORMAT(1H1)
 2012 FORMAT(10X,*REPLICATION NO.*,I4,10X,*SEED =*,F15.5,/)
 3001 FORMAT(13X,2F4.2,2X,F6.5,F6.0,
```

```
     +F4.3,F4.2,18X,F4.0,/,33X,F5.3)
3002  FORMAT(15X,2F5.2,3X,F7.5,
     +F7.0,F5.3,F5.2,21X,F4.0,36X,F6.3)
      TYPE REAL INV,ICOST
C     INITIAL CONDITIONS
C     READ ATTRIBUTES OF EXISTING PRODUCTS
      DO 2020 K=1,10
      READ 2001,(XX(K,KK),KK=1,19)
2020  CONTINUE
C     READ REPLICATION NO. AND RANDOM NO.SEED
      READ 2003,NREP,SEED
C     SET SEED FOR RANDOM NUMBER GENERATOR
      CALL RANSET(SEED)
      DUM=RANF(-1)
      DUM=RANF(-1)
C     READ ATTRIBUTES OF FUTURE PRODUCTS
      DO 3003 M=1,30
      READ 3001,(ZZ(M,KK),KK=1,8)
3003  CONTINUE
C     PRINT OUT PRODUCT ATTRIBUTE VALUES
      PRINT 2010
      DO 2005 K=1,10
2005  PRINT 2002,K,(XX(K,KK),KK=1,19)
      DO 2006 M=1,30
2006  PRINT 3002,(ZZ(M,KK),KK=1,8)
C     PRINT HEADINGS FOR OUTPUT
      PRINT 2011
      PRINT  2012,NREP,SEED
      NVAR=6
      NRUNS=2**NVAR
C     ALGORITHM FOR GENERATING ZERO-ONE VALUES OF EXPERIMENTAL VARIABLES
      DO 9000 JJJ=1,NRUNS
      AAA=JJJ-1.
      KKK=1
9003  BBB=INT(AAA/2.)
      I(NVAR-KKK+1)=INT(AAA-2.*BBB)
      AAA=BBB
      IF(KKK-NVAR)9001,9002,9001
9001  KKK=KKK+1
      GO TO 9003
9002  CONTINUE
      SIG1=0.025
      IF(I(1).EQ.1) SIG1=0.10
      EFELFAC=I(2)
      INVFAC=I(3)
      SLSCOM=I(4)
      PART=I(5)
      ANEEDI=I(6)
      SUMPR=SUMXPR=SUMPR2=0
      NPROD=10
      NSALS=6
      LENGTH=100
      MXPROD=15
      DO 2009 K=1,NPROD
      DO 2102 L=1,NSALS
```

```
      ORDERS(K,L)=XX(K,1)
      EFFEL(K,L)=1.0
      IF(EFELFAC.EQ.0.) GO TO 30
32    EFFEL(K,L)=XX(K,3)
30    CONTINUE
2102  PREORD(K,L)=XX(K,2)
      ITIME(K)=XX(K,5)
      AA(K)=XX(K,6)
      KON(K)=XX(K,7)
      PMEL(K)=XX(K,8)
      PREL(K)=XX(K,9)
      SALMAX(K)=XX(K,10)
      CUMPRO(K)=NSALS*XX(K,11)
      CUMCST(K)=NSALS*XX(K,12)
      SETUP(K)=NSALS*XX(K,13)
      AVCOIN(K)=XX(K,14)
      PROF9(K)=NSALS*XX(K,15)
      UPROF9(K)=XX(K,16)
      PROF3(K)=NSALS*XX(K,17)
      UPROF3(K)=XX(K,18)
      BPRAMM(K)=XX(K,19)
2009  CONTINUE
      DO 10  L=1,NSALS
      EFPART(L)=0.
      DO 10  K=1,NPROD
      DELOR(K,L)=ORDERS(K,L)-PREORD(K,L)
      FORC(K,L)=ORDERS(K,L)
      SAVE(K,L)=PREORD(K,L)
      EFF(K,L)=1.0
      PEFF(K,L)=0.99
10    CONTINUE
      ITIQ=0
      DELP=0.01
      DELPAR=0.05
      STOIC=3.00
      ICOST=19.
      FCOS=2000*NPROD*NSALS
      SUMX=SUMX2=SUMY=SUMY2=SUMXY=0
      TQSAL=0
      NOMCAP=1000*NPROD*NSALS
      SAL3Q=3*NOMCAP
      BETAU=1.2
      BETAL=0.8
      ALP1=0.5
      ALP3=0.02
      ALP4=0.02
      ALP5=0.05
      ALP7=0.5
      DUM=0.999
      DO 20  K=1,NPROD
      DUM=DUM+.001
      PRES(K)=DUM
      NAME(K)=K
      PROF(K)=PROF3(K)
      UPROF(K)=UPROF3(K)
```

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```
      TSAL(K)=NSALS*ORDERS(K,1)
      INV(K)=0.2*TSAL(K)
      UINL(K)=0.3*TSAL(K)
      RINL(K)=0.1*TSAL(K)
      DROP(K)=0
      RPC(K)=RPI(K)=0
      ITRPI(K)=0
      ITRPC(K)=1
      PROM(K)=1000*NSALS
      PRICE(K)=20
      LOSTSL(K)=0
      SHARE(K)=TSAL(K)/NOMCAP
      PROGOL(K)=UPROF3(K)
      IS(K)=0
      IPGR(K)=0
      ISO(K,1)=1
      ISO(K,2)=2
      ISO(K,3)=3
      IPCG(K,1)=IPCG(K,2)=IPCG(K,3)=0
      BETA1(K)=0.2
      BETA2(K)=0.2
      BETA3(K)=1.0
      QSAL(K)=0
      PRFD(K)=PRICE(K)**PREL(K)
      PMFD(K)=PROM(K)**PMEL(K)
      IFORC(K)=0
20    CONTINUE
      DO 1000 KLOCK = 1, LENGTH
C                                           CALL MONTHLY SUBROUTINES
      CALL FCAST
      CALL INVENT
      CALL GENPRO
      CALL PRREC
      CALL SLSMEN
      CALL SLSGEN
      CALL BOOK
C                                           ADVANCE TIME-IN-QUARTER COUNTER
      ITIQ = ITIQ + 1
C                                           HAS QUARTER ENDED
      IF (ITIQ.LT.3) GO TO 1000
C                                           CALL QUARTERLY SUBROUTINES
      CALL NEWPRO
      CALL EXEC
1000  CONTINUE
5999  CONTINUE
C     CALL OUTPUT ROUTINE
      CALL SUMARY(LENGTH)
9000  CONTINUE
      END
```

```
      SUBROUTINE FCAST
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/FCASTB/DELOR(15,6),ALP1,FORC(15,6)
      COMMON/FCASTC/SAVE(15,6)
      COMMON/FCASTD/TSLFOR
C                                           FORECAST SALES
C                                           ZERO OUT TOTAL SALES FORECAST
      TSLFOR = 0.
      DO 149 K = 1, NPROD
C                                           INDEX PREVIOUS FORECAST
      PFORC(K) = TFORC(K)
C                                           ZERO OUT FORECAST FOR PRODUCT K
      TFORC(K) = 0.
      DO 148 L = 1, NSALS
C                                           FORECAST CHANGE IN SALES
      PSAVE=SAVE(K,L)
      SAVE(K,L)=ALP1*ORDERS(K,L)+(1-ALP1)*FORC(K,L)
      CHANGE=SAVE(K,L)-PSAVE
      PDELOR(K,L)=DELOR(K,L)
      DELOR(K,L)=ALP1*CHANGE+(1-ALP1)*DELOR(K,L)
      FORC(K,L)=SAVE(K,L)+(ALP1*DELOR(K,L)/(1-ALP1))
      IF (FORC(K,L).LT.0.) FORC(K,L) = 0.
C                                           ACCUMULATE FORECAST FOR PRODUCT K
      TFORC(K) = TFORC(K) + FORC(K,L)
  148 CONTINUE
C                                           ACCUMULATE TOTAL SALES FORECAST
      TSLFOR = TSLFOR + TFORC(K)
  149 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE GENPRO
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/GENPRB/SCHED,ERR
      TYPE REAL INV
C                                           ZERO OUT TOTAL PRODUCTION
      TPROD=0.
      DO 249 K=1,NPROD
      ACTPRO(K)=0.
C                                           IS PRODUCT K TO BE DROPPED
      IF (DROP(K).EQ.1) GO TO 249
C                                           SCHEDULE PRODUCTION
      SCHED = TFORC(K)-INV(K) + SCINL(K)
C                                           GENERATE PRODUCTION
C                                           GENERATE ERROR
      ACTPRO(K)=SCHED*(1+.025*RNDUM(X))
C                                           ACCUMULATE TOTAL PRODUCTION
      TPROD=TPROD+ACTPRO(K)
  249 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE INVENT
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PUELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/INVNTB/ALP7
      COMMON/INVNTC/INVFAC
      TYPE REAL INV
C                                             SCHEDULING OF INVENTORY
C                                             INVENTORY ON HAND IS AVAILABLE
C                                             FROM SUBROUTINE BOOK
      DO 199 K = 1, NPROD
C                                             ADJUST LIMITS ON INVENTORY
      UINL(K) = ALP7*UINL(K) + (1-ALP7)*TSAL(K)*0.3
      RINL(K) = ALP7*RINL(K) + (1.-ALP7)*TSAL(K)*0.1
C                                             COMPARE INVENTORY WITH LIMITS
C                                             IS PRESENT INVENTORY WITHIN UPPER LIMIT
      IF (INV(K).LE.UINL(K)) GO TO 151
C                                             UPPER LIMIT EXCEEDED
C                                             SCHEDULE DECREASED LEVEL
      SCINL(K)=INV(K)+0.5*(UINL(K)-INV(K))
      IF(INVFAC.EQ.0.) GO TO 161
C                                             INCREASE PRESSURE ON SALES DEPT
      PRES(K) = PRES(K) + DELP
      PRES(K) = AMIN1(PRES(K),1.2)
161   CONTINUE
C                                             LOWER LIMITS ON INVENTORY
      UINL(K) = .95*UINL(K)
      RINL(K) = .95*RINL(K)
      GO TO 199
C                                             IS PRESENT INVENTORY WITHIN LOWER LIMIT
151   IF (INV(K).GE.RINL(K)) GO TO 152
C                                             BELOW LOWER LEVEL
C                                             SCHEDULE INCREASED LEVEL
      SCINL(K)=INV(K)+0.5*(RINL(K)-INV(K))
      IF(INVFAC.EQ.0.) GO TO 162
C                                             DECREASE PRESSURE ON SALES DEPT
      PRES(K) = PRES(K) - DELP
      PRES(K) = AMAX1(PRES(K),0.8)
162   CONTINUE
C                                             RAISE LIMITS ON INVENTORY
      UINL(K) = 1.05*UINL(K)
      RINL(K) = 1.05*RINL(K)
      GO TO 199
C                                             NEITHER LIMIT BREECHED
152   SCINL(K) = INV(K) + 0.01*(INV(K))
199   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PRREC
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/PRRECB/RPC(15),RPI(15),ITRPI(15),ITRPC(15)
C                                  PRICE AND PROMOTION RECOMMENDATIONS
      DO 324 K = 1,NPROD
C                                  IS CURRENT FORECAST HIGHER THAN PREVIOU
      IF (TFORC(K).LE.PFORC(K)) GO TO 320
C                                  CURRENT FORECAST HIGHER
C                                  WAS PREVIOUS FORECAST MET
 310  IF (TSAL(K).GE.PFORC(K)) GO TO 318
C                                  PREVIOUS FORECAST NOT MET
C                                  INCREASE PRESSURE ON SALES DEPT.
 312  PRES(K)=PRES(K)+DELP
      PRES(K)=AMIN1(PRES(K),1.2)
C                                  WAS PROMOTION INCREASE REQUESTED
C                                  MORE RECENT THAN PRICE CUT REQUEST
      IF(RPC(K).EQ.1.OR.RPI(K).EQ.1) GO TO 324
      IF(ITRPI(K).LT.ITRPC(K)) GO TO 316
C                                  REQUEST PRICE CUT
 314  RPC(K)=1
      ITRPC(K)= KLOCK
      GO TO 324
C                                  REQUEST PROMOTION INCREASE
 316  RPI(K)=1
      ITRPI(K)=KLOCK
      GO TO 324
C                                  PREVIOUS FORECAST MET
C                                  DECREASE PRESSURE ON SALES DEPT.
 318  PRES(K)=PRES(K)-DELP
      PRES(K)=AMAX1(PRES(K),0.8)
      GO TO 324
C                                  CURRENT FORECAST NOT HIGHER
C                                  WAS PREVIOUS FORECAST MET
 320  IF(TSAL(K).GT.PFORC(K)) GO TO 324
C                                  PREVIOUS FORECAST NOT MET
C                                  REQUEST PROMOTION INCREASE
      RPI(K)=1
      ITRPI(K)=KLOCK
C                                  INCREASE PRESSURE ON SALES DEPT
      PRES(K)=PRES(K)+DELP
      PRES(K)=AMIN1(PRES(K),1.2)
 324  CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SLSMEN
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/SLSMNB/BASIS(15),MKTRNK(15),DOORD,DEFF,PEFF(15,6),
     1 RESRNK(15,6),RNK(15),PERD1(15),PART,SMRNK(15,6),PERD2,DPERD,
     2 EFPART(15),DELPAR,MOTFOR(15),VOLRNK(15),SLSRNK(15),RNKFAC
      COMMON/SLSMNC/DVDE(15,6)
      COMMON/SLS1/ANEEDI
      COMMON/SLS2/SLSCOM
      COMMON/BOOKB/TPROF,PREINV(15),INHCOS(15),CUMPRO(15),
     1 CUMCST(15),ICOST,BPRAM,COSTPR(15),SETUP(15),AVCOIN(15),COSTS(15),
     2 FCOS,REV,PROF(15),UPROF(15),SUMX,SUMX2,SUMY,SUMY2,SUMXY
     3,UCSTPR(15)
      COMMON/EXECUB/UPROF3(15),PROGOL(15),BETA1(15),ALP3,BETA2(15),
     1 IS(15),IPGR(15),ISO(15,3),UPROF9(15),BETA3(15),ALP4,BETAU,
     2 BETAL,ALP5,IPCG(15,3)
      TYPE REAL MOTFOR,MKTRNK
      A=0.075
C     RANK PRODUCTS ON THE BASIS OF PRESSURE FROM THE MARKET MANAGER
      DO 501 K=1,NPROD
  501 BASIS(K)=-PRES(K)
      CALL RANK(NPROD,BASIS,MKTRNK)
C     CALCULATE MARGINAL RESPONSE TO MARGINAL EFFORT
      DO 539 L=1,NSALS
      DO 514 K=1,NPROD
C     CALCULATE MARGINAL RESPONSE OF ORDERS
      DDORD=(ORDERS(K,L)-PREORD(K,L))-PDELOR(K,L)
C     CALCULATE MARGINAL EFFORT
      DEFF=(EFF(K,L)-PEFF(K,L))*1000.
      IT=DEFF
      DEFF=IT/10.
      IF(DEFF) 512,510,512
  510 BASIS(K)=0.
      GO TO 513
C     CALCULATE MARGINAL RESPONSE
  512 BASIS(K)=-(DDORD/DEFF)
 513  CONTINUE
      DVDE(K,L)=BASIS(K)
  514 CONTINUE
C     RANK PRODUCTS ON BASIS OF MARGINAL RESPONSE
      CALL RANK(NPROD,BASIS,RNK)
      DO 525 K=1,NPROD
      RESRNK(K,L)=RNK(K)
 525  CONTINUE
C     CALCULATE FIRST PERCEIVED DIFFERENCE IN RANKINGS
      PERD1(L)=0
      DO 530 K=1,NPROD
  530 PERD1(L)=PERD1(L)+ABS(MKTRNK(K)-RESRNK(K,L))
  539 CONTINUE
      IF(SLSCOM.EQ.0) GO TO 5551
C     CALCULATE AVERAGE RESPONSE FOR SALES REGION 1
      JJ=NSALS/2
```

```
      DO 5550 K=1,NPROD
      DUM=0.
      DO 5541 L=1,JJ
 5541 DUM=DUM+DVDE(K,L)
      DO 5542 L=1,JJ
 5542 DVDE(K,L)=DUM/JJ
C     CALCULATE AVERAGE RESPONSE FOR SALES REGION 2
      JJ1=JJ+1
      DUM=0.
      DO 5543 L=JJ1,NSALS
 5543 DUM=DUM+DVDE(K,L)
      DO 5544 L=JJ1,NSALS
 5544 DVDE(K,L)=DUM/JJ
 5550 CONTINUE
 5551 CONTINUE
C     ADJUSTMENT IN SALES MANAGERS RANKING DUE TO PARTICIPATION OF SALESMEN
      DO 1000 L=1,NSALS
C     CALCULATE MARGINAL CONTRIBUTION PER MARGINAL UNIT OF EFFORT
      DO 540 K=1,NPROD
 540  BASIS(K)=(PRICE(K)-UCSTPR(K))*DVDE(K,L)
C     RANK ON BASIS OF MARGINAL CONTRIBUTION
      CALL RANK(NPROD,BASIS,RNK)
C     IS PARTICIPATION PERMITTED
      IF(PART.NE.1.) GO TO 550
C     RANK ON BASIS OF MARGINAL CONTRIBUTION RANK AND PRIORITY
C     RANKING FROM MARKETING V.P.
      DO 541 K=1,NPROD
 541  BASIS(K)=RNK(K)+MKTRNK(K)
C     CALCULATE SALES MGRS RANKING
      CALL RANK(NPROD,BASIS,RNK)
      GO TO 559
 550  CONTINUE
C     RANK ON BASIS OF PRIORITY RANK FROM MARKETING V.P.
      DO 558 K=1,NPROD
 558  RNK(K)=MKTRNK(K)
  559 CONTINUE
C     CALCULATE 2ND PERCEIVED DIFFERENCE IN RANKINGS
      PERD2=0
      DO 560 K=1,NPROD
      SMRNK(K,L)=RNK(K)
  560 PERD2=PERD2+ABS(SMRNK(K,L)-RESRNK(K,L))
      DUM=1.0
      IF(ANEEDI.EQ.0.) GO TO 576
C     CALCULATE CHANGE IN PERCEIVED DIFFERENCE
      DPERD=PERD1(L)-PERD2
C     ADJUST EFFECTS OF PARTICIPATION
C     HAS THERE BEEN A CHANGE IN PERCEIVED DIFFERENCE
      IF(DPERD.GT.0.) GO TO 573
C     REDUCE EFFECTS OF PARTICIPATION
      EFPART(L)=EFPART(L)-DELPAR
      GO TO 575
C     INCREASE EFFECTS OF PARTICIPATION
  573 EFPART(L)=EFPART(L)+(DELPAR*0.5*DPERD)
C     CALCULATE EFFECT PARAMETER
      IF(EFPART(L).GE.0.) GO TO 575
```

```
      DUM1=5.*ABS(EFPART(L))
      DUM=1.0-(0.025*(1.-EXP(-A*DUM1)))
      GO TO 576
575   CONTINUE
      DUM=0.05*(1.-EXP(-A*EFPART(L)))+1.0
576   CONTINUE
C     CALCULATE MOTIVATING FORCE
      DO 579 K=1,NPROD
  579 MOTFOR(K)=DUM*PRES(K)
      DO 582 K=1,NPROD
582   BASIS(K)=-ORDERS(K,L)
      CALL RANK(NPROD,BASIS,VOLRNK)
C     MAKE SALESMANS FINAL RANKING
      DO 587 K=1,NPROD
      BASIS(K)=SMRNK(K,L)+VOLRNK(K)
587   CONTINUE
      CALL RANK(NPROD,BASIS,SLSRNK)
C     CALCULATE RANK-FACTOR
      DUMM=NPROD/2.
      DO 592 K=1,NPROD
      IT=SLSRNK(K)
      DUM=IT-DUMM-0.5
      RNKFAC=1.0-(0.04444*DUM)
C     INCREMENT PREVIOUS EFFORT
      PEFF(K,L)=EFF(K,L)
C     CALCULATE NEW EFFORT
  592 EFF(K,L)=MOTFOR(K)*RNKFAC
1000  CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SLSGEN
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/SLSGNB/TORD(15),AA(15),DEM,KON(15),PRFD(15),PMEL(15),
     1 PREL(15),PMFD(15),NOISE,SIG1,LOSTSL(15)
      COMMON/SLSGNC/TTSAL
      COMMON/SLSGND/EFFEL(15,6)
      COMMON/SLSGNX/NOMDEM(15)
      COMMON/NEWPROX/BPRAMM(15)
      TYPE REAL NOISE,INV
C     ZERO OUT TOTAL SALES OF ALL PRODUCTS
      TTSAL=0.
C     SALES GENERATION
      DO 749 K=1,NPROD
C     ADVANCE DEMAND GENERATING TIME PARAMETER
      ITIME(K)=ITIME(K)+1
C     ZERO OUT TOTAL ORDERS OF K
      TORD(K)=0.
C     CALCULATE NOMINAL DEMAND FROM WIEBULL EQUATION
      DUM=-1*AA(K)*((ITIME(K)+2)**2)
      DEM=KON(K)*AA(K)*(ITIME(K)+2)*EXP(DUM)
      DUM=DEM
C     SAVE NOMINAL DEMAND
      NOMDEM(K)=DEM
C     CALCULATE MAX PAST NOMINAL DEMAND
      SALMAX(K)=AMAX1(SALMAX(K),DEM)
C     ADJUST DEMAND DUE TO PRICE AND PROMOTION FACTORS
      DEM=(DEM*PRFD(K)*(PROM(K)**PMEL(K)))/
     +((PRICE(K)**PREL(K))*PMFD(K))
      DO 710 L=1,NSALS
C     RESET PREVIOUS PERIODS ORDERS
      PREORD(K,L)=ORDERS(K,L)
  710 CONTINUE
      SCALE=2000.
      JJ=NSALS/2
      JJ1=JJ+1
      DO 730 L=1,JJ
      IF(DROP(K).EQ.1.) GO TO 720
C     GENERATE RANDOM DEVIATION FROM NOMINAL DEMAND
      NOISE=SIG1*DUM*RNDUM(ERR)
      GO TO 721
 720  NOISE=0.
 721  CONTINUE
C     GENERATE EFFORT DEVIATION
      DEV=DEM*(EFF(K,L)-EFF(K,L)**EFFEL(K,L))
      DEV=2.*DEV
C     GENERATE ORDERS
      ORDERS(K,L)=DEM*EFF(K,L)-DEV+NOISE
 730  CONTINUE
      DO 731 L=JJ1,NSALS
      IF(DROP(K).EQ.1.) GO TO 722
C     GENERATE RANDOM DEVIATION FROM NOMINAL DEMAND
```

```
      NOISE=SIG1*DUM*RNDUM(ERR)
      GO TO 723
722   NOISE=0.
723   CONTINUE
C     GENERATE EFFORT DEVIATION
      DEV=DEM*(EFF(K,L)-EFF(K,L)**EFFEL(K,L))
      DEV=2.*DEV
C     GENERATE ORDERS
      ORDERS(K,L)=DEM*EFF(K,L)+DEV+NOISE
731   CONTINUE
      DO 711 L=1,NSALS
711   TORD(K)=TORD(K)+ORDERS(K,L)
C     CALCULATE AMOUNT OF K AVAILABLE
      DUM=ACTPRO(K)+INV(K)
C     DO ORDERS EXCEED AMOUNT AVAILABLE
      IF(TORD(K).LE.DUM) GO TO 715
C     SET TOTAL SALES EQUAL TO AMOUNT AVAILABLE
      TSAL(K)=DUM
C     RAISE INVENTORY LIMITS
      UINL(K)=1.05*UINL(K)
      RINL(K)=1.05*RINL(K)
      GO TO 716
C     SET TOTAL SALES EQUAL TO TOTAL ORDERS
  715 TSAL(K)=TORD(K)
C     ACCUMULATE SALES OF ALL PRODUCTS
716   TTSAL=TTSAL+TSAL(K)
C     ACCUMULATE QUARTERLY SALES
      QSAL(K)=QSAL(K)+TSAL(K)
  749 CONTINUE
      RETURN
      END
```

