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A Computerized Organization Model: Its Development And The Measurement Of its Benefits In A Strategic Planning Situation

Richard Albert Nobbs

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A COMPUTERIZED ORGANIZATION MODEL: ITS DEVELOPMENT
AND THE MEASUREMENT OF ITS BENEFITS IN A
STRATEGIC PLANNING SITUATION

by

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Submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Graduate Studies
The University of Western Ontario
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ABSTRACT

Strategic planning is very important for providing direction, improving performance, and ensuring continued success of organizations. In recent years an increasing emphasis has been placed upon the use of computerized organization models as tools for evaluating strategic planning proposals. The developers of such models, however, have been uncertain of the real values or benefits obtained from them.

The first purpose of this research was to obtain objective evidence of the values of a computerized organization model in one small company. The project was designed to develop a model in a real situation, make test applications and measure the model's benefits relative to existing methods of evaluating strategic planning proposals.

The model was developed in such a way that it could estimate the financial results and physical facilities needs of the company's operations, under specified conditions, for each of one to five forecast years. Objective measurements taken during test applications indicated that the model reduced calculating times significantly, and made more comprehensive evaluations than a manager could using previously existing hand evaluation methods. The subjective evaluations indicated that the model was very useful to the organization's managers and provided desirable new predictive capabilities. The cost-benefits analysis valued the model's results significantly higher than the costs associated with it.

A further purpose of the research was to gather, from other organizations, information that might assist the formulation of similar projects in the future. Organizations similar to the one involved in the project were asked to assess the results in relation to potential applicability of the model to their operations. Conditions under which the modelling approach might be applied successfully were determined. The results indicated considerable potential and interest for similar applications in other small organizations.

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CHAPTER I

INTRODUCTION

This chapter discusses the topic area, the purpose of the research, the choice of research design, the scope and limitations, the field research procedures, and summarizes the results and conclusions.

Organization Models and Strategic Planning

Strategic or long-range planning involves the choice of objectives, operations, resources, policies and plans for long-term development in any organization. Planning is very important for providing direction, improving performance and ensuring continued success. The process is complex, poorly understood by many practising managers, difficult to implement and control, and impossible to structure rigidly.

Two important factors play key roles in restricting the effective use of strategic planning. As Vancil (50) has shown the accuracy of forecasts, even in good planning situations, declines rapidly as the forecast time horizon is extended. Second, the sheer magnitude of calculations in most applications deters the establishment and continuous revising of comprehensive plans.

A major purpose of computerized organization models is to help overcome these two drawbacks to comprehensive planning. They are intended to provide rapid, low-cost evaluations of planning

proposals and revisions. If a model can do this, the importance of forecast accuracy declines because the sensitivity of plans to forecasts can be assessed readily; and evaluations can be made quickly for potential plan revisions. With a capability for rapid revisions a plan does not have to be viewed as an inviolable proposal that is only restyled annually at a cost of several man-months of labour. A computerized company model should help bring into reality the company plan that is as flexible as the environment and as adaptive as management thinking.

The use of computerized organization models for strategic (or long-range) planning evaluations is not new. Recent articles by Gershefski (12; 13) and a book edited by Schrieber (39) show that their use is increasing in large corporations. The model developers are convinced that the techniques are valuable but they have not reported measurements of the real benefits obtained. This research was intended to help fill that void by measuring the benefits that can accrue from replacing hand evaluation methods with a computerized organization model. The results were expected to add support for the value of the organization modelling approach and to provide impetus for widespread developments to improve the process of planning in all types of organizations.

The Purpose of the Research

This research project was undertaken, in view of the void cited above, to obtain objective evidence of the values of a computerized organization model in one small company. The evidence was to be obtained

by measuring the benefits to the specific organization of replacing machine-aided "hand" computation methods used to evaluate planning alternatives with a computerized model representing the essential features, functions and results of that organization and its operations.

The intention was first to select a small-to-medium-sized industrial or commercial company as a candidate for the project and then develop a computerized model of that company, as seen by its top management. The model would be applied to evaluate proposed alternative strategic plans, comparing the model's performance with that of the company's planning staff using its previously existing evaluation methods. The actual procedures followed will be outlined later in this chapter and are reported in detailed form in Chapters IV to VI.