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      SUBROUTINE BOOK
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/SLSGNC/TTSAL
      COMMON/SLSGNB/TORD(15),AA(15),DEM,KON(15),PRFD(15),PMEL(15),
     1 PREL(15),PMFD(15),NOISE,SIG1,LOSTSL(15)
      COMMON/SLSGND/EFFEL(15,6)
      COMMON/SLSGNX/NOMDEM(15)
      COMMON/BOOKB/TPROF,PREINV(15),INHCOS(15),CUMPRO(15),
     1 CUMCST(15),ICOST,BPRAM,COSTPR(15),SETUP(15),AVCOIN(15),COSTS(1
     2 FCOS,REV,PROF(15),UPROF(15),SUMX,SUMX2,SUMY,SUMY2,SUMXY
     3,UCSTPR(15)
      COMMON/BOOKC/STOIC
      COMMON/FCASTB/DELOR(15,6),ALP1,FORC(15,6)
      COMMON/FCASTC/SAVE(15,6)
      COMMON/PRRECB/RPC(15),RPI(15),ITRPI(15),ITRPC(15)
      COMMON/SLSMNB/BASIS(15),MKTRNK(15),DOORD,DEFF,PEFF(15,6),
     1 RESRNK(15,6),RNK(15),PERD1(15),PART,SMRNK(15,6),PERD2,DPERD,
     2 EFPART(15),DELPAR,MOTFOR(15),VOLRNK(15),SLSRNK(15),RNKFAC
      COMMON/NEWPRB/ITIQ,TPQSAL,TQSAL,NOMCAP,SAL3Q,MXPROD,SHARE(15)
      COMMON/NEWPROX/BPRAMM(15)
      COMMON/NEWPRXX/NAME(15)
      COMMON/EXECUB/UPROF3(15),PROGOL(15),BETA1(15),ALP3,BETA2(15),
     1 IS(15),IPGR(15),ISO(15,3),UPROF9(15),BETA3(15),ALP4,BETAU,
     2 BETAL,ALP5,IPCG(15,3)
      COMMON/SUM2/SUMPR,SUMXPR,SUMPR2
      TYPE REAL INV,ICOST
      TYPE REAL INHCOS
C     CALCULATE PROFITS AND OTHER BOOKKEEPING
C     ZERO OUT TOTAL PROFIT
      TPROF=0.
      DO 799 K=1,NPROD
C     INDEX PREVIOUS INVENTORY VALUE
      PREINV(K)=INV(K)
C     CALCULATE INVENTORY ON HAND
      INV(K)=ACTPRO(K)+PREINV(K)-TSAL(K)
      INV(K)=AMAX1(INV(K),0.0)
C     CALCULATE INVENTORY HOLDING COST
      INHCOS(K)=((INV(K)+PREINV(K))/2)*STOIC
C     CALCULATE COST OF PRODUCTION
      COSTPR(K)=UCSTPR(K)=0.
      IF(ACTPRO(K).EQ.0.) GO TO 785
C     CALCULATE NEW CUMULATIVE PRODUCTION TOTAL
      CUMPRO(K)=CUMPRO(K)+ACTPRO(K)
C     INCREMENT OLD CUMULATIVE TOTAL PRODUCTION COST
      DUM=CUMCST(K)
C     CALCULATE NEW CUMULATIVE TOTAL PRODUCTION COST
      BPRAM=BPRAMM(K)
      CUMCST(K)=(ICOST*(CUMPRO(K)**(BPRAM+1.)))/(BPRAM+1.)
C     CALCULATE PRODUCTION COST FOR THIS PERIOD
      COSTPR(K)=(CUMCST(K)-DUM)+SETUP(K)
C     CALCULATE UNIT COST OF PRODUCTION
```

```
      PMFD(I)=PMFD(I+1)
      BPRAMM(I)=BPRAMM(I+1)
      PRICE(I)=PRICE(I+1)
      PREL(I)=PREL(I+1)
      PRFD(I)=PRFD(I+1)
      LOSTSL(I)=LOSTSL(I+1)
      QSAL(I)=QSAL(I+1)
      SALMAX(I)=SALMAX(I+1)
      PREINV(I)=PREINV(I+1)
      CUMPRO(I)=CUMPRO(I+1)
      CUMCST(I)=CUMCST(I+1)
      DO  9  L=1,NSALS
      PDELOR(I,L)=PDELOR(I+1,L)
      DELOR(I,L)=DELOR(I+1,L)
      ORDERS(I,L)=ORDERS(I+1,L)
      PREORD(I,L)=PREORD(I+1,L)
      SAVE(I,L)=SAVE(I+1,L)
      FORC(I,L)=FORC(I+1,L)
      EFF(I,L)=EFF(I+1,L)
      PEFF(I,L)=PEFF(I+1,L)
      EFFEL(I,L)=EFFEL(I+1,L)
 9    CONTINUE
      UCSTPR(I)=UCSTPR(I+1)
      SETUP(I)=SETUP(I+1)
      PROF(I)=PROF(I+1)
      PROF3(I)=PROF3(I+1)
      PROF9(I)=PROF9(I+1)
      UPROF(I)=UPROF(I+1)
      UPROF3(I)=UPROF3(I+1)
      UPROF9(I)=UPROF9(I+1)
      SHARE(I)=SHARE(I+1)
      PROGOL(I)=PROGOL(I+1)
      BETA1(I)=BETA1(I+1)
      BETA2(I)=BETA2(I+1)
      IS(I)=IS(I+1)
      IPGR(I)=IPGR(I+1)
      ISO(I,1)=ISO(I+1,1)
      ISO(I,2)=ISO(I+1,2)
      ISO(I,3)=ISO(I+1,3)
      IPCG(I,1)=IPCG(I+1,1)
      IPCG(I,2)=IPCG(I+1,2)
      IPCG(I,3)=IPCG(I+1,3)
      BETA3(I)=BETA3(I+1)
 10   CONTINUE
      K=K-1
 9799 CONTINUE
      IF(K.LT.NPROD) GO TO 9798
      IF(KLOCK.LE.10) GO TO 791
 C    ACCUMULATE SUMMARY STATISTICS
      SUMX=SUMX+KLOCK
      SUMX2=SUMX2+(KLOCK**2)
 C    ZERO-OUT PRESSURE SUMMATION TERM
      SUBP=0.
 C    SUM UP PRESSURE VALUES
      DO 793 K=1,NPROD
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      UCSTPR(K)=(CUMCST(K)-DUM)/ACTPRO(K)
C     CALCULATE AVE COST OF INVENTORY
785   IF(ACTPRO(K).EQ.0.0.AND.PREINV(K).EQ.0.0) GO TO 786
      AVCOIN(K)=(COSTPR(K)+AVCOIN(K)*PREINV(K))/(ACTPRO(K)+PREINV(K))
      GO TO 787
786   AVCOIN(K)=0.
787   CONTINUE
C     CALCULATE COSTS FOR PRODUCT K
      COSTS(K)=(TSAL(K)*AVCOIN(K))+PROM(K)+INHCOS(K)+
     +FCOS*(TSAL(K)/TTSAL)
C     CALCULATE REVENUE
      REV=PRICE(K)*TSAL(K)
C     CALCULATE PAST 9 MONTH AVERAGE PROFIT
      PROF9(K)=.2*PROF(K)+.8*PROF9(K)
      UPROF9(K)=.2*UPROF(K)+.8*UPROF9(K)
C     CALCULATE PROFIT
      PROF(K)=REV-COSTS(K)
C     CALCULATE UNIT PROFIT
      UPROF(K)=0.
      IF(TSAL(K).EQ.0.) GO TO 789
      UPROF(K)=PROF(K)/TSAL(K)
C     ACCUMULATE TOTAL PROFIT
  789 TPROF=TPROF+PROF(K)
C     CALCULATE CURRENT 3 MONTH AVERAGE PROFIT
      PROF3(K)=.5*PROF(K)+.5*PROF3(K)
      UPROF3(K)=.5*UPROF(K)+.5*UPROF3(K)
799   CONTINUE
C     BEGIN LOOP FOR INDEXING OF PARAMETERS WHEN A PRODUCT IS DROPPED
      K=0
9798  K=K+1
C     IS PRODUCT K TO BE DROPPED
      IF(DROP(K).NE.1.OR.INV(K).NE.0.0) GO TO 9799
C     ADJUST PARAMETERS
C     ADJUST PARAMETERS
      NPROD=NPROD-1
      DO 10  I=K,NPROD
      NAME(I)=NAME(I+1)
      PFORC(I)=PFORC(I+1)
      TFORC(I)=TFORC(I+1)
      UINL(I)=UINL(I+1)
      RINL(I)=RINL(I+1)
      TSAL(I)=TSAL(I+1)
      INV(I)=INV(I+1)
      PRES(I)=PRES(I+1)
      DROP(I)=DROP(I+1)
      NOMDEM(I)=NOMDEM(I+1)
      RPC(I)=RPC(I+1)
      RPI(I)=RPI(I+1)
      ITRPI(I)=ITRPI(I+1)
      ITRPC(I)=ITRPC(I+1)
      ITIME(I)=ITIME(I+1)
      AA(I)=AA(I+1)
      KON(I)=KON(I+1)
      PROM(I)=PROM(I+1)
      PMEL(I)=PMEL(I+1)
```