It was anticipated that the use of the computerized organization model would change the process of evaluating planning alternatives in the company selected. The changes expected were:

1. A reduction in the time and costs of evaluating proposed plans,
2. A reduction in the number of working days needed to complete evaluations,
3. An increase in the number of relevant variables included in evaluations,
4. An increase in the number of important effects discovered before implementation of plans, and
5. An increase in the number of alternatives considered to develop plans dealing with particular proposals.

These factors were to be recorded empirically. Given that managers in an actual planning situation would consider these changes beneficial, their values could be estimated and compared with the costs of attainment. The research was also designed to obtain subjective evaluations of the benefits expected to accrue to an organization using a computer model for planning calculations. The researcher anticipated that the accumulated evidence would demonstrate that an organization model was an asset to the planning process.

A further purpose of the research was to gather, from other organizations, information that might assist the formulation of similar projects in the future. Six small companies, contacted in March 1970, had refused to become involved in the research. These firms were similar in size to the organization selected. The conclusion drawn, after the success of the field research was known, was that the six other organizations could make a significant contribution. They could provide answers to questions such as:

1. Why had those companies declined involvement initially?
2. Did they have characteristics similar to those of the firm that did participate?
3. Could assessments of the project results by other company executives suggest key characteristics that might foster or mitigate success of similar model applications?
4. Would companies that had refused to participate in unproven research reverse their decisions and be willing to participate in a replication of a similar project?

The intention was to contact the six other companies, provide them with summary information about the project and interview their presidents to obtain the necessary assessments. However, in August 1971 the researcher found that one of the above cited companies had ceased to exist. Early in 1971 it had become a part of a major division of a multi-national conglomerate. The remaining five firms were approached to obtain answers to the above types of questions which could provide guidelines for future research with organization models in small companies.

Contributions from the Research

Contributions from the research were greater than expected when the project was initiated. As shown in the results summary at the end of this chapter and in Chapters IX and X, the stated purposes were more than fulfilled. The contributions included:

1. Objective evidence, pertaining to the five changes outlined on page 3, that indicated the applications of the computerized organization model were a valuable addition to the planning process in one small company.
2. A cost-benefits analysis that indicated the techniques were economical to use in a small organization where prior computer applications had not been made.
3. Details of the procedures used for the successful development and application of an organization model in a real situation. These included the development approach taken, the structure of the model itself, operating details, and

specific examples of the flexibility that could be built into such a model.

4. Evidence that emphasized the importance of a common product unit for use in an organization model.
5. Details of the procedures used to develop a common product unit in a situation where company executives maintained there was too much diversity to obtain such a unit.
6. Indications that the development of an organization model, in a poorly structured planning situation, could be a significant influencing factor in the modification of the overall planning process in a direction considered beneficial by the executives involved.
7. Indications that the existence of some particular company characteristics should foster successful applications of similar models in other situations, while the existence of other characteristics would likely mitigate success.
8. Details of the reasons why some companies that could have helped fulfill the research purpose, while accruing benefits from it, refused to become involved in an unproven research proposal.
9. Evidence that a majority of those same companies might have agreed to participate in the replication of a successful research project when expected benefits had been demonstrated.

The Scope and Limitations of the Research

The approach decided upon to determine the benefits that could be obtained from computerized organization models was that of the

development and application of one model in one specific organization.

This would involve close co-operation from one group of managers such as Morton needed for his dissertation research at Harvard (31). As previously found by Holt, et al (19), a major advantage of this approach was that a close assessment could be made of a particular modelling technique and the benefits arising from its application. Objective measures could be obtained readily for the five beneficial changes listed in the preceding section; and the managers' assessments could be gathered throughout the period of model development and application. This approach would also enable a detailed accounting of model development procedures, an organization model and its operations--information that could be very valuable for analysts attempting to use a similar approach. Overall, the researcher felt that this type of project would be of the greatest value to others working in the area.

The chosen research design restricted the scope to the development and application of one computer model in a specific organization. This did not appear to be a severe restriction since the research of Gershefski (13) and Miller and Starr (29) indicated that the structure of many organizations and their planning evaluation procedures should be basically similar in nature. No attempt could be made to prove that assumption. Only an accumulation of research results from similar projects in a large number of different situations could establish it as fact. Although limited to a specific situation, the computer model was developed with an adaptive form as a preparation for future research projects that could determine the degree of similarity of structure and evaluation procedures in

different organizations.