```
793   SUBP=SUBP+PRES(K)
C     CALCULATE AVERAGE PRESSURE VALUE
      SUMPR=SUMPR+(SUBP/NPROD)
      SUMXPR=SUMXPR+(KLOCK*SUBP/NPROD)
      SUMPR2=SUMPR2+(SUBP/NPROD)**2
      TPROF=TPROF/1000.
      SUMY=SUMY+TPROF
      SUMXY=SUMXY+(KLOCK*TPROF)
      IF(TPROF.EQ.0.) RETURN
      SUMY2=SUMY2+(TPROF**2)
791   CONTINUE
      RETURN
      END
```

NEWPRO CDC 6400 FTN V3.0-L260 OPT=1 0

```
      SUBROUTINE NEWPRO
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/NEWPRB/ITIQ,TPQSAL,TQSAL,NOMCAP,SAL3Q,MXPROD,SHARE(15)
      COMMON/NEWPRC/EFELFAC
      COMMON/NEWPROX/BPRAMM(15)
      COMMON/NEWPRXX/NAME(15)
      COMMON/NEWPRZ/ZZ(30,8)
      COMMON/FCASTB/DELOR(15,6),ALP1,FORC(15,6)
      COMMON/FCASTC/SAVE(15,6)
      COMMON/PRRECB/RPC(15),RPI(15),ITRPI(15),ITRPC(15)
      COMMON/SLSMNB/BASIS(15),MKTRNK(15),DDORD,DEFF,PEFF(15,6),
     1 RESRNK(15,6),RNK(15),PERD1(15),PART,SMRNK(15,6),PERD2,DPERD,
     2 EFPART(15),DELPAR,MOTFOR(15),VOLRNK(15),SLSRNK(15),RNKFAC
      COMMON/SLSGNB/TORD(15),AA(15),DEM,KON(15),PRFD(15),PMEL(15),
     1 PREL(15),PMFD(15),NOISE,SIG1,LOSTSL(15)
      COMMON/SLSGND/EFFEL(15,6)
      COMMON/SLSGNX/NOMDEM(15)
      COMMON/BOOKB/TPROF,PREINV(15),INHCOS(15),CUMPRO(15),
     1 CUMCST(15),ICOST,BPRAM,COSTPR(15),SETUP(15),AVCOIN(15),COSTS(15),
     2 FCOS,REV,PROF(15),UPROF(15),SUMX,SUMX2,SUMY,SUMY2,SUMXY
     3,UCSTPR(15)
      COMMON/EXECUB/UPROF3(15),PROGOL(15),BETA1(15),ALP3,BETA2(15),
     1 IS(15),IPGR(15),ISO(15,3),UPROF9(15),BETA3(15),ALP4,BETAU,
     2 BETAL,ALP5,IPCG(15,3)
      TYPE REAL INV
C     NEW PRODUCT DECISION SECTOR
C     INDEX PREVIOUS QUARTER SALES
      TPQSAL=TQSAL
C     ACCUMULATE GRAND TOTAL QUARTERLY SALES
      TQSAL=0.
      DO 810 K=1,NPROD
      TQSAL=TQSAL+QSAL(K)
  810 CONTINUE
C     PRODUCT ELIMINATION DECISION
      DO 870 K=1,NPROD
      DUMX=0.50*SALMAX(K)
      IF(NOMDEM(K).LT.DUMX) GO TO 880
870   CONTINUE
      RETURN
  880 CONTINUE
C     DROP PRODUCT K
      DROP(K)=1.
C     ADD NEW PRODUCT
      NPROD=NPROD+1
C     SET PARAMETERS FOR NEW PRODUCT
C     SET INITIAL VALUES FOR NEW PRODUCT
      K=NPROD
      NAME(K)=NAME(K-1)+1
      M=NAME(K)-10
      AA(K)=ZZ(M,3)
      KON(K)=ZZ(M,4)
      END
```

```
      PMEL(K)=ZZ(M,5)
      PREL(K)=ZZ(M,6)
      SETUP(K)=ZZ(M,7)
      BPRAMM(K)=ZZ(M,8)
      DO 821 L=1,NSALS
      ORDERS(K,L)=200
      PREORD(K,L)=100
      DELOR(K,L)=100
      FORC(K,L)=ORDERS(K,L)
      SAVE(K,L)=PREORD(K,L)
      EFF(K,L)=1.0
      PEFF(K,L)=0.99
841   EFFEL(K,L)=1.0
      IF(EFELFAC.EQ.0.) GO TO 840
842   EFFEL(K,L)=ZZ(M,1)
840   CONTINUE
821   CONTINUE
      ITIME(K)=0
      SALMAX(K)=0.
      CUMPRO(K)=CUMCST(K)=0
      PRES(K)=1.0
      TSAL(K)=NSALS*ORDERS(K,1)
      UINL(K)=0.3*TSAL(K)
      RINL(K)=0.1*TSAL(K)
      INV(K)=0
      DROP(K)=0
      RPC(K)=RPI(K)=0
      ITRPI(K)=0
      ITRPC(K)=1
      PROM(K)=1000*NSALS
      PRICE(K)=20.
      LOSTSL(K)=0.
      SHARE(K)=0.
      PROGOL(K)=0.
      IS(K)=0
      IPGR(K)=0
      ISO(K,1)=1
      ISO(K,2)=2
      ISO(K,3)=3
      IPCG(K,1)=IPCG(K,2)=IPCG(K,3)=0
      BETA1(K)=0.2
      BETA2(K)=0.2
      BETA3(K)=1.0
      QSAL(K)=0
      PRFD(K)=20**PREL(K)
      PMFD(K)=PROM(K)**PMEL(K)
      TFORC(K)=0
      AVCOIN(K)=0
      PROF9(K)=0
      PROF3(K)=0
      PROF(K)=0.
      UPROF9(K)=0
      UPROF3(K)=0
      UPROF(K)=0.
      RETURN
```

```
      SUBROUTINE EXEC
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,5),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      COMMON/FCASTD/TSLFOR
      COMMON/NEWPRB/ITIQ,TPQSAL,TQSAL,NOMCAP,SAL3Q,MXPROD,SHARE(15)
      COMMON/EXECUB/UPROF3(15),PROGOL(15),BETA1(15),ALP3,BETA2(15),
     1 IS(15),IPGR(15),ISO(15,3),UPROF9(15),BETA3(15),ALP4,BETAU,
     2 BETAL,ALP5,IPCG(15,3)
      COMMON/PRRECB/RPC(15),RPI(15),ITRPI(15),ITRPC(15)
      COMMON/BOOKB/TPROF,PREINV(15),INHCOS(15),CUMPRO(15),
     1 CUMCST(15),ICOST,BPRAM,COSTPR(15),SETUP(15),AVCOIN(15),COSIS(15),
     2 FCOS,REV,PROF(15),UPROF(15),SUMX,SUMX2,SUMY,SUMY2,SUMXY
     3,UCSTPR(15)
      COMMON/BOOKC/STDIC
C     PRICE AND PROMOTION DECISIONS
C     DECREASE EMPHASIS ON RECENT FAILURE
      DO 999 K=1,NPROD
C     BYPASS PRICE AND PROMOTION DECISIONS IF PRODUCT IS NEW
      IF(ITIME(K).LE.6) GO TO 999
C     DID PROFIT EXCEED PROFIT GOAL
      IF(UPROF3(K).GT.PROGOL(K)) GO TO 930
C     REDUCE EMPHASIS ON RECENT SUCCESS
      BETA1(K)=BETA1(K)*(1-ALP3)
C     REDUCE PROFIT GOAL
      PROGOL(K)=(1.-BETA2(K))*PROGOL(K)+BETA2(K)*UPROF3(K)
      PROGOL(K)=AMAX1(0.0,PROGOL(K))
C     INDEX SEARCH COUNTER
      IS(K)=IS(K)+1
C     HAVE ALL ALTERNATIVES BEEN TRIED
      IF(IS(K)-4) 926,927,928
C     WAS SEARCH EMPLOYED
  926 IF(IS(K)-1) 935,935,929
C     SET INDEX FOR POSSIBLE PROFIT GOAL REDUCTION
  927 IPGR(K)=1
      GO TO 935
C     RESET SEARCH COUNTER
  928 IS(K)=1
C     ALTER ORDER OF SEARCH
  929 DUM=ISO(K,1)
      ISO(K,1)=ISO(K,2)
      ISO(K,2)=ISO(K,3)
      ISO(K,3)=DUM
      GO TO 935
C     INCREASE EMPHASIS ON RECENT SUCCESS
  930 BETA1(K)=ALP3*(1-BETA1(K))+BETA1(K)
C     RAISE PROFIT GOAL
      PROGOL(K)=(1-BETA1(K))*PROGOL(K)+BETA1(K)*UPROF3(K)
      PROGOL(K)=AMAX1(0.0,PROGOL(K))
C     WAS STRATEGY SEARCH EMPLOYED
      IF(IS(K)) 935,935,932
C     WAS PROFIT GOAL REDUCED
  932 IF(IS(K).GE.4) GO TO 933
```

```
      BETA2(K)=BETA2(K)*(1-ALP3)
      GO TO 934
C     INCREASE EMPHASIS ON RECENT FAILURE
  933 BETA2(K)=BETA2(K)+ALP3*(1-BETA2(K))
C     RESET SEARCH INDICATOR (SEARCH WAS SUCCESSFUL)
  934 IS(K)=0
C     WAS PRICE CHANGED TO INCREASE PROFIT
  935 IF(IPCG(K,1))950,950,936
C     WAS PROFIT GREATER THAN 9 MONTH AVERAGE PROFIT
  936 IF(UPROF3(K).GT.UPROF9(K)) GO TO 938
      IPCG(K,1)=IPCG(K,1)-3
C     WAS PRICE INCREASED
      IF(BETA3(K)-1) 940,941,941
  938 IPCG(K,1)=IPCG(K,1)+1
C     WAS PRICE INCREASED
      IF(BETA3(K)-1) 941,940,940
C     INCREASE PRICE CHANGE MULTIPLIER
  940 BETA3(K)=BETA3(K)+ALP4
      BETA3(K)=AMIN1(BETA3(K),BETAU)
      IPCG(K,1)=IPCG(K,1)-3
      GO TO 950
C     DECREASE PRICE CHANGE MULTIPLIER
  941 BETA3(K)=BETA3(K)-ALP4
      BETA3(K)=AMAX1(BETA3(K),BETAL)
      IPCG(K,1)=IPCG(K,1)+2
      GO TO 950
C     COMPUTE PROJECTED PROFITS
  950 DUM=PRJPRO(INV(K),STDIC,UCSTPR(K),TFORC(K),SETUP(K),FCOS,
     1TSLFOR,PRICE(K),PROM(K))
C     DO PROJECT PROFITS MEET PROFIT GOAL
      IF(DUM.GE.PROGOL(K)) GO TO 970
C     DENY PROMOTION INCREASE AND PRICE CUT REQUESTS
      RPI(K)=0
      RPC(K)=0
C     HAVE ALL STRATEGIES BEEN TRIED
      IF(IPGR(K).EQ.1) GO TO 960
C     SEARCH FOR NEW STRATEGY
      DUMM=ISO(K,1)
      IF(DUMM-2) 952,953,954
C     INCREASE PRESSURE ON SALES DEPARTMENT
  952 PRES(K)=PRES(K)+DELP
      GO TO 955
C     INCREASE PROMOTION
  953 PROM(K)=(1+ALP5)*PROM(K)
C     REVISE FORECAST
  955 TFORC(K)=1.03*TFORC(K)
      GO TO 956
C     DECREASE PROMOTION
  954 PROM(K)=(1-ALP5)*PROM(K)
C     REVISE PROJECTED PROFIT
  956 DUM=PRJPRO(INV(K),STDIC,UCSTPR(K),TFORC(K),SETUP(K),FCOS,
     1TSLFOR,PRICE(K),PROM(K))
      GO TO 961
C     REDUCE PROFIT GOAL
  960 PROGOL(K)=(1-BETA2(K))*PROGOL(K)+BETA2(K)*UPROF3(K)
```

```
      PROGOL(K)=AMAX1(0.0,PROGOL(K))
C     IS PROJECT PROFIT GREATER THAN PROFIT GOAL
  961 IF(DUM.GT.PROGOL(K)) GO TO 996
C     HAS PRICE RAISED SUCCESSFULLY OR DECREASED UNSUCCESSFULLY
      IF(IPCG(K,1)) 962,996,996
C     RAISE PRICE
  962 BETA3(K)=AMAX1(1.01,BETA3(K))
      PRICE(K)=BETA3(K)*PRICE(K)
      GO TO 995
C     CALCULATE PRICE CHANGE INDEX
  970 DUM=(IPCG(K,1)+IPCG(K,2)+IPCG(K,3))
C     IS THERE A REQUEST FOR A PRICE CUT
      IF(RPC(K).GT.0) GO TO 980
C     IS THERE A REQUEST FOR A PROMOTION INCREASE
      IF(RPI(K).GT.0.) GO TO 976
C     HAS PRICE CHANGED IN LAST 9 MONTHS
      IF(DUM.GT.0.) GO TO 996
C     CHANGE PRICE IN BEST PAST DIRECTION
      BETA3(K)=AMIN1(1.01,BETA3(K))
      BETA3(K)=AMAX1(.99,BETA3(K))
      PRICE(K)=BETA3(K)*PRICE(K)
      GO TO 995
C     INCREASE PROMOTION
  976 PROM(K)=(1+ALP5)*PROM(K)
      GO TO 996
C     HAS PRICE CHANGED IN LAST 9 MONTHS
  980 IF(DUM.GT.0.) GO TO 996
C     CUT PRICE
      BETA3(K)=AMIN1(.99,BETA3(K))
      PRICE(K)=BETA3(K)*PRICE(K)
      GO TO 995
C     UPDATE PRICE CHANGE INDEX
  995 DUM=1
      GO TO 997
C     UPDATE PRICE CHANGE INDEX
  996 DUM=0
C     UPDATE PRICE CHANGE RECORD
  997 IPCG(K,3)=IPCG(K,2)
      IPCG(K,2)=IPCG(K,1)
      IPCG(K,1)=DUM
  999 CONTINUE
C     QUARTERLY HOUSEKEEPING
C     CALCULATE 3-QUARTER SALES AVERAGE
      SAL3Q=0.5*TQSAL+0.5*SAL3Q
      DO 885 K=1,NPROD
C     CALCULATE 3-QUARTER AVERAGE SHARE OF TOTAL SALES
      SHARE(K)=0.5*(QSAL(K)/TQSAL)+0.5*SHARE(K)
C     ZERO OUT PRICE AND PROMOTION REQUESTS
      RPI(K)=RPC(K)=0.
C     ZERO-OUT QUARTER SALES
      QSAL(K)=0.
  885 CONTINUE
C     ZERO OUT TIME IN QUARTER
      ITIQ=0
  899 CONTINUE
      RETURN
      END
```

SUMARY CDC 6400 FTN V3.0-L260 OPT=1

```
      SUBROUTINE SUMARY(LENGTH)
      COMMON/BOOKB/TPROF,PREINV(15),INHCOS(15),CUMPRO(15),
     1 CUMCST(15),ICOST,BPRAM,COSTPR(15),SETUP(15),AVCOIN(15),COSTS(15),
     2 FCOS,REV,PROF(15),UPROF(15),SUMX,SUMX2,SUMY,SUMY2,SUMXY
     3,UCSTPR(15)
      COMMON/SUM1/I(6)
      COMMON/SUM2/SUMPR,SUMXPR,SUMPR2
      COMMON/SUM3/NREP
      DIMENSION IX(6)
      TYPE REAL MEAN
203   FORMAT(1X,I2,5X,6I2,F10.4,F10.5,F20.4,F10.4)
C                                                  CALCULATE MEAN
      MEAN=SUMY/(LENGTH-10)
      PMEAN=SUMPR/(LENGTH-10)
      DO 333 KL=1,6
333   IX(KL)=I(KL)+1
C                                                  CALCULATE VARIANCE
      VAR=((LENGTH-10)*SUMY2-SUMY**2)/(LENGTH-10)**2
      VARPR=((LENGTH-10)*SUMPR2-SUMPR**2)/((LENGTH-10)**2)
      SQVAR=SQRT(VAR)
      SQVPR=SQRT(VARPR)
      PRINT 203,NREP,(IX(KL),KL=1,6),PMEAN,SQVPR,MEAN,SQVAR
      PUNCH 203,NREP,(IX(KL),KL=1,6),PMEAN,SQVPR,MEAN,SQVAR
      RETURN
      END
```