Within the chosen situation, the scope of the model and its applications was intentionally broad. The model dealt with aggregate annual results for the organization as a whole, viewing its operations as the managers did for developing and evaluating plans. The model considered all aspects of the company's operations but not in great detail. For example, it evaluated inventory levels needed, but did not deal in any way with the mix of specific products that would be needed in inventory for daily, weekly, monthly or even annual sales. The model was intended as a useful tool for aggregate, strategic planning in a specific organization.

In order to determine the model's benefits, it was necessary to develop one that would be accepted and used by the organization's managers. These men evaluated projects with respect to the financial accounting results that could be expected, including all aspects of fixed and variable accounting costs. The main criterion used for selection of a planning proposal was its effects on the percentages of gross profits and after-tax profits in relation to sales. Thus the model was structured in relation to the company's financial accounting framework. This should not limit the generality of the research since most manufacturing companies of a similar size would likely use similar information for evaluations. However, only future applications could validate that assumption.

The Field Research Procedures

The field research began in January 1970 with a telephone approach to several public companies in Southwestern Ontario. At the researcher's request these firms forwarded copies of their latest, audited financial statements for perusal in developing the research design for an actual company project. Representatives of one of these publicly held companies were interviewed early in February 1970 and the conclusion taken was that their interests would not be compatible with the purpose of the planned project.

As a result of this experience, the researcher began formulating the structure of a computerized organization model to use in discussions with other companies. Then a written approach was made to seven more firms during March and early April 1970. An introductory letter (see Appendix A) outlined the proposed research project and its purpose and requested an exploratory interview. For each favorable response, a meeting was arranged to appraise company management of project details and to enable the researcher to gather information about the company and its operations. The feasibility of conducting the research in that particular organization was then studied, with the final decision based on the selection criteria detailed in Chapter IV.

The selection criteria were applied in relation to:

1. Size and authority structure ,
2. Willingness to co-operate ,
3. Use of planning ,
4. Nature of the organization ,

5. Use of computer services ,
6. Performance success ,
7. Representativeness , and
8. Pattern of management.

The first three were considered to be most important.

The company chosen for the project was a relatively small manufacturing firm producing moulded plastic products with annual sales of approximately \$2,000,000. The company's authority structure was set up along the functional lines of finance-control, marketing and manufacturing with department heads who were fully responsible for the operations in their areas. Overall direction was controlled by the President and the Chairman of the Board but all of the top managers were involved in problem-solving, decision-making and planning activities.

The managers were not following any formally-established set of planning procedures but they recognized the importance of and need for strategic planning and were doing a significant amount on an informally-structured basis.

The company did not have computer facilities but a time-shared service for the project was available through the University of Western Ontario.

Although not financially successful (in terms of profit) at the time the project started, the company had been successful, in the past, in relation to the plastics moulding industry generally and appeared to have great potential.

A deciding factor in the selection was that the managers

showed great willingness to co-operate--even to revealing, for the project, the most intimate details of the company's operations. They were also eager to learn how a computer model might be beneficial for planning evaluations.

After the selection of the company, the model development began. This consisted of three main phases: determining the major components, developing the major functional relationships and programming the model.

The major components were selected first on the basis of the financial accounting framework and organizational functions. Initially, these were determined to be the selling, administration and manufacturing cost components, and an income and balance sheet component (hereafter called the financial component). The need for further components was then determined on the basis of operating activity necessary to generate financial results, and activities needed to operate the model for planning evaluations. This led to the development of a production component to represent the physical operating facilities, a model change component to enter planning information into the model and a report-generating component to print results. Additional operating activities, such as sales forecasting, were embodied in the previously-established components for the model.

Major functional relationships were developed by examining five years of historical data for trends and interrelated factors in the financial statements. When it appeared that two or more factors were closely related, an attempt was made to develop a functional relationship using multiple regression analysis. When that failed (i.e. when it was not statistically significant at the 95% level) or

when it did not appear to be appropriate, functional relationships were established on the basis of the managers' descriptions of how results were generated in actual situations.

The computer programs were developed in the BASIC programming language for use on a time-shared computer facility. As such, the actual program detail was dependent upon the programming and hardware restrictions of the computer service used. For example, hardware restrictions made it necessary to develop a separate program for each component of the model and to transfer information between components through the use of computer storage files.

In programming each component, the logic and calculating sequence was first worked out using flow charts; then a preliminary program was written. As each program was developed, it was checked and corrected for syntax errors that would prevent it operating. When all programs had been refined, the model was run through a series of trials to check for and correct errors in the logic and calculations of the functional relationships.

The model was first used to evaluate several planning proposals in parallel with the company controller. The procedure was to have the Controller gather the information required for a particular evaluation and have him carry it out, recording the amount of time required. The Controller then used the model to make the same evaluation. The results were compared. After this parallel set of evaluations had been made for the first alternative for a proposal, the Controller was asked to use the model to evaluate any number of further alternatives he might wish to consider. The Controller was

chosen because he was the one who had been responsible for gathering complete information and preparing the evaluation for each planning proposal.

Further applications were made in two management planning sessions in which all five managers were present. Here, the procedure was to enter into the model the key elements of ideas expressed by any of the managers, run an evaluation and present the results to the group as quickly as they could be printed out. These sessions were planned to provide the managers with a means of testing their ideas immediately. They were later asked to assess the value of these sessions compared to the ones they would normally have had.

The performance of the model was evaluated subjectively and objectively. The subjective evaluations were obtained by interviewing each manager regarding the model's usefulness, its benefits to date and those expected in the future, the manner in which he might be able to make use of the model and his impressions about the changes the research project had brought about in the company. Each manager was also asked to weigh the benefits of conducting evaluations with and without the model relative to the costs involved.

The objective measures were obtained during the model applications in parallel with the Controller's evaluations by recording the comparative times required, the number of relevant variables considered, the number of important effects predicted and the number of alternatives considered.

After the field work had been completed successfully the researcher prepared an article for publication in a management journal

outlining the nature of the project and its accomplishments (Nobbs, 37). Copies of this article were sent with a covering letter to the presidents of the five companies that had been contacted previously but not selected for the project (for various reasons). The researcher then made appointments with those executives to discuss the organization modelling concept and obtain information about the companies and their executives assessments of the project. The questionnaire included as Appendix L was used to record information after the interviews. The results gathered were used to amplify the assessment of why the project had been successful and to indicate some of the potential for similar applications in other situations. The details are included in Chapter X.

Results and Conclusions

The research project, model development and the model itself had many effects in the organization involved in the research. These provided the anticipated evidence that the model application was a valuable addition to the planning process.

First, the objective measures taken during the model applications indicated several changes in plan evaluations that the managers regarded as improvements. The model reduced the time required for the evaluation of the first alternative for any proposed plan by an average of 83%. It reduced the time required to evaluate subsequent alternatives to one-tenth of that required for a machine-aided hand computation. The model also considered an average of more than twice as many relevant variables as the Controller did in his evaluations, and predicted an average of twice as many important effects as the managers

had determined they would have to deal with if each plan was implemented. In addition, the model provided the managers with predictions of the balance sheet results. This, they thought, was highly desirable. They had not previously considered the balance sheet in their evaluations because of the time required to develop and modify it for each hand evaluation.

Second, the subjective measures indicated the managers felt the model benefits outweighed the monthly costs for the teletype terminal, model storage and computer use. They also felt the planning evaluations were much more beneficial using the model than using their previous methods. A primary reason for this was that, although it was relatively easy for them to evaluate the results of a specific project over a number of years, the complexities of evaluating long-term results for the company had prevented them from making such forecasts by hand. The model was constructed to predict a company forecast for a period of one to five years.

Third, the model development was beneficial to the company in that it induced the managers to examine, in a new light, several aspects of the operation. For example, the company had no historical records of work force size and no specific methods had been established to determine just how large the work force should be. A functional relationship had to be developed to enable the model to predict the work force size for any given sales level. This forced the Manufacturing Vice-President to examine the work force--and ultimately decide that its current size was larger than required for the production volume.