```
      FUNCTION PRJPRO(INV,STOIC,UCSTPR,TFORC,SETUP,FCOS,
     +TSLFOR,PRICE,PROM)
      TYPE REAL INV
    9 FORMAT(20X,*TFORC IS 0.0*)
C     CALCULATION OF PROJECTED PROFIT
C     ESTIMATE TOTAL INVENTORY HOLDING COSTS
      DUM1=INV*STOIC
C     ESTIMATE PRODUCTION COSTS
      DUM2=UCSTPR*TFORC+SETUP
C     ESTIMATE FIXED COST ALLOCATION
      DUM3=0.0
      IT=TSLFOR
      IF(IT.EQ.0) GO TO 8
      DUM3=FCOS*(TFORC/TSLFOR)
C     ESTIMATE UNIT PROFIT
    8 IT=TFORC
      IF(IT.EQ.0) GO TO 10
      PRJPRO=PRICE-((DUM1+DUM2+DUM3+PROM)/TFORC)
      RETURN
   10 PRJPRO=0.
      PRINT 9
      RETURN
      END
```

RNDUM CDC 6400 FTN V3.0-L260 OPT=1 07/29

```
      FUNCTION RNDUM(X)
C     THIS SUBROUTINE GENERATES A RANDOM VARIABLE FROM A NORMAL DISTRIBUTION
C     WITH MEAN=0 AND STANDARD DEVEATION=1.0
      X=SQRT(-2.0*ALOG(RANF(-1.0)))*COS(6.283185307*RANF(-2.0))
      RNDUM=X
      RETURN
      END
```

RANK

```
      SUBROUTINE RANK(NP,BASIS,RNK)
      COMMON ACTPRO(15),DELP,DROP(15),EFF(15,6),INV(15),
     1ITIME(15),KLOCK,NPROD,NSALS,ORDERS(15,6),PDELOR(15,6),
     2PFORC(15),PREORD(15,6),PRES(15),PRICE(15),PROF3(15),PROF9(15),
     3PROM(15),QSAL(15),RINL(15),SALMAX(15),SCINL(15),TFORC(15),
     4TPROD,TSAL(15),UINL(15)
      TYPE INTEGER DUM1
      DIMENSION BASIS(15),RNK(15)
      DUMM=10.**7.
C     RANK LOWEST VALUE OF BASIS FIRST, HIGHEST VALUE OF BASIS LAST
      DO 20 J=1,NP
C     SET INITIAL VALUES OF DUMMY VARIABLES
      DUM1=1.
      DUM2=BASIS(1)
      DO 10 K=2,NP
C     COMPARE LOWEST NUMBER WITH NEXT VALUE OF BASIS
      IF(DUM2.LE.BASIS(K)) GO TO 10
      DUM1=K
C     LET DUM2 EQUAL NEW LOWEST VALUE
      DUM2=BASIS(K)
   10 CONTINUE
C     DEFINE RANK OF NEW LOWEST VALUE
      RNK(DUM1)=J
C     ASSIGN ARBITRARILY HIGH VALUE TO BASIS
      BASIS(DUM1)=DUMM
   20 CONTINUE
      RETURN
      END
```

APPENDIX IV

Initial Conditions Program

```
      PROGRAM IC(INPUT,OUTPUT,PUNCH)
 101  FORMAT(*1*,I2,2F5.0,2F4.2,I2,F6.5,I6,F4.3,F4.2,F5.0,F6.0,F7.0,
     +F4.0,F5.2)
 102  FORMAT(*2*,I2,2(F9.2,F6.2),F5.3)
      N=200
      N=3
      SEED=21987325.24789
      CALL RANSET(SEED)
      DO 1000 JJKM=1,7
      DO 1000 NPROD=1,N
      CUMCST=CUMPRC=0.
      ORDERS=0.
      SALMAX=0.
      PROF3=PROF9=UPROF3=UPROF9=0.
      FCOS=2000
      PROM=1000
      ACCST=17.
      STDIC=3.00
C GENERATE LEARNING CURVE PARAMETER
      BPRAM=-0.0175-(0.005*RANF(-1))
C GENERATE AGE OF PRODUCT
C RANBGE OF AGE IS 1 TO 33
      ITIME=1.0+(100*RANF(-1))/3
C     GENERATE ELASTICITY OF EFFORT
      EFFEL=2.*RANF(-1)
      EFFELL=EFFEL
C GENERATE PROMOTION ELASTICITY
C RANGE OF PMEL IS 0.07 TO 0.40
      PMEL=(RANF(-1)/3)+0.07
C GENERATE PRICE ELASTICITY
C RANGE OF PREL IS 1.25 TO 3.50
      PREL=(RANF(-1)*2.25)+1.251
C GENERATE WEIBULL K PARAMETER FORM A NORMAT DISTRIBUTION WITH MEAN
C OF 100000 AND STD DEV OF 25000
      DUM=SQRT(-2.*ALOG(RANF(-1.)))*COS(6.283185307*RANF(-2.))
      KON=DUM*25000+100000
C GENERATE WEIBULL A PARAMETER
      DUM=SQRT(-2.*ALOG(RANF(-1.)))*COS(6.283185307*RANF(-2.))
      AA=0.001+0.0005*DUM+0.0001*(DUM**2)
C     GENERATE SETUP COSTS
      SETUP=(RANF(-1)*500.)+250
      DO 900 IT=1,ITIME
C     INCREMENT PREVIOUS ORDERS
C     CALCULATE ORDERS
      PRECRD=ORDERS
      DUM=-1*AA*((IT+2)**2)
      ORDERS=KON*AA*(IT+2)*EXP(DUM)
C     CALCULATE MAX SALES
      SALMAX=AMAX1(SALMAX,ORDERS)
C    CALCULATE CUMULATIVE PRODUCTION
      CUMPRC=CUMPRC+ORDERS
C      INCREMENT PREVIOUS CUMULATIVE COST
      DUM=CUMCST
C    CALCULATE CUMULATIVE COST
      CUMCST=ACCST*(CUMPRC**(BPRAM+1.))/(BPRAM+1.)
C     CALCULATE COST OF PRODUCTION
      COSTPR=(CUMCST-DUM)+SETUP