Fourth, the model development provided the managers with methods to predict some factors they had been unable to predict in the past. One major benefit was from the establishment of a common product unit enabling the development of value units and production rate units for use in the model. These provided the capability for estimating production volumes and hours, equipment needs and plant and inventory space needs in relation to forecast sales. Prior to the development of the model, the Manufacturing Vice-President had only been able to assess these needs after they had arisen and become a problem.

Finally, the research project was a causal factor in hastening the managers' establishment of formalized planning procedures. When the actual model development began in April 1970 there was strong emphasis in the company on the need for, and importance of, planning --particularly in view of its poor financial position and the depressed state of the Canadian economy. However, the planning had been informal and there was not always complete communication among the five managers. The probing interviews and group meetings required for the project were a catalyst (to an unmeasured extent) in the management's conversion over a six-month period from irregularly-scheduled, informal planning sessions to completely regular and formally-recorded sessions for planning and the exchange of ideas.

In addition, in the years before the research began the Marketing and Manufacturing Vice-Presidents had not been provided with the company's formal statements of financial results. Therefore, they were unable to answer questions about the overall financial effects of some of their decisions. Within a month of the model

development start, they began to receive this information as regularly as the President and Chairman of the Board and felt it enabled them to put their activities into perspective. The research project was influential in pointing out the need for this change.

All of the above results would not likely be attained in every situation where an organization model development and application project was carried out. Many would be clearly dependent upon conditions existing before the model development began. For example, in this situation the model was a catalyst in the emergence of formal planning procedures. In an organization with existing procedures the same effect would not be expected. A similar statement could be made regarding improvements in communication to managers and the provision of new information.

However, the key results relating to increased speed and comprehensiveness of calculations should hold. These factors provide the evidence of the real value of the model evaluation technique for any organization. A computerized model should give any group of managers the capability to: evaluate planning proposals in a much shorter time; consider more relevant factors in their evaluations; evaluate more alternatives of any proposal; determine many unanticipated effects of their proposals.

The field research portion of this project required 11 months after the organization was chosen--from April 1970 through February 1971. The model development phase alone spanned seven months. However, with the structure of the model set up, a similar application in a different situation should require a much shorter time for development even if

the organization structure were quite different. If the assumption (stated on page 7) regarding the similarity of plan evaluation structures was proven valid, the model development in another situation would consist mainly of determining the parameter and variable values for the model. This should require about two months. A further two to three months would likely be needed to debug and test such a model before it could be said to be in working condition. The end result would likely be a reduction of six to seven months for development and verification. A key opportunity remaining for future research, then, is to determine whether the model developed in this project can be applied in general form to other situations.

The assessments of the model and project results that were obtained from other organizations revealed a potential for further applications. The presidents of the five firms all agreed that a model of the type developed could be very useful in particular kinds of organizations. Two of the presidents were prepared to consider immediate involvement in a duplicate research project and two could foresee conditions under which their firms could make beneficial use of the model. Only one of the presidents suggested the approach would not be appropriate for any of his operations because the model was more sophisticated than the one needed for strategic planning in the particular situation.

The assessments by other organizations suggested some company characteristics that should foster success of similar model applications. The key characteristics mentioned in the assessments were a limited

number of product lines, relatively stable types of products, a competitive market with opportunities for change and growth, a felt need for or the existence of long-range forecasts and strategic planning procedures, and a need for relatively frequent evaluations of planning proposals in view of changing conditions. The presidents also indicated that as long as the results justified the costs in relation to company size their executives would willingly co-operate and participate in a modelling project.

The presidents of the other organizations also cited some characteristics that would likely preclude a successful application. These were suggested to be a relatively stable market, a high market share with few expansion possibilities, closely predictable sales volumes, existing long-range forecasts, and no felt need for re-evaluation more than once a year. If the above characteristics were perceived to exist the assessors estimated that the model costs would not be justified by its use. However, where the characteristics favouring success existed they predicted an organization model application would be very beneficial.

CHAPTER II

STRATEGIC PLANNING AND ORGANIZATION MODELS

This chapter defines strategic planning and discusses its nature and importance, the potential for planning evaluation models, definitions of model terms, the concept of an organization model, and the existence and use of organization models.