      AVCOIN=COSTPR/ORDERS
C     CALCULATE INVENTORY HOLDING COSTS
      INHCOS=0.2*ORDERS*STDIC
C     CALCULATE PROFIT
      PROFIT=(20*ORDERS)-(COSTPR+INHCOS+FCOS+PROM)
      UPROF=PROFIT/ORDERS
C     CALCULATE PROFIT MOVING AVERAGES
      PROF3=0.5*PROFIT+0.5*PROF3
      PROF9=0.2*PROFIT+0.8*PROF9
      UPROF3=0.5*UPROF+0.5*UPROF3
      UPROF9=0.2*UPROF+0.8*UPROF9
 900  CONTINUE
      PRINT 101,NPROD,ORDERS,PRECRD,EFFEL,EFFELL,ITIME,AA,KON,
     +PMEL,PREL,SALMAX,CUMPRC,CUMCST,SETUP,AVCOIN
      PRINT 102,NPROD,PROF9,UPROF9,PROF3,UPROF3,BPRAM
1000  CONTINUE
      END
```

APPENDIX V

Analysis of Variance Output

AOV -- PAJAMA ANALYSIS

CURRENT TIME 1706 - 23 DATE 08/16/71
ELAPSED SINCE LAST CURRENT TIME 5,89 SECONDS

SUB-EFFECTS TABLE
FOR FACTORIAL WITH REPLICATES DESIGN

DEPENDENT VARIABLE IS X(10) PROFIT

- OVERALL -

MINIMUM VALUE	MAXIMUM VALUE	MEAN	FREQ	SUM	STANDARD DEVIATION	SUM OF SQUARES	SUM OF SQUARED DEVIATIONS FROM THE MEANS
31,9956000	106,67500	63,025512	384	24201,79650	16,49982	1629600,05701	104269,44808

- BY FACTOR CATEGORIES -

SUM	FREQ	MEAN	MEAN INCREMENT	SUM OF SQUARES	MARKET X(2) A	RESPONSE X(3) B	INVENT X(4) C	SLS X(5) D	COMM X(6) E	NEED I X(7) F	REP NO X(1) G
12332,1405	192	64,22990	1,20439	846474,9924	1	0	0	0	0	0	0
11869,6560	192	61,82113	-1,20439	783125,0648	2	0	0	0	0	0	0
11463,1901	192	59,70412	-3,32140	729703,3127	0	1	0	0	0	0	0
12738,6064	192	66,34691	3,32140	899896,7445	0	2	0	0	0	0	0
5810,7269	96	60,52841	-0,38010	374589,9635	1	1	0	0	0	0	0
6521,4136	96	67,93139	0,38010	471885,0290	1	2	0	0	0	0	0
5652,4632	96	58,87983	0,38010	355113,3493	2	1	0	0	0	0	0
6217,1928	96	64,76243	-0,38010	428011,7155	2	2	0	0	0	0	0
12120,0926	192	63,12548	0,09997	819740,6283	0	0	1	0	0	0	0
12081,7039	192	62,92554	-0,09997	809859,4289	0	0	2	0	0	0	0
6198,1197	96	64,56375	0,23388	428617,0514	1	0	1	0	0	0	0
6134,0208	96	63,89605	-0,23388	417857,9411	1	0	2	0	0	0	0
5921,9729	96	61,68722	-0,23388	391123,5769	2	0	1	0	0	0	0
5947,6831	96	61,95503	0,23388	392001,4879	2	0	2	0	0	0	0
5745,7025	96	59,85107	0,04698	367788,0730	0	1	1	0	0	0	0
5717,4876	96	59,55716	-0,04698	361915,2397	0	1	2	0	0	0	0
6374,3901	96	66,39990	-0,04698	451952,5553	0	2	1	0	0	0	0
6364,2163	96	66,29392	0,04698	447944,1892	0	2	2	0	0	0	0
2919,7461	48	60,82804	-0,08119	189858,7856	1	1	1	0	0	0	0
2890,9808	48	60,22877	0,08119	184731,1768	1	1	2	0	0	0	0
3278,3736	48	68,29945	0,08119	238758,7648	1	2	1	0	0	0	0
3243,0400	48	67,56333	-0,08119	233126,7642	1	2	2	0	0	0	0
2825,9564	48	58,87409	0,08119	177929,2864	2	1	1	0	0	0	0
2826,5068	48	58,88556	-0,08119	177184,0629	2	1	2	0	0	0	0

3096,0165	48	64,50034	-0,08119	213194,2905	2	2	1	0	0	0	0
3121,1763	48	65,02451	0,08119	214817,4249	2	2	2	0	0	0	0
12130,1442	192	63,17783	0,15232	819970,8848	0	0	0	1	0	0	0
12071,6523	192	62,87319	-0,15232	809629,1723	0	0	0	2	0	0	0
6192,5642	96	64,50588	0,12366	427883,2434	1	0	0	1	0	0	0
6139,5763	96	63,95392	-0,12366	418591,7490	1	0	0	2	0	0	0
5937,5800	96	61,84979	-0,12366	392087,6415	2	0	0	1	0	0	0
5932,0760	96	61,79246	0,12366	391037,4233	2	0	0	2	0	0	0
5765,2111	96	60,05428	0,19784	369614,2731	0	1	0	1	0	0	0
5697,9790	96	59,35395	-0,19784	360089,0397	0	1	0	2	0	0	0
6364,9331	96	66,30139	-0,19784	450356,6118	0	2	0	1	0	0	0
6373,6733	96	66,39243	0,19784	449540,1327	0	2	0	2	0	0	0
2924,8551	48	60,93448	-0,06775	190088,5079	1	1	0	1	0	0	0
2385,8718	48	60,12233	0,06775	184501,4556	1	1	0	2	0	0	0
3267,7091	48	68,07727	0,06775	237794,7355	1	2	0	1	0	0	0
3253,7045	48	67,78551	-0,06775	234090,2934	1	2	0	2	0	0	0
2840,3560	48	59,17408	0,06775	179525,7652	2	1	0	1	0	0	0
2812,1072	48	58,58557	-0,06775	175587,5841	2	1	0	2	0	0	0
3097,2240	48	64,52550	-0,06775	212561,8762	2	2	0	1	0	0	0
3119,9638	48	64,99935	0,06775	215449,8392	2	2	0	2	0	0	0
6072,8400	96	63,25875	-0,01905	411637,5447	0	0	1	1	0	0	0
6047,2526	96	62,99221	0,01905	408103,0836	0	0	1	2	0	0	0
6057,3342	96	63,09692	0,01905	408333,3402	0	0	2	1	0	0	0
6024,3997	96	62,75416	-0,01905	401526,0887	0	0	2	2	0	0	0
3097,9778	48	64,54120	-0,27947	214632,4687	1	0	1	1	0	0	0
3100,1419	48	64,58629	0,27947	213984,5827	1	0	1	2	0	0	0
3094,5864	48	64,47055	0,27947	213250,7747	1	0	2	1	0	0	0
3039,4344	48	63,32155	-0,27947	204607,1664	1	0	2	2	0	0	0
2974,8622	48	61,97630	0,27947	197005,0760	2	0	1	1	0	0	0
2947,1107	48	61,39814	-0,27947	194118,5010	2	0	1	2	0	0	0
2962,7178	48	61,72329	-0,27947	195082,5655	2	0	2	1	0	0	0
2984,9653	48	62,18678	0,27947	196919,9223	2	0	2	2	0	0	0
2893,4284	48	60,27976	0,09758	186590,1340	0	1	1	1	0	0	0
2852,2741	48	59,42238	-0,09758	181197,9391	0	1	1	2	0	0	0
2871,7827	48	59,82881	-0,09758	183024,1391	0	1	2	1	0	0	0
2845,7049	48	59,28552	0,09758	178891,1006	0	1	2	2	0	0	0
3179,4116	48	66,23774	-0,09758	225047,4107	0	2	1	1	0	0	0
3194,9785	48	66,56205	0,09758	226905,1446	0	2	1	2	0	0	0
3185,5215	48	66,36503	0,09758	225309,2011	0	2	2	1	0	0	0
3178,6945	48	66,22281	-0,09758	222534,9881	0	2	2	2	0	0	0
1467,5899	24	61,14958	0,11640	95980,2488	1	1	1	1	0	0	0
1452,1562	24	60,50651	-0,11640	93878,5379	1	1	1	2	0	0	0

1457,2652	24	60,71938	-0,11640	94108,2591	1	1	2	1	0	0	0
1433,7156	24	59,73815	0,11640	90622,9177	1	1	2	2	0	0	0
1630,3979	24	67,93283	-0,11640	118652,2199	1	2	1	1	0	0	0
1647,9857	24	68,66607	0,11640	120106,0448	1	2	1	2	0	0	0
1637,3212	24	68,22172	0,11640	119142,5156	1	2	2	1	0	0	0
1605,7189	24	66,90495	-0,11640	113984,2486	1	2	2	2	0	0	0
1425,8385	24	59,40994	-0,11640	90609,8852	2	1	1	1	0	0	0
1400,1179	24	58,33825	0,11640	87319,4012	2	1	1	2	0	0	0
1414,5175	24	58,93823	0,11640	88915,8800	2	1	2	1	0	0	0
1411,9593	24	58,83289	-0,11640	88268,1829	2	1	2	2	0	0	0
1549,0237	24	64,54265	0,11640	106395,1908	2	2	1	1	0	0	0
1546,9923	24	64,45803	-0,11640	106799,0998	2	2	1	2	0	0	0
1548,2033	24	64,50835	-0,11640	106166,6855	2	2	2	1	0	0	0
1572,9760	24	65,54067	0,11640	108650,7395	2	2	2	2	0	0	0
11093,5967	192	57,77915	-5,24636	681991,6513	0	0	0	0	1	0	0
13108,1998	192	68,27187	5,24636	947608,4059	0	0	0	0	2	0	0
5648,9455	96	58,84318	-0,14035	353382,3446	1	0	0	0	1	0	0
6683,1950	96	69,61661	0,14035	493092,6479	1	0	0	0	2	0	0
5444,6512	96	56,71512	0,14035	328609,3068	2	0	0	0	1	0	0
6425,0048	96	66,92713	-0,14035	454515,7580	2	0	0	0	2	0	0
5425,0468	96	56,51090	2,05315	326118,7838	0	1	0	0	1	0	0
6038,1433	96	62,89733	-2,05315	403584,5290	0	1	0	0	2	0	0
5668,5499	96	59,04739	-2,05315	355872,8675	0	2	0	0	1	0	0
7070,0565	96	73,64642	2,05315	544023,8769	0	2	0	0	2	0	0
2766,2723	48	57,63067	0,43583	169160,7649	1	1	0	0	1	0	0
3044,4546	48	63,42614	-0,43583	205429,1986	1	1	0	0	2	0	0
2882,6732	48	60,05569	-0,43583	184221,5797	1	2	0	0	1	0	0
3638,7404	48	75,80709	0,43583	287663,4493	1	2	0	0	2	0	0
2658,7745	48	55,39114	-0,43583	156959,0190	2	1	0	0	1	0	0
2993,6887	48	62,36851	0,43583	198155,3304	2	1	0	0	2	0	0
2785,8767	48	58,03910	0,43583	171651,2878	2	2	0	0	1	0	0
3431,3161	48	71,48575	-0,43583	256360,4276	2	2	0	0	2	0	0
5546,8541	96	57,77973	-0,09939	342192,0065	0	0	1	0	1	0	0
6573,2385	96	68,47123	0,09939	477548,6218	0	0	1	0	2	0	0
5546,7425	96	57,77857	0,09939	339799,6449	0	0	2	0	1	0	0
6534,9513	96	68,07251	-0,09939	470059,7840	0	0	2	0	2	0	0
2826,6019	48	58,88754	-0,19010	177164,2176	1	0	1	0	1	0	0
3371,5179	48	70,23995	0,19010	251452,8338	1	0	1	0	2	0	0
2822,3436	48	58,79883	0,19010	176218,1269	1	0	2	0	1	0	0
3311,6772	48	68,99328	-0,19010	241639,8141	1	0	2	0	2	0	0
2720,2522	48	56,67192	0,19010	165027,7888	2	0	1	0	1	0	0
3201,7207	48	66,70251	-0,19010	226095,7881	2	0	1	0	2	0	0
2724,3990	48	56,75831	-0,19010	163581,5180	2	0	2	0	1	0	0
3223,2841	48	67,15175	0,19010	228419,9699	2	0	2	0	2	0	0
2717,1848	48	56,60802	0,04955	164203,3870	0	1	1	0	1	0	0
3028,5177	48	63,09412	-0,04955	203584,6861	0	1	1	0	2	0	0

2707,8620	48	56,41379	-0,04955	161915,3968	0	1	2	0	1	0	0
3009,6256	48	62,70053	0,04955	199999,8429	0	1	2	0	2	0	0
2829,6693	48	58,95144	-0,04955	177988,6195	0	2	1	0	1	0	0
3544,7209	48	73,84835	0,04955	273963,9358	0	2	1	0	2	0	0
2938,8896	48	59,14335	0,04955	177884,2480	0	2	2	0	1	0	0
3525,3357	48	73,44449	-0,04955	270059,9411	0	2	2	0	2	0	0
1384,6143	24	57,69226	0,00189	85069,7313	1	1	1	0	1	0	0
1535,1319	24	63,96382	-0,00189	104789,0553	1	1	1	0	2	0	0
1381,6589	24	57,56908	-0,00189	84091,0336	1	1	2	0	1	0	0
1509,3229	24	62,88845	0,00189	100640,1433	1	1	2	0	2	0	0
1441,9875	24	60,08282	-0,00189	92094,4863	1	2	1	0	1	0	0
1936,3869	24	76,51608	0,00189	146663,7784	1	2	1	0	2	0	0
1440,6855	24	60,02857	0,00189	92127,0934	1	2	2	0	1	0	0
1902,3544	24	75,09810	-0,00189	140999,6709	1	2	2	0	2	0	0
1332,5705	24	55,52377	-0,00189	79133,6557	2	1	1	0	1	0	0
1493,3859	24	62,22441	0,00189	98795,6307	2	1	1	0	2	0	0
1326,2340	24	55,25850	0,00189	77824,3633	2	1	2	0	1	0	0
1500,3029	24	62,51262	-0,00189	99359,6996	2	1	2	0	2	0	0
1387,6817	24	57,82007	0,00189	85894,1332	2	2	1	0	1	0	0
1708,3349	24	71,18062	-0,00189	127300,1574	2	2	1	0	2	0	0
1398,1950	24	58,25813	-0,00189	85757,1547	2	2	2	0	1	0	0
1722,9813	24	71,79089	0,00189	129060,2703	2	2	2	0	2	0	0
5527,1695	96	57,57468	-0,35679	339363,9662	0	0	0	1	1	0	0
6602,9747	96	68,78699	0,35679	480586,9187	0	0	0	1	2	0	0
5566,4272	96	57,98362	0,35679	342607,6852	0	0	0	2	1	0	0
6505,2251	96	67,76276	-0,35679	467021,4872	0	0	0	2	2	0	0
2811,6933	48	58,57694	-0,18543	175824,8656	1	0	0	1	1	0	0
3380,8709	48	70,43481	0,18543	252059,3779	1	0	0	1	2	0	0
2837,2522	48	59,10942	0,18543	177557,4790	1	0	0	2	1	0	0
3302,3241	48	68,79842	-0,18543	241034,2700	1	0	0	2	2	0	0
2715,4762	48	56,57242	0,18543	163559,1006	2	0	0	1	1	0	0
3222,1039	48	67,12716	-0,18543	226528,5408	2	0	0	1	2	0	0
2729,1750	48	56,85781	-0,18543	165050,2062	2	0	0	2	1	0	0
3202,9010	48	66,72710	0,18543	225987,2171	2	0	0	2	2	0	0
2709,6678	48	56,45141	-0,05287	162782,5151	0	1	0	1	1	0	0
3055,5433	48	63,65715	0,05287	206831,7581	0	1	0	1	2	0	0
2715,3790	48	56,57040	0,05287	163336,2688	0	1	0	2	1	0	0
2982,6000	48	62,13750	-0,05287	196752,7709	0	1	0	2	2	0	0
2817,5017	48	58,69795	0,05287	176601,4511	0	2	0	1	1	0	0
3547,4314	48	73,90482	-0,05287	273755,1606	0	2	0	1	2	0	0
2851,0482	48	59,39684	-0,05287	179271,4164	0	2	0	2	1	0	0
3522,6251	48	73,38802	0,05287	270268,7163	0	2	0	2	2	0	0
1377,7438	24	57,40599	-0,03567	83992,5713	1	1	0	1	1	0	0
1547,1113	24	64,46297	0,03567	106095,9366	1	1	0	1	2	0	0
1388,5285	24	57,85535	0,03567	85168,1935	1	1	0	2	1	0	0
1497,3433	24	62,38930	-0,03567	99333,2620	1	1	0	2	2	0	0
1433,9495	24	59,74790	0,03567	91832,2942	1	2	0	1	1	0	0
1833,7596	24	76,40665	-0,03567	145962,4413	1	2	0	1	2	0	0
1448,7237	24	60,36349	-0,03567	92389,2855	1	2	0	2	1	0	0
1804,9809	24	75,20753	0,03567	141701,0080	1	2	0	2	2	0	0
1331,9240	24	55,49683	0,03567	78789,9437	2	1	0	1	1	0	0

1508,4328	24	62,85133	-0,03567	100735,8215	2	1	0	1	2	0	0
1326,8505	24	55,28544	-0,03567	78168,0752	2	1	0	2	1	0	0
1485,2567	24	61,88570	0,03567	97419,5088	2	1	0	2	2	0	0
1393,5522	24	57,64801	-0,03567	84769,1569	2	2	0	1	1	0	0
1713,6718	24	71,40299	0,03567	127792,7193	2	2	0	1	2	0	0
1402,3245	24	58,43019	0,03567	86882,1309	2	2	0	2	1	0	0
1717,6443	24	71,56851	-0,03567	128567,7083	2	2	0	2	2	0	0
2759,8011	48	57,49586	-0,06035	169448,0064	0	0	1	1	1	0	0
3313,0389	48	69,02164	0,06035	242189,5383	0	0	1	1	2	0	0
2787,0510	48	58,06360	0,06035	172744,0001	0	0	1	2	1	0	0
3260,1996	48	67,92083	-0,06035	235359,0836	0	0	1	2	2	0	0
2767,3484	48	57,65351	0,06035	169935,9598	0	0	2	1	1	0	0
3289,9359	48	68,54033	-0,06035	238397,3604	0	0	2	1	2	0	0
2779,3742	48	57,90363	-0,06035	169863,6651	0	0	2	2	1	0	0
3245,0255	48	67,60470	0,06035	231662,4036	0	0	2	2	2	0	0
1399,8945	24	58,32894	0,06651	87254,5789	1	0	1	1	1	0	0
1696,0833	24	70,75347	-0,06651	127377,8898	1	0	1	1	2	0	0
1426,7274	24	59,44614	-0,06651	89909,6387	1	0	1	2	1	0	0
1673,4345	24	69,72644	0,06651	124074,9440	1	0	1	2	2	0	0
1411,7988	24	58,82495	-0,06651	88570,2866	1	0	2	1	1	0	0
1682,7875	24	70,11615	0,06651	124680,4881	1	0	2	1	2	0	0
1410,5448	24	58,77270	0,06651	87647,8403	1	0	2	2	1	0	0
1628,8896	24	67,87040	-0,06651	116959,3261	1	0	2	2	2	0	0
1359,9066	24	56,66277	-0,06651	82193,4275	2	0	1	1	1	0	0
1614,9555	24	67,28982	0,06651	114811,6485	2	0	1	1	2	0	0
1360,3455	24	56,68107	0,06651	82834,3614	2	0	1	2	1	0	0
1586,7651	24	66,11521	-0,06651	111284,1396	2	0	1	2	2	0	0
1355,5696	24	56,48207	0,06651	81365,6732	2	0	2	1	1	0	0
1607,1482	24	66,96451	-0,06651	113716,8924	2	0	2	1	2	0	0
1368,8294	24	57,03456	-0,06651	82215,8448	2	0	2	2	1	0	0
1616,1359	24	67,33900	0,06651	114703,0775	2	0	2	2	2	0	0
1359,1644	24	56,63185	0,06515	82059,6786	0	1	1	1	1	0	0
1534,2640	24	63,92767	-0,06515	104530,4554	0	1	1	1	2	0	0
1358,0204	24	56,58418	-0,06515	82143,7084	0	1	1	2	1	0	0
1494,2537	24	62,26057	0,06515	99054,2307	0	1	1	2	2	0	0
1350,5034	24	56,27098	-0,06515	80722,8365	0	1	2	1	1	0	0
1521,2793	24	63,38664	0,06515	102301,3027	0	1	2	1	2	0	0
1357,3586	24	56,55661	0,06515	81192,5604	0	1	2	2	1	0	0
1488,3463	24	62,01443	-0,06515	97698,5402	0	1	2	2	2	0	0
1400,6367	24	58,35986	-0,06515	87388,3278	0	2	1	1	1	0	0
1778,7749	24	74,11562	0,06515	137659,0829	0	2	1	1	2	0	0
1429,0325	24	59,54302	0,06515	90600,2917	0	2	1	2	1	0	0
1765,9459	24	73,58108	-0,06515	136304,8529	0	2	1	2	2	0	0
1416,8650	24	59,03604	0,06515	89213,1233	0	2	2	1	1	0	0
1768,6565	24	73,69402	-0,06515	136096,0778	0	2	2	1	2	0	0
1422,0156	24	59,25065	-0,06515	88671,1247	0	2	2	2	1	0	0
1756,6792	24	73,19497	0,06515	133963,8634	0	2	2	2	2	0	0
689,8637	12	57,48864	0,03429	42210,9252	1	1	1	1	1	0	0
777,7262	12	64,81052	-0,03429	53769,3236	1	1	1	1	2	0	0
694,7506	12	57,89588	-0,03429	42858,8061	1	1	1	2	1	0	0
757,4056	12	63,11713	0,03429	51019,7317	1	1	1	2	2	0	0
687,8801	12	57,32334	-0,03429	41781,6462	1	1	2	1	1	0	0
769,3851	12	64,11542	0,03429	52326,6129	1	1	2	1	2	0	0

693,7779	12	57,81482	0,03429	42309,3874	1	1	2	2	1	0	0
739,9377	12	61,66147	-0,03429	48313,5303	1	1	2	2	2	0	0
710,0308	12	59,16923	-0,03429	45043,6538	1	2	1	1	1	0	0
920,3571	12	76,69643	0,03429	73608,5662	1	2	1	1	2	0	0
731,9568	12	60,99640	0,03429	47090,8326	1	2	1	2	1	0	0
916,0289	12	76,33574	-0,03429	73055,2122	1	2	1	2	2	0	0
723,9187	12	60,32656	0,03429	46788,6405	1	2	2	1	1	0	0
913,4025	12	76,11688	-0,03429	72353,8751	1	2	2	1	2	0	0
716,7669	12	59,73057	-0,03429	45338,4529	1	2	2	2	1	0	0
888,9519	12	74,07932	0,03429	68645,7957	1	2	2	2	2	0	0
669,3007	12	55,77506	-0,03429	39848,7534	2	1	1	1	1	0	0
756,5378	12	63,04482	0,03429	50761,1318	2	1	1	1	2	0	0
663,2698	12	55,27248	0,03429	39284,9023	2	1	1	2	1	0	0
736,8481	12	61,40401	-0,03429	46034,4989	2	1	1	2	2	0	0
662,6233	12	55,21861	0,03429	38941,1903	2	1	2	1	1	0	0
751,8942	12	62,65785	-0,03429	49974,6897	2	1	2	1	2	0	0
663,5807	12	55,29839	-0,03429	38863,1730	2	1	2	2	1	0	0
748,4086	12	62,36738	0,03429	49385,0099	2	1	2	2	2	0	0
690,6059	12	57,55049	0,03429	42344,6741	2	2	1	1	1	0	0
858,4178	12	71,53482	-0,03429	64090,5167	2	2	1	1	2	0	0
697,0758	12	58,08965	-0,03429	43549,4591	2	2	1	2	1	0	0
849,9170	12	70,82642	0,03429	63249,6407	2	2	1	2	2	0	0
692,9463	12	57,74553	-0,03429	42424,4829	2	2	2	1	1	0	0
855,2540	12	71,27117	0,03429	63742,2026	2	2	2	1	2	0	0
705,2487	12	58,77072	0,03429	43332,6718	2	2	2	2	1	0	0
867,7273	12	72,31061	-0,03429	65318,0676	2	2	2	2	2	0	0
11767,9630	192	61,29147	-1,73404	766208,2084	0	0	0	0	0	1	0
12433,8335	192	64,75955	1,73404	863391,8488	0	0	0	0	0	2	0
5989,1540	96	62,38702	-0,10884	397020,5385	1	0	0	0	0	1	0
6342,9865	96	66,07278	0,10884	449454,4540	1	0	0	0	0	2	0
5779,8090	96	60,19593	0,10884	369187,6700	2	0	0	0	0	1	0
6090,8470	96	63,44632	-0,10884	413937,3948	2	0	0	0	0	2	0
5596,7067	96	58,29903	0,32895	347544,6245	0	1	0	0	0	1	0
5866,4834	96	61,10920	-0,32895	382158,6883	0	1	0	0	0	2	0
6171,2563	96	64,28392	-0,32895	418663,5839	0	2	0	0	0	1	0
6567,3501	96	68,40990	0,32895	481233,1605	0	2	0	0	0	2	0
2830,6366	48	58,97160	-0,04288	177827,0251	1	1	0	0	0	1	0
2980,0903	48	62,08521	0,04288	196962,9383	1	1	0	0	0	2	0
3158,5174	48	65,80245	0,04288	219393,5133	1	2	0	0	0	1	0
3362,8962	48	70,06034	-0,04288	252491,5156	1	2	0	0	0	2	0
2766,0701	48	57,62646	0,04288	169917,5994	2	1	0	0	0	1	0
2886,3931	48	60,13319	-0,04288	185195,7500	2	1	0	0	0	2	0
3012,7389	48	62,76539	-0,04288	199270,0766	2	2	0	0	0	1	0
3204,4539	48	66,75946	0,04288	228741,6449	2	2	0	0	0	2	0
5899,7381	96	61,45561	0,06416	386448,3109	0	0	1	0	0	1	0
6220,3545	96	64,79536	-0,06416	433292,3174	0	0	1	0	0	2	0
5868,2249	96	61,12734	-0,06416	379759,8975	0	0	2	0	0	1	0
6213,4790	96	64,72374	0,06416	430099,5314	0	0	2	0	0	2	0

3017,4605	48	62,86376	0,07873	201929,4080	1	0	1	0	0	1	0
3180,6592	48	66,26373	-0,07873	226687,6434	1	0	1	0	0	2	0
2971,6935	48	61,91028	-0,07873	195091,1305	1	0	2	0	0	1	0
3162,3273	48	65,88182	0,07873	222766,8106	1	0	2	0	0	2	0
2882,2776	48	60,04745	-0,07873	184518,9029	2	0	1	0	0	1	0
3039,6953	48	63,32699	0,07873	206604,6740	2	0	1	0	0	2	0
2896,5314	48	60,34440	0,07873	184668,7670	2	0	2	0	0	1	0
3051,1517	48	63,56566	-0,07873	207332,7208	2	0	2	0	0	2	0
2810,8786	48	58,55997	0,04983	176334,4149	0	1	1	0	0	1	0
2934,8239	48	61,14216	-0,04983	191453,6581	0	1	1	0	0	2	0
2785,6281	48	58,03809	-0,04983	171210,2096	0	1	2	0	0	1	0
2931,6595	48	61,07624	0,04983	190705,0302	0	1	2	0	0	2	0
3088,8595	48	64,35124	-0,04983	210113,8960	0	2	1	0	0	1	0
3285,5306	48	68,44855	0,04983	241838,6593	0	2	1	0	0	2	0
3082,3969	48	64,21660	0,04983	208549,6879	0	2	2	0	0	1	0
3281,8195	48	68,37124	-0,04983	239394,5012	0	2	2	0	0	2	0
1423,8614	24	59,32756	-0,13640	90399,7302	1	1	1	0	0	1	0
1495,8847	24	62,32853	0,13640	99459,0564	1	1	1	0	0	2	0
1406,7752	24	58,61563	0,13640	87227,2949	1	1	2	0	0	1	0
1484,2056	24	61,84190	-0,13640	97503,8819	1	1	2	0	0	2	0
1593,5991	24	66,39996	0,13640	111529,6777	1	2	1	0	0	1	0
1684,7745	24	70,19894	-0,13640	127228,5870	1	2	1	0	0	2	0
1564,9183	24	65,20493	-0,13640	107863,8356	1	2	2	0	0	1	0
1678,1217	24	69,92174	0,13640	125262,9287	1	2	2	0	0	2	0
1387,0172	24	57,79238	0,13640	85934,6847	2	1	1	0	0	1	0
1438,9392	24	59,95580	-0,13640	91994,6017	2	1	1	0	0	2	0
1379,0529	24	57,46054	-0,13640	83982,9146	2	1	2	0	0	1	0
1447,4539	24	60,31058	0,13640	93201,1483	2	1	2	0	0	2	0
1495,2604	24	62,30252	-0,13640	98584,2182	2	2	1	0	0	1	0
1600,7561	24	66,69817	0,13640	114610,0723	2	2	1	0	0	2	0
1517,4785	24	63,22827	0,13640	100685,8524	2	2	2	0	0	1	0
1603,6978	24	66,82074	-0,13640	114131,5726	2	2	2	0	0	2	0
5893,1706	96	61,38719	-0,05660	384389,8102	0	0	0	1	0	1	0
6236,9735	96	64,96847	0,05660	435582,0747	0	0	0	1	0	2	0
5874,7924	96	61,19575	0,05660	381819,3981	0	0	0	2	0	1	0
6196,8599	96	64,55062	-0,05660	427809,7742	0	0	0	2	0	2	0
3008,1159	48	62,66908	0,06268	200418,1477	1	0	0	1	0	1	0
3184,4483	48	66,34267	-0,06268	227465,0957	1	0	0	1	0	2	0
2981,0381	48	62,10496	-0,06268	196602,3907	1	0	0	2	0	1	0
3158,5382	48	65,80288	0,06268	221989,3583	1	0	0	2	0	2	0
2885,0547	48	60,10531	-0,06268	183970,6625	2	0	0	1	0	1	0
3052,5253	48	63,59428	0,06268	208116,9790	2	0	0	1	0	2	0
2893,7543	48	60,28655	0,06268	185217,0074	2	0	0	2	0	1	0
3038,3217	48	63,29837	-0,06268	205820,4159	2	0	0	2	0	2	0
2810,5461	48	58,55304	-0,03955	175341,0486	0	1	0	1	0	1	0
2954,6650	48	61,55552	0,03955	194273,2245	0	1	0	1	0	2	0
2786,1606	48	58,04501	0,03955	172203,5759	0	1	0	2	0	1	0
2911,8184	48	60,66288	-0,03955	187885,4638	0	1	0	2	0	2	0
3082,6245	48	64,22134	0,03955	209047,7616	0	2	0	1	0	1	0
3282,3085	48	68,38143	-0,03955	241308,8501	0	2	0	1	0	2	0
3088,6318	48	64,34650	-0,03955	209615,8223	0	2	0	2	0	1	0

3285,0415	48	68,43836	0,03955	239924,3104	0	2	0	2	0	2	0
1425,3771	24	59,39071	0,04651	90132,6158	1	1	0	1	0	1	0
1499,4780	24	62,47825	-0,04651	99955,8921	1	1	0	1	0	2	0
1405,2595	24	58,55248	-0,04651	87494,4094	1	1	0	2	0	1	0
1480,6123	24	61,69218	0,04651	97007,0462	1	1	0	2	0	2	0
1582,7368	24	65,94745	-0,04651	110285,5320	1	2	0	1	0	1	0
1684,9703	24	70,20710	0,04651	127509,2036	1	2	0	1	0	2	0
1575,7786	24	65,65744	0,04651	109107,9813	1	2	0	2	0	1	0
1677,9259	24	69,91358	-0,04651	124982,3121	1	2	0	2	0	2	0
1385,1590	24	57,71537	-0,04651	85208,4328	2	1	0	1	0	1	0
1455,1870	24	60,63279	0,04651	94317,3324	2	1	0	1	0	2	0
1380,9011	24	57,53755	0,04651	84709,1665	2	1	0	2	0	1	0
1431,2061	24	59,63359	-0,04651	90878,4176	2	1	0	2	0	2	0
1499,8857	24	62,49524	0,04651	96762,2297	2	2	0	1	0	1	0
1597,3383	24	66,55576	-0,04651	113797,6466	2	2	0	1	0	2	0
1512,8532	24	63,03555	-0,04651	100507,8409	2	2	0	2	0	1	0
1607,1156	24	66,96315	0,04651	114941,9983	2	2	0	2	0	2	0
2955,1982	48	61,56663	0,03436	193678,7854	0	0	1	1	0	1	0
3117,6418	48	64,95087	-0,03436	217958,7593	0	0	1	1	0	2	0
2944,5399	48	61,34458	-0,03436	192769,5255	0	0	1	2	0	1	0
3102,7127	48	64,63985	0,03436	215333,5581	0	0	1	2	0	2	0
2937,9724	48	61,20776	-0,03436	190710,0249	0	0	2	1	0	1	0
3119,3318	48	64,98608	0,03436	217623,3154	0	0	2	1	0	2	0
2930,2525	48	61,04693	0,03436	189049,8726	0	0	2	2	0	1	0
3094,1472	48	64,46140	-0,03436	212476,2160	0	0	2	2	0	2	0
1510,5743	24	62,94060	0,05894	101272,6327	1	0	1	1	0	1	0
1587,4035	24	66,14181	-0,05894	113359,8361	1	0	1	1	0	2	0
1506,8962	24	62,78692	-0,05894	100656,7753	1	0	1	2	0	1	0
1593,2557	24	66,38565	0,05894	113327,8073	1	0	1	2	0	2	0
1497,5416	24	62,39757	-0,05894	99145,5151	1	0	2	1	0	1	0
1597,0448	24	66,54353	0,05894	114105,2596	1	0	2	1	0	2	0
1474,1519	24	61,42300	0,05894	95945,6154	1	0	2	2	0	1	0
1565,2923	24	65,22010	-0,05894	108661,5510	1	0	2	2	0	2	0
1444,6239	24	60,19266	-0,05894	92406,1527	2	0	1	1	0	1	0
1530,2383	24	63,75993	0,05894	104598,9232	2	0	1	1	0	2	0
1437,6537	24	59,90224	0,05894	92112,7502	2	0	1	2	0	1	0
1509,4570	24	62,89404	-0,05894	102005,7506	2	0	1	2	0	2	0
1440,4308	24	60,01795	0,05894	91564,5098	2	0	2	1	0	1	0
1522,2970	24	63,42862	-0,05894	103518,0557	2	0	2	1	0	2	0
1456,1205	24	60,67086	-0,05894	93104,2573	2	0	2	2	0	1	0
1528,8647	24	63,70270	0,05894	103814,6651	2	0	2	2	0	2	0
1415,3806	24	58,97419	0,04732	89252,7000	0	1	1	1	0	1	0
1478,0478	24	61,58532	-0,04732	97337,4340	0	1	1	1	0	2	0
1395,4980	24	58,14575	-0,04732	87081,7149	0	1	1	2	0	1	0
1450,7761	24	60,69900	0,04732	94116,2241	0	1	1	2	0	2	0
1395,1855	24	58,13190	-0,04732	86088,3486	0	1	2	1	0	1	0
1476,6172	24	61,52572	0,04732	96935,7905	0	1	2	1	0	2	0
1390,6426	24	57,94428	0,04732	85121,8610	0	1	2	2	0	1	0
1455,0423	24	60,62676	-0,04732	93769,2396	0	1	2	2	0	2	0
1539,8175	24	64,15907	-0,04732	104426,0854	0	2	1	1	0	1	0
1639,5940	24	68,31642	0,04732	120621,3253	0	2	1	1	0	2	0
1549,0419	24	64,54341	0,04732	105687,8106	0	2	1	2	0	1	0

1645,9366	24	68,58069	-0,04732	121217,3340	0	2	1	2	0	2	0
1542,8069	24	64,28362	0,04732	104621,6763	0	2	2	1	0	1	0
1642,7146	24	68,44644	-0,04732	120687,5248	0	2	2	1	0	2	0
1539,5899	24	64,14958	-0,04732	103928,0117	0	2	2	2	0	1	0
1639,1049	24	68,29604	0,04732	118706,9764	0	2	2	2	0	2	0
719,5923	12	59,96602	0,16327	46073,1020	1	1	1	1	0	1	0
747,9976	12	62,33313	-0,16327	49907,1468	1	1	1	1	0	2	0
704,2691	12	58,68909	-0,16327	44326,6282	1	1	1	2	0	1	0
747,8871	12	62,32392	0,16327	49551,9096	1	1	1	2	0	2	0
705,7849	12	58,81540	-0,16327	44059,5138	1	1	2	1	0	1	0
751,4804	12	62,62337	0,16327	50049,7453	1	1	2	1	0	2	0
700,9904	12	58,41587	0,16327	43167,7811	1	1	2	2	0	1	0
732,7252	12	61,06043	-0,16327	47455,1366	1	1	2	2	0	2	0
790,9820	12	65,91517	-0,16327	55199,5307	1	2	1	1	0	1	0