A growing emphasis has been placed upon the importance of planning and the use of the computer as an evaluation tool in many organizations. Much of the literature has stressed that major factors influencing the success of organizations are the planning and control of their activities. The planning process determines how an organization's scarce resources should be allocated in attempts to achieve its predetermined objectives. Control ensures that the use of resources will be such that the intent or purpose of the plans will be achieved to the greatest extent possible. Although this research concentrated on one particular type of tool to aid in the strategic planning process it must be remembered, as Anthony points out, that planning and control do not relate to separable main categories of activities (1, p 10). Some elements of control enter the planning process directly while, at the same time, planned activities are not feasible unless they are subjected to control during implementation.

The most important planning occurs at the top management level in that such planning determines the objectives, purpose and nature of

an organization, as well as the overall direction of its activities and the use of its resources. This has been labelled strategic planning by Anthony and others while being called long-range planning by Warren (51) and others. The writer prefers to designate the apex of the planning activities in an organization as strategic planning. The nature of the activity is definitely long-range, in relation to its effects upon an organization, and "strategic" connotes purposeful direction without need for further amplification. The meaning of the term "strategic planning" and the reasons for its choice will become clear in the sections below defining it and describing its nature.

A further purpose of this chapter is to delineate the essence of one particular type of tool that can be applied for planning evaluations (the organization or company model), and to report on its existence and use. The term "organization model" has been chosen to remove any implication that such models can be employed only in industrial or commercial situations--they are equally applicable in government and institutional settings. The adjectives that have been applied with similar frequency to essentially the same type of model are "company", "corporate", "corporate financial", and "planning". All such models are intended as evaluation tools for use in the overall planning process in organizations. The concept involved will be amplified after the discussion of strategic planning.

The Definition of Strategic Planning

Strategic planning is a complex process involving the establishment of organizational objectives (what the organization is now and

intends to be in the future) and determining the general strategies and plans to be followed in attempts to attain the objectives.

Anthony's definition is as follows:

"Strategic planning is the process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use, and disposition of these resources. (1, p 16)."

The above definition introduces, in general terms, a very extensive and complex set of interdependent activities. These activities include the choice of products, markets, technology, processes and resources (material, human and financial) for an organization. Involved also is the prediction of changing environmental conditions, likely critical events (with their timing, probabilities of occurrence and consequences) and other factors; and their combination into an analysis for the selection of strategy, objectives, and so on. The many decisions made at the top management level result in policies and/or guidelines which are then transmitted down through the organization's hierarchy to lower levels for detailed planning and control. However, the process is circular because more detailed planning at lower levels will likely determine infeasibilities and changes to be transmitted upward for adjustments to the strategic plans (1, p 32).

In its simplest sense a strategy can be defined as a plan of action formulated in a manner intended to fulfill a purpose which is to assist in the attainment of an objective or objectives. Definitional difficulties arise because several strategies might be selected in attempting to attain one objective and any one strategy might be intended to help attain a multiple of objectives. Thain attempted to encompass

all possibilities in an early and brief definition of long-range planning:

"Long-range planning is deciding where a company should be going and how it should get there. A long-range plan is a set of objectives and key decisions and plans as to how the objectives should be achieved. (48, p 2)."

Whether we accept the exact wording of the above definitions or not they suggest that strategic planning must, by its nature, be an inward and outward looking activity. The organization's environment must be considered as well as the internal deployment and use of resources. This activity is carried on at the top management level in order to assess and prepare for external and internal changes to which the organization might be subjected. If an organization was operating in a stable environment and not changing in size or activities there would be no need for formulating objectives and planning ways to attain them. Several authors have emphasized that a major purpose of strategic planning is to help top managers deal with change effectively by helping them anticipate the effects of change (see for example Thain, 48, p 3; Steiner, 45, p 18; and Warren, 51, p 18). However, to this it might be added that "the purpose of long-range planning is not nearly so much having a plan as developing processes, attitudes, and perspectives which make planning possible (Perrin, 38, p 5)."