839,4059	12	69,95049	0,16327	63452,6893	1	2	1	1	0	2	0
802,6171	12	66,88476	0,16327	56330,1471	1	2	1	2	0	1	0
845,3685	12	70,44738	-0,16327	63775,8977	1	2	1	2	0	2	0
791,7568	12	65,97973	0,16327	55086,0013	1	2	2	1	0	1	0
845,5644	12	70,46370	-0,16327	64056,5143	1	2	2	1	0	2	0
773,1615	12	64,43012	-0,16327	52777,8343	1	2	2	2	0	1	0
832,5573	12	69,37977	0,16327	61206,4144	1	2	2	2	0	2	0
695,7883	12	57,98236	-0,16327	43179,5980	2	1	1	1	0	1	0
730,0502	12	60,83752	0,16327	47430,2872	2	1	1	1	0	2	0
691,2289	12	57,60241	0,16327	42755,0867	2	1	1	2	0	1	0
708,8899	12	59,07408	-0,16327	44564,3145	2	1	1	2	0	2	0
689,3807	12	57,44839	0,16327	42028,8348	2	1	2	1	0	1	0
725,1369	12	60,42807	-0,16327	46867,0452	2	1	2	1	0	2	0
689,6722	12	57,47268	-0,16327	41954,0798	2	1	2	2	0	1	0
722,3171	12	60,19309	0,16327	46314,1030	2	1	2	2	0	2	0
748,8356	12	62,40297	0,16327	49226,5547	2	2	1	1	0	1	0
800,1881	12	66,68234	-0,16327	57168,6360	2	2	1	1	0	2	0
746,4248	12	62,20207	-0,16327	49357,6635	2	2	1	2	0	1	0
800,5680	12	66,71400	0,16327	57441,4363	2	2	1	2	0	2	0
751,0501	12	62,58751	-0,16327	49535,6749	2	2	2	1	0	1	0
797,1502	12	66,42918	0,16327	56631,0105	2	2	2	1	0	2	0
766,4284	12	63,86903	0,16327	51150,1774	2	2	2	2	0	1	0
806,5476	12	67,21230	-0,16327	57500,5620	2	2	2	2	0	2	0
5693,3185	96	59,30540	3,26029	358818,3011	0	0	0	0	1	1	0
5400,2782	96	56,25290	-3,26029	323173,3502	0	0	0	0	1	2	0
6074,6445	96	63,27755	-3,26029	407369,9073	0	0	0	0	2	1	0
7033,5553	96	73,26620	3,26029	540218,4986	0	0	0	0	2	2	0
2891,5325	48	60,24027	-0,02033	184878,7165	1	0	0	0	1	1	0
2757,4127	48	57,44610	0,02033	168503,6281	1	0	0	0	1	2	0
3097,6212	48	64,53378	0,02033	212141,8220	1	0	0	0	2	1	0
3585,5738	48	74,69945	-0,02033	280950,8259	1	0	0	0	2	2	0
2801,7857	48	58,37054	0,02033	173939,5847	2	0	0	0	1	1	0
2642,8655	48	55,05970	-0,02033	154669,7221	2	0	0	0	1	2	0
2977,0233	48	62,02132	-0,02033	195248,0853	2	0	0	0	2	1	0
3447,9815	48	71,83295	0,02033	259267,6727	2	0	0	0	2	2	0
2780,8559	48	57,93450	-0,43161	171312,6105	0	1	0	0	1	1	0
2644,1910	48	55,08731	0,43161	154806,1733	0	1	0	0	1	2	0
2815,6509	48	58,66356	0,43161	176252,0140	0	1	0	0	2	1	0
3222,2924	48	67,13109	-0,43161	227352,5149	0	1	0	0	2	2	0

2912,4627	48	60,67631	0,43161	187505,6907	0	2	0	0	1	1	0
2756,0872	48	57,41848	-0,43161	168367,1769	0	2	0	0	1	2	0
3258,7936	48	67,89153	-0,43161	231157,8932	0	2	0	0	2	1	0
3811,2629	48	79,40131	0,43161	312865,9837	0	2	0	0	2	2	0
1414,3789	24	58,93245	0,05024	88366,4120	1	1	0	0	1	1	0
1351,8934	24	56,32889	-0,05024	80794,3529	1	1	0	0	1	2	0
1416,2577	24	59,01074	-0,05024	89260,6131	1	1	0	0	2	1	0
1628,1969	24	67,84154	0,05024	116168,5854	1	1	0	0	2	2	0
1477,1539	24	61,54808	-0,05024	96512,3045	1	2	0	0	1	1	0
1405,5193	24	59,56330	0,05024	87709,2752	1	2	0	0	1	2	0
1681,3635	24	70,05681	0,05024	122881,2088	1	2	0	0	2	1	0
1957,3769	24	81,55737	-0,05024	164782,2405	1	2	0	0	2	2	0
1360,4769	24	56,93654	-0,05024	82946,1985	2	1	0	0	1	1	0
1292,2976	24	53,84573	0,05024	74011,8204	2	1	0	0	1	2	0
1399,5932	24	58,31638	0,05024	86971,4009	2	1	0	0	2	1	0
1594,0955	24	66,42065	-0,05024	111163,9295	2	1	0	0	2	2	0
1435,3088	24	59,80453	0,05024	90993,3862	2	2	0	0	1	1	0
1350,5679	24	56,27366	-0,05024	80597,9017	2	2	0	0	1	2	0
1577,4301	24	65,72625	-0,05024	108276,6844	2	2	0	0	2	1	0
1853,8860	24	77,24525	0,05024	148083,7432	2	2	0	0	2	2	0
2851,1689	48	59,39935	0,02921	181064,3680	0	0	1	0	1	1	0
2695,6852	48	56,16011	-0,02921	161127,6385	0	0	1	0	1	2	0
3048,5692	48	63,51186	-0,02921	205363,9429	0	0	1	0	2	1	0
3524,6693	48	73,43061	0,02921	272164,6790	0	0	1	0	2	2	0
2842,1496	48	59,21145	-0,02921	177753,9331	0	0	2	0	1	1	0
2704,5930	48	56,34569	0,02921	162045,7117	0	0	2	0	1	2	0
3026,0753	48	63,04324	0,02921	202005,9644	0	0	2	0	2	1	0
3508,8869	48	73,10179	-0,02921	268053,8197	0	0	2	0	2	2	0
1447,5017	24	60,31257	-0,14415	92981,0262	1	0	1	0	1	1	0
1379,1002	24	57,46251	0,14415	84183,1914	1	0	1	0	1	2	0
1569,9588	24	65,41495	0,14415	108948,3818	1	0	1	0	2	1	0
1801,5590	24	75,06496	-0,14415	142504,4520	1	0	1	0	2	2	0
1444,0311	24	60,16796	0,14415	91897,6903	1	0	2	0	1	1	0
1378,3125	24	57,42969	-0,14415	84320,4367	1	0	2	0	1	2	0
1527,6624	24	63,65260	-0,14415	103193,4402	1	0	2	0	2	1	0
1784,0148	24	74,33395	0,14415	138446,3739	1	0	2	0	2	2	0
1403,6672	24	58,48613	0,14415	86083,3418	2	0	1	0	1	1	0
1316,5850	24	54,85771	-0,14415	76944,4470	2	0	1	0	1	2	0
1478,6104	24	61,60877	-0,14415	96435,5611	2	0	1	0	2	1	0
1723,1103	24	71,79626	0,14415	129660,2270	2	0	1	0	2	2	0
1398,1185	24	58,25494	-0,14415	85856,2429	2	0	2	0	1	1	0
1326,2805	24	55,26169	0,14415	77725,2751	2	0	2	0	1	2	0
1498,4129	24	62,43387	0,14415	98812,5241	2	0	2	0	2	1	0
1724,8712	24	71,86963	-0,14415	129607,4457	2	0	2	0	2	2	0
1395,6501	24	58,15209	-0,02272	86898,5748	0	1	1	0	1	1	0
1321,5347	24	55,06395	0,02272	77304,8122	0	1	1	0	1	2	0
1415,2285	24	58,96785	0,02272	89435,8401	0	1	1	0	2	1	0
1613,2892	24	67,22038	-0,02272	114148,8460	0	1	1	0	2	2	0
1385,2057	24	57,71690	0,02272	84414,0357	0	1	2	0	1	1	0
1322,6563	24	55,11068	-0,02272	77501,3612	0	1	2	0	1	2	0
1400,6224	24	58,35927	-0,02272	86796,1739	0	1	2	0	2	1	0
1609,0032	24	67,04180	0,02272	113203,6690	0	1	2	0	2	2	0

1455,5188	24	60,64662	0,02272	94165,7952	0	2	1	0	1	1	0
1374,1505	24	57,25627	-0,02272	83822,8263	0	2	1	0	1	2	0
1633,3407	24	68,05586	-0,02272	115948,1028	0	2	1	0	2	1	0
1911,3901	24	79,64084	0,02272	158015,8330	0	2	1	0	2	2	0
1456,9439	24	60,70600	-0,02272	93339,8975	0	2	2	0	1	1	0
1381,9367	24	57,58070	0,02272	84544,3506	0	2	2	0	1	2	0
1625,4529	24	67,72720	0,02272	115209,7905	0	2	2	0	2	1	0
1899,8825	24	79,16178	-0,02272	154850,1507	0	2	2	0	2	2	0
705,4567	12	58,78806	-0,12464	44291,8035	1	1	1	0	1	1	0
679,1575	12	56,59647	0,12464	40777,9278	1	1	1	0	1	2	0
718,4047	12	59,86706	0,12464	46107,9267	1	1	1	0	2	1	0
816,7271	12	68,06059	-0,12464	58681,1286	1	1	1	0	2	2	0
708,9222	12	59,07685	0,12464	44074,6084	1	1	2	0	1	1	0
672,7358	12	56,06132	-0,12464	40016,4251	1	1	2	0	1	2	0
697,8530	12	58,15442	-0,12464	43152,6865	1	1	2	0	2	1	0
811,4698	12	67,62248	0,12464	57487,4568	1	1	2	0	2	2	0
742,0450	12	61,83708	0,12464	48689,2227	1	2	1	0	1	1	0
699,9425	12	58,32955	-0,12464	43405,2636	1	2	1	0	1	2	0
851,5541	12	70,96284	-0,12464	62840,4551	1	2	1	0	2	1	0
984,6319	12	82,06933	0,12464	83823,3234	1	2	1	0	2	2	0
735,1089	12	61,25907	-0,12464	47823,0818	1	2	2	0	1	1	0
705,5767	12	58,79806	0,12464	44304,0115	1	2	2	0	1	2	0
829,8094	12	69,15078	0,12464	60040,7538	1	2	2	0	2	1	0
972,5450	12	81,04542	-0,12464	80958,9171	1	2	2	0	2	2	0
690,1934	12	57,51612	0,12464	42606,7713	2	1	1	0	1	1	0
642,3771	12	53,53143	-0,12464	36526,8844	2	1	1	0	1	2	0
696,8235	12	58,06865	-0,12464	43327,9134	2	1	1	0	2	1	0
796,5621	12	66,38017	0,12464	55467,7173	2	1	1	0	2	2	0
676,2835	12	56,35696	-0,12464	40339,4272	2	1	2	0	1	1	0
649,9205	12	54,16004	0,12464	37484,9361	2	1	2	0	1	2	0
702,7594	12	58,56412	0,12464	43643,4874	2	1	2	0	2	1	0
797,5334	12	66,46112	-0,12464	55716,2122	2	1	2	0	2	2	0
713,4739	12	59,45615	-0,12464	45476,5705	2	2	1	0	1	1	0
674,2079	12	56,18399	0,12464	40417,5627	2	2	1	0	1	2	0
781,7865	12	65,14888	0,12464	53107,6477	2	2	1	0	2	1	0
926,5482	12	77,21235	-0,12464	74192,5096	2	2	1	0	2	2	0
721,6350	12	60,15292	0,12464	45516,8157	2	2	2	0	1	1	0
676,3600	12	56,36333	-0,12464	40240,3390	2	2	2	0	1	2	0
795,6435	12	66,30363	-0,12464	55169,0367	2	2	2	0	2	1	0
927,3378	12	77,27015	0,12464	73891,2336	2	2	2	0	2	2	0
2850,9687	48	59,39518	0,35085	180253,3455	0	0	0	1	1	1	0
2676,2009	48	55,75418	-0,35085	159130,6207	0	0	0	1	1	2	0
3042,2019	48	63,37921	-0,35085	204135,4647	0	0	0	1	2	1	0
3560,7725	48	74,18277	0,35085	276451,4540	0	0	0	1	2	2	0
2842,3498	48	59,21562	-0,35085	178564,9556	0	0	0	2	1	1	0
2724,0774	48	56,75161	0,35085	164042,7295	0	0	0	2	1	2	0
3032,4425	48	63,17589	0,35085	203254,4425	0	0	0	2	2	1	0
3472,7825	48	72,34964	-0,35085	263767,0446	0	0	0	2	2	2	0
1449,2911	24	60,38713	0,05617	93204,0994	1	0	0	1	1	1	0
1362,4022	24	56,76676	-0,05617	82620,7661	1	0	0	1	1	2	0
1558,8748	24	64,95103	-0,05617	107214,0483	1	0	0	1	2	1	0
1822,0461	24	75,91859	0,05617	144844,3295	1	0	0	1	2	2	0
1442,2417	24	60,09340	-0,05617	91674,6170	1	0	0	2	1	1	0
1395,0105	24	58,12544	0,05617	85882,8619	1	0	0	2	1	2	0
1538,7964	24	64,11652	0,05617	104927,7737	1	0	0	2	2	1	0

1763,5277	24	73,48032	-0,05617	136106,4964	1	0	0	2	2	2	0
1401,6776	24	58,40323	-0,05617	87049,2461	2	0	0	1	1	1	0
1313,7986	24	54,74161	0,05617	76509,8545	2	0	0	1	1	2	0
1483,3771	24	61,80738	0,05617	96921,4164	2	0	0	1	2	1	0
1738,7267	24	72,44695	-0,05617	131607,1244	2	0	0	1	2	2	0
1400,1081	24	58,33784	0,05617	86890,3386	2	0	0	2	1	1	0
1329,0669	24	55,37779	-0,05617	78159,8676	2	0	0	2	1	2	0
1493,6462	24	62,23526	-0,05617	98326,6688	2	0	0	2	2	1	0
1709,2548	24	71,21895	0,05617	127660,5483	2	0	0	2	2	2	0
1393,3708	24	58,05712	-0,07259	85956,3189	0	1	0	1	1	1	0
1316,2970	24	54,84571	0,07259	76826,1961	0	1	0	1	1	2	0
1417,1753	24	59,04897	0,07259	89384,7297	0	1	0	1	2	1	0
1638,3680	24	68,26533	-0,07259	117447,0284	0	1	0	1	2	2	0
1387,4850	24	57,81187	0,07259	85356,2916	0	1	0	2	1	1	0
1327,8940	24	55,32892	-0,07259	77979,9772	0	1	0	2	1	2	0
1398,6756	24	58,27815	-0,07259	86847,2843	0	1	0	2	2	1	0
1583,9244	24	65,99685	0,07259	109905,4866	0	1	0	2	2	2	0
1457,5979	24	60,73325	0,07259	94297,0266	0	2	0	1	1	1	0
1359,9038	24	56,66266	-0,07259	82304,4245	0	2	0	1	1	2	0
1625,0266	24	67,70944	-0,07259	114750,7350	0	2	0	1	2	1	0
1922,4049	24	80,10020	0,07259	159004,4256	0	2	0	1	2	2	0
1454,8548	24	60,61937	-0,07259	93708,6641	0	2	0	2	1	1	0
1396,1834	24	58,17431	0,07259	86062,7523	0	2	0	2	1	2	0
1633,7670	24	68,07363	0,07259	116407,1582	0	2	0	2	2	1	0
1888,6581	24	78,70242	-0,07259	153861,5581	0	2	0	2	2	2	0
706,9889	12	58,91574	-0,13950	44191,6189	1	1	0	1	1	1	0
670,7549	12	55,89624	0,13950	39800,9524	1	1	0	1	1	2	0
718,3982	12	59,86568	0,13950	45940,9968	1	1	0	1	2	1	0
828,7231	12	69,06026	-0,13950	60154,9397	1	1	0	1	2	2	0
707,3900	12	58,94917	0,13950	44174,7931	1	1	0	2	1	1	0
681,1385	12	56,76154	-0,13950	40993,4005	1	1	0	2	1	2	0
697,8695	12	58,15579	-0,13950	43319,6163	1	1	0	2	2	1	0
799,4738	12	66,62282	0,13950	56013,6457	1	1	0	2	2	2	0
742,3022	12	61,85852	0,13950	49012,4805	1	2	0	1	1	1	0
691,6473	12	57,63727	-0,13950	42817,8137	1	2	0	1	1	2	0
840,4365	12	70,03638	-0,13950	61273,0515	1	2	0	1	2	1	0
993,3230	12	82,77692	0,13950	84689,3898	1	2	0	1	2	2	0
734,8517	12	61,23764	-0,13950	47499,8240	1	2	0	2	1	1	0
713,8720	12	59,48933	0,13950	44889,4615	1	2	0	2	1	2	0
840,9269	12	70,07724	0,13950	61608,1574	1	2	0	2	2	1	0
964,0539	12	80,33782	-0,13950	80092,8506	1	2	0	2	2	2	0
686,3819	12	57,19849	0,13950	41764,7000	2	1	0	1	1	1	0
645,5421	12	53,79518	-0,13950	37025,2437	2	1	0	1	1	2	0
698,7871	12	58,23226	-0,13950	43443,7328	2	1	0	1	2	1	0
809,6449	12	67,47041	0,13950	57292,0887	2	1	0	1	2	2	0
680,0950	12	56,67458	-0,13950	41181,4985	2	1	0	2	1	1	0
646,7555	12	53,89629	0,13950	36986,5767	2	1	0	2	1	2	0
700,8061	12	58,40051	0,13950	43527,6680	2	1	0	2	2	1	0
784,4506	12	65,37088	-0,13950	53891,8408	2	1	0	2	2	2	0
715,2957	12	59,60797	-0,13950	45284,5461	2	2	0	1	1	1	0
668,2565	12	55,68804	0,13950	39484,6108	2	2	0	1	1	2	0
784,5900	12	65,38250	0,13950	53477,6836	2	2	0	1	2	1	0
929,0818	12	77,42348	-0,13950	74315,0358	2	2	0	1	2	2	0
720,0131	12	60,00109	0,13950	45708,8401	2	2	0	2	1	1	0
682,3114	12	56,85928	-0,13950	41173,2909	2	2	0	2	1	2	0
792,8401	12	66,07001	-0,13950	54799,0008	2	2	0	2	2	1	0
924,8042	12	77,06702	0,13950	73768,7075	2	2	0	2	2	2	0

1423,8290	24	59,32621	-0,11788	90167,0906	0	0	1	1	1	1	0
1335,9721	24	55,66550	0,11788	79280,9158	0	0	1	1	1	2	0
1531,3692	24	63,80705	0,11788	103511,6948	0	0	1	1	2	1	0
1781,6697	24	74,23624	-0,11788	138677,8435	0	0	1	1	2	2	0
1427,3399	24	59,47250	0,11788	90897,2774	0	0	1	2	1	1	0
1359,7131	24	56,65471	-0,11788	81846,7226	0	0	1	2	1	2	0
1517,2000	24	63,21667	-0,11788	101872,2481	0	0	1	2	2	1	0
1742,9995	24	72,62498	0,11788	133486,8355	0	0	1	2	2	2	0
1427,1397	24	59,46415	0,11788	90086,2949	0	0	2	1	1	1	0
1340,2287	24	55,84286	-0,11788	79849,7048	0	0	2	1	1	2	0
1510,8327	24	62,95136	-0,11788	100623,7699	0	0	2	1	2	1	0
1779,1031	24	74,12930	0,11788	137773,6105	0	0	2	1	2	2	0
1415,0099	24	58,95875	-0,11788	87667,6782	0	0	2	2	1	1	0
1364,3643	24	56,84851	0,11788	82196,0069	0	0	2	2	1	2	0
1515,2426	24	63,13511	0,11788	101382,1944	0	0	2	2	2	1	0
1729,7829	24	72,07429	-0,11788	130280,2091	0	0	2	2	2	2	0

720,9465	12	60,08054	-0,06195	46297,3472	1	0	1	1	1	1	0
678,9280	12	56,57733	0,06195	40957,2317	1	0	1	1	1	2	0
789,6075	12	65,80065	0,06195	54975,2854	1	0	1	1	2	1	0
908,4755	12	75,70629	-0,06195	72402,6044	1	0	1	1	2	2	0
726,5352	12	60,54460	0,06195	46683,6790	1	0	1	2	1	1	0
700,1722	12	58,34768	-0,06195	43225,9597	1	0	1	2	1	2	0
780,3510	12	65,02925	-0,06195	53973,0964	1	0	1	2	2	1	0
893,0835	12	74,42362	0,06195	70101,8476	1	0	1	2	2	2	0
728,3245	12	60,69372	0,06195	46906,7922	1	0	2	1	1	1	0
683,4742	12	56,95618	-0,06195	41663,5344	1	0	2	1	1	2	0
769,2170	12	64,10142	-0,06195	52238,7629	1	0	2	1	2	1	0
913,5705	12	76,13088	0,06195	72441,7252	1	0	2	1	2	2	0
715,7065	12	59,64221	-0,06195	44990,9381	1	0	2	2	1	1	0
694,8383	12	57,90319	0,06195	42656,9022	1	0	2	2	1	2	0
758,4454	12	63,20378	0,06195	50954,6773	1	0	2	2	2	1	0
870,4442	12	72,53702	-0,06195	66004,6488	1	0	2	2	2	2	0
702,8625	12	58,57187	0,06195	43869,7433	2	0	1	1	1	1	0
657,0441	12	54,75368	-0,06195	38323,6841	2	0	1	1	1	2	0
741,7614	12	61,81345	-0,06195	48536,4094	2	0	1	1	2	1	0
873,1942	12	72,76618	0,06195	66275,2391	2	0	1	1	2	2	0
700,8047	12	58,40039	-0,06195	44213,5985	2	0	1	2	1	1	0
659,5409	12	54,96174	0,06195	38620,7629	2	0	1	2	1	2	0
736,8490	12	61,40408	0,06195	47899,1517	2	0	1	2	2	1	0
849,9161	12	70,82634	-0,06195	63384,9879	2	0	1	2	2	2	0
698,8151	12	58,23459	-0,06195	45179,5028	2	0	2	1	1	1	0
656,7545	12	54,72954	0,06195	38186,1704	2	0	2	1	1	2	0
741,6157	12	61,80131	0,06195	48385,0070	2	0	2	1	2	1	0
865,5325	12	72,12771	-0,06195	65331,8853	2	0	2	1	2	2	0
699,3034	12	58,27528	0,06195	42676,7401	2	0	2	2	1	1	0
669,5260	12	55,79383	-0,06195	39539,1047	2	0	2	2	1	2	0
756,7972	12	63,06643	-0,06195	50427,5171	2	0	2	2	2	1	0
859,3387	12	71,61156	0,06195	64275,5604	2	0	2	2	2	2	0

699,8547	12	58,32122	-0,00061	43513,9183	0	1	1	1	1	1	0
659,3097	12	54,94247	0,00061	38545,7603	0	1	1	1	1	2	0
715,5259	12	59,62716	0,00061	45738,7817	0	1	1	1	2	1	0
818,7381	12	68,22817	-0,00061	58791,6737	0	1	1	1	2	2	0
695,7954	12	57,98295	0,00061	43384,6565	0	1	1	2	1	1	0
662,2250	12	55,18542	-0,00061	38759,0519	0	1	1	2	1	2	0
699,7026	12	58,30855	-0,00061	43697,0584	0	1	1	2	2	1	0
794,5511	12	66,21259	0,00061	55397,1723	0	1	1	2	2	2	0

693,5161	12	57,79301	0,00061	42442,4006	0	1	2	1	1	1	0
656,9873	12	54,74894	-0,00061	38280,4359	0	1	2	1	1	2	0
701,6494	12	58,47078	-0,00061	43645,9480	0	1	2	1	2	1	0
819,6299	12	68,30249	0,00061	58655,3547	0	1	2	1	2	2	0
691,6896	12	57,64080	-0,00061	41971,6350	0	1	2	2	1	1	0
665,6690	12	55,47242	0,00061	39220,9253	0	1	2	2	1	2	0
698,9730	12	58,24775	0,00061	43150,2259	0	1	2	2	2	1	0
789,3733	12	65,78111	-0,00061	54548,3143	0	1	2	2	2	2	0
723,9743	12	60,33119	0,00061	46653,1723	0	2	1	1	1	1	0
676,6624	12	56,38853	-0,00061	40735,1555	0	2	1	1	1	2	0
815,8433	12	67,98694	-0,00061	57772,9131	0	2	1	1	2	1	0
962,9316	12	80,24430	0,00061	79886,1698	0	2	1	1	2	2	0
731,5445	12	60,96204	-0,00061	47512,6209	0	2	1	2	1	1	0
697,4881	12	58,12401	0,00061	43087,6708	0	2	1	2	1	2	0
817,4974	12	68,12478	0,00061	58175,1897	0	2	1	2	2	1	0
948,4485	12	79,03737	-0,00061	78129,6632	0	2	1	2	2	2	0
733,6235	12	61,13530	-0,00061	47643,8543	0	2	2	1	1	1	0
683,2414	12	56,93678	0,00061	41569,2690	0	2	2	1	1	2	0
809,1833	12	67,43194	0,00061	56977,8219	0	2	2	1	2	1	0
959,4732	12	79,95610	-0,00061	79118,2558	0	2	2	1	2	2	0
723,3203	12	60,27669	0,00061	45696,0432	0	2	2	2	1	1	0
698,6953	12	58,22461	-0,00061	42975,0816	0	2	2	2	1	2	0
816,2696	12	68,02247	-0,00061	58231,9685	0	2	2	2	2	1	0
940,4096	12	78,36747	0,00061	75731,8948	0	2	2	2	2	2	0
353,5702	6	58,92837	0,01251	22163,1626	1	1	1	1	1	1	0
336,2935	6	56,04892	-0,01251	20047,7526	1	1	1	1	1	2	0
366,0221	6	61,00368	-0,01251	23909,9394	1	1	1	1	2	1	0
411,7041	6	68,61735	0,01251	29859,3842	1	1	1	1	2	2	0
351,8965	6	58,64775	-0,01251	22128,6409	1	1	1	2	1	1	0
342,8641	6	57,14402	0,01251	20730,1652	1	1	1	2	1	2	0
352,3825	6	58,73043	0,01251	22197,9873	1	1	1	2	2	1	0
405,0230	6	67,50383	-0,01251	28821,7444	1	1	1	2	2	2	0
353,4187	6	58,90312	-0,01251	22028,4563	1	1	2	1	1	1	0
334,4614	6	55,74357	0,01251	19753,1899	1	1	2	1	1	2	0
352,3661	6	58,72768	0,01251	22031,0575	1	1	2	1	2	1	0
417,0190	6	69,50317	-0,01251	30295,5555	1	1	2	1	2	2	0
355,5035	6	59,25058	0,01251	22046,1522	1	1	2	2	1	1	0
338,2744	6	56,37907	-0,01251	20263,2352	1	1	2	2	1	2	0
345,4869	6	57,58115	-0,01251	21121,6290	1	1	2	2	2	1	0
394,4539	6	65,74180	0,01251	27191,9014	1	1	2	2	2	2	0
367,3963	6	61,23272	-0,01251	24134,1846	1	2	1	1	1	1	0
342,6345	6	57,10575	0,01251	20909,4691	1	2	1	1	1	2	0
423,5957	6	70,59762	0,01251	31065,3460	1	2	1	1	2	1	0
496,7714	6	82,79523	-0,01251	42543,2201	1	2	1	1	2	2	0
374,6487	6	62,44145	0,01251	24555,0381	1	2	1	2	1	1	0
357,3281	6	59,55135	-0,01251	22495,7945	1	2	1	2	1	2	0
427,9584	6	71,32807	-0,01251	31775,1090	1	2	1	2	2	1	0
488,0605	6	81,34342	0,01251	41280,1032	1	2	1	2	2	2	0
374,9059	6	62,48432	0,01251	24878,2959	1	2	2	1	1	1	0
349,0129	6	58,16880	-0,01251	21910,3446	1	2	2	1	1	2	0
416,8509	6	69,47515	-0,01251	30707,7054	1	2	2	1	2	1	0
496,5516	6	82,75860	0,01251	42146,1697	1	2	2	1	2	2	0
360,2030	6	60,03383	-0,01251	22944,7859	1	2	2	2	1	1	0
356,5639	6	59,42732	0,01251	22393,6670	1	2	2	2	1	2	0
412,9583	6	68,82642	0,01251	29933,0483	1	2	2	2	2	1	0
475,9934	6	79,33223	-0,01251	38812,7474	1	2	2	2	2	2	0
346,2943	6	57,71408	-0,01251	21350,7557	2	1	1	1	1	1	0
323,0162	6	53,83603	0,01251	18497,9977	2	1	1	1	1	2	0
349,5039	6	58,25063	0,01251	21828,8423	2	1	1	1	2	1	0

407,0340	6	67,83900	-0,01251	28932,2895	2	1	1	1	2	2	0
343,9089	6	57,31815	0,01251	21256,0156	2	1	1	2	1	1	0
319,3509	6	53,22682	-0,01251	18028,8866	2	1	1	2	1	2	0
347,3200	6	57,68667	-0,01251	21499,0711	2	1	1	2	2	1	0
389,5281	6	64,92135	0,01251	26535,4279	2	1	1	2	2	2	0
340,0974	6	56,68290	0,01251	20413,9443	2	1	2	1	1	1	0
322,5259	6	53,75432	-0,01251	18527,2460	2	1	2	1	1	2	0
349,2833	6	58,21388	-0,01251	21614,8905	2	1	2	1	2	1	0
402,0109	6	67,10182	0,01251	28359,7992	2	1	2	1	2	2	0
336,1861	6	56,03102	-0,01251	19925,4829	2	1	2	2	1	1	0
327,3945	6	54,56577	0,01251	18957,6901	2	1	2	2	1	2	0
353,4861	6	58,91435	0,01251	22028,5969	2	1	2	2	2	1	0
394,9225	6	65,82042	-0,01251	27356,4130	2	1	2	2	2	2	0
356,5780	6	59,42967	0,01251	22518,9877	2	2	1	1	1	1	0
334,0279	6	55,67132	-0,01251	19825,6864	2	2	1	1	1	2	0
392,2576	6	65,37627	-0,01251	26707,5671	2	2	1	1	2	1	0
466,1502	6	77,69337	0,01251	37342,9496	2	2	1	1	2	2	0
356,8958	6	59,48263	-0,01251	22957,5828	2	2	1	2	1	1	0
340,1800	6	56,69667	0,01251	20591,8763	2	2	1	2	1	2	0
389,5290	6	64,92150	0,01251	26400,0806	2	2	1	2	2	1	0
460,3980	6	76,73133	-0,01251	36849,5600	2	2	1	2	2	2	0
358,7177	6	59,78628	-0,01251	22765,5584	2	2	2	1	1	1	0
334,2286	6	55,70477	0,01251	19658,9244	2	2	2	1	1	2	0
392,3324	6	65,38873	0,01251	26770,1165	2	2	2	1	2	1	0
462,9216	6	77,15360	-0,01251	36972,0861	2	2	2	1	2	2	0
363,1173	6	60,51955	0,01251	22751,2572	2	2	2	2	1	1	0
342,1314	6	57,02190	-0,01251	20581,4146	2	2	2	2	1	2	0
403,3111	6	67,21852	-0,01251	28398,9202	2	2	2	2	2	1	0
464,4162	6	77,40270	0,01251	36919,1474	2	2	2	2	2	2	0

AOV -- PAJAMA ANALYSIS

CURRENT TIME 1709 - 24 DATE 08/16/71
ELAPSED SINCE LAST CURRENT TIME 154,36 SECONDS

A N A L Y S I S O F V A R I A N C E T A B L E
FOR FACTORIAL WITH REPLICATES DESIGN

DEPENDENT VARIABLE IS X(10) PROFIT

SOURCE OF VARIANCE	SUM OF SQUARES	DEGS, OF FREEDOM	MEAN SQUARE	F STATISTIC	APPROX, SIGNIFICANCE PROBABILITY OF F STAT,
A	557,01018944	1	557,01018944	2,18699	0,136
B	4236,16338074	1	4236,16338074	16,63243	<0,0005
AB	55,47779959	1	55,47779959	0,21782	0,646
C	3,83774034	1	3,83774034	0,01507	0,870
AC	21,00436053	1	21,00436053	0,08247	0,766
BC	0,84760752	1	0,84760752	0,00333	0,909
ABC	2,53137755	1	2,53137755	0,00994	0,884
D	8,90964159	1	8,90964159	0,03498	0,831
AD	5,87166865	1	5,87166865	0,02305	0,852
BD	15,03070407	1	15,03070407	0,05902	0,795
ABD	1,76243495	1	1,76243495	0,00692	0,894
CD	0,13942696	1	0,13942696	0,00055	0,930
ACD	29,99096533	1	29,99096533	0,11775	0,729
BCD	3,65627186	1	3,65627186	0,01436	0,872
ABCD	5,20301016	1	5,20301016	0,02043	0,858
E	10569,33763218	1	10569,33763218	41,49836	<0,0005
AE	7,56450010	1	7,56450010	0,02970	0,840
BE	1618,72522342	1	1618,72522342	6,35560	0,012
ABE	72,94080515	1	72,94080515	0,28639	0,600
CE	3,79328296	1	3,79328296	0,01489	0,870
ACE	13,87718592	1	13,87718592	0,05449	0,801
BCE	0,94278785	1	0,94278785	0,00370	0,907
ABCE	0,00137524	1	0,00137524	0,00001	0,947
DE	48,88281315	1	48,88281315	0,19193	0,665

ADE	13,20318713	1	13,20318713	0,05184	0,805
BDE	1,07333079	1	1,07333079	0,00421	0,904
ABDE	0,48861194	1	0,48861194	0,00192	0,917
CDE	1,39865953	1	1,39865953	0,00549	0,899
ACDE	1,69863613	1	1,69863613	0,00667	0,895
BCDE	1,63006603	1	1,63006603	0,00640	0,895
ABCDE	0,45150466	1	0,45150466	0,00177	0,918
F	1154,64459023	1	1154,64459023	4,53348	0,032
AF	4,54890685	1	4,54890685	0,01786	0,863
BF	41,55210870	1	41,55210870	0,16315	0,688
ABF	0,70614270	1	0,70614270	0,00277	0,912
CF	1,58077151	1	1,58077151	0,00621	0,896
ACF	2,38021889	1	2,38021889	0,00935	0,886
BCF	0,95346117	1	0,95346117	0,00374	0,907
ABCF	7,14395001	1	7,14395001	0,02805	0,843
DF	1,23029156	1	1,23029156	0,00483	0,902
ADF	1,50887559	1	1,50887559	0,00592	0,897
BDF	0,60061421	1	0,60061421	0,00236	0,914
ABDF	0,83057372	1	0,83057372	0,00326	0,909
CDF	0,45333072	1	0,45333072	0,00178	0,918
ACDF	1,33386172	1	1,33386172	0,00524	0,900
BCDF	0,85994258	1	0,85994258	0,00338	0,909
ABCDF	10,23652613	1	10,23652613	0,04019	0,822
EF	4081,72280455	1	4081,72280455	16,02606	<0,0005
AEF	0,15866915	1	0,15866915	0,00062	0,929
BEF	71,53450621	1	71,53450621	0,28087	0,603
ABEF	0,96921199	1	0,96921199	0,00381	0,906
CEF	0,32762987	1	0,32762987	0,00129	0,922
ACEF	7,97965389	1	7,97965389	0,03133	0,837
BCEF	0,19823018	1	0,19823018	0,00078	0,927
ABCEF	5,96592351	1	5,96592351	0,02342	0,852

DEF	47.26882768	1	47.26882768	0.18559	0.670
ADEF	1.21150377	1	1.21150377	0.00476	0.902
BDEF	2.02320235	1	2.02320235	0.00794	0.890
ABDEF	7.47326610	1	7.47326610	0.02934	0.840
CDEF	5.33561187	1	5.33561187	0.02095	0.857
ACDEF	1.47362943	1	1.47362943	0.00579	0.898
BCDEF	0.00014467	1	0.00014467	0.00000	0.949
ABCDEF	0.06007752	1	0.06007752	0.00024	0.936
REMAINING ERROR	81501.73475838	320	254.69292112		
TOTAL	104269.44799805	383			

REMAINING ERROR IS REPLICATION EFFECT PLUS ALL INTERACTIONS BETWEEN REPLICATIONS AND OTHER EFFECTS

A IS CATEGORY VARIABLE X(2) MARKET
B IS CATEGORY VARIABLE X(3) RESPONSE
C IS CATEGORY VARIABLE X(4) INVENT
D IS CATEGORY VARIABLE X(5) SLS COMM
E IS CATEGORY VARIABLE X(6) PART
F IS CATEGORY VARIABLE X(7) NFED I
G IS CATEGORY VARIABLE X(1) REP NO