Steiner develops a lengthy outline of the main characteristics of strategic planning in order to bolster his attempts at formulating a definition (45, Chapter 2). The following is a paraphrasing of his outline. Strategic planning is an activity carried out by top management and its staff (at headquarters and major divisions) relating

exclusively to decisions in the province of those levels. The process is continuous although subject to irregular timing of results and heavily weighted by the subjective values of the managers. Strategic planning usually deals with unstructured problems subject to high uncertainty and risk with a wide range of alternatives from which to choose. The scope is usually broad and requires large amounts of inaccurate data about the future which is derived from, and relates to, areas of knowledge outside the organization. Strategic planning is original in the sense that it is the source or origin of guidelines for all other planning in an organization (activities that can, in turn, require the modification of strategic plans). As a result it usually covers a long time horizon, however, the time in which a strategy takes effect may be very short--albeit with consequences that will extend over a long time spectrum. Conceptually, strategic planning covers the entire scope of the organization and its internal and external environment. The process usually leads to the development of new and generally debatable objectives, policies, and strategies for which the effectiveness and efficiency will likely be considerably difficult to measure in practice (taken from Steiner, 45, pp 37-39).

The Importance of Strategic Planning

The current importance and need for strategic (and other) planning is related mainly to the nature of the environment in which organizations of all types must operate. The change from the early part of the twentieth century to now is well illustrated by Bennis:

"The environment was thought to be placid, predictable, and uncomplicated. Man was thought to be placid, predictable,

and uncomplicated. 'All you have to do,' said Henry Ford in one of his speeches to the Ford executives, 'is to set the work before the men and they will do it.' Organizations based on these assumptions will fail; if not today, then tomorrow [because this environment does not exist].

"The environment now is busy, clogged and dense with opportunities and threats; it is turbulent, uncertain, and dynamic. The people who work for organizations are more complicated than ever before. They have needs, motives, anxieties, and to make matters even more complicated, they bring higher expectations than ever before to our institutions (3, p 81)."

The increasing emphasis on planning has been particularly noticeable in business organizations but some of the reasons for it can be applied directly to other types of organizations. Rapid market changes, competition, technological, political and social changes, and many other factors in the environment of organizations compel them to be more concerned about planning their operations for the future. Many authors refer to the increasing importance of strategic planning and the following reasons have been compounded from several sources (Steiner, 45, pp 15-17; S.R.I., 44, p 8; and Thain, 48, pp 6-15):

1. An increasingly complex and dynamic environment including population and social changes, changing consumer tastes, political changes and government regulations, economic fluctuations, labour union activities, and greater emphasis on the social responsibilities of business.
2. Increasing competitive pressures and market changes as indicated by business failures, increasing product obsolescence, and the rapid growth of new industries.
3. Increasing rates of development and change in technology.
4. The increasing size of corporations with a coincident need for more internal co-ordination and better communication.

5. The increasing complexity of the job of managing a business especially with respect to decision-making complexity and the number of relevant variables to consider.
6. The increasing futurity of decisions and the time needed for implementation especially as this affects resources planning and the lead times before results are realized.
7. The increasing ability and desire of business to make trends and manage by objectives rather than scrambling to react to changes in trends induced by others.

Much of the current stress on the importance of strategic planning is related to increasing rates of change in many factors in the total environment of organizations. In these circumstances one danger for a top management using strategic planning is that it might adhere to one plan of action for too long because of the great deal of time and effort expended on developing the plan. Gershefski's research results indicate that companies using organization models feel that this is one pitfall that the models help them to avoid because of the speed and relatively low costs of getting predictions on the possible effects of change (13, p 3).

The Potential for Evaluation Models

As indicated above the strategic planning process is very complex but it can be considered as consisting of three main phases: problem diagnosis, decision-making, and planning for implementation (Thain, 48, Chapter 5). These are not distinct phases, nor can any one of them be considered as consisting solely of the type of activity

suggested by its label which is intended to suggest only its major emphasis. The following descriptions have been extracted from Thain's report (48, Chapter 5, *passim*). The first phase includes the activities of formulating goals and objectives (deciding what the organization should be), analysing what the organization now is and how it is performing, and determining what the problems are (or where changes must be made to attain goals and objectives). The second phase includes the activities of defining the problem(s), gathering and analysing information, finding alternative strategic solutions, evaluating the alternatives, and choosing a strategy or set of strategies. The third phase includes the activities of describing the strategic decision, planning the tactics to use in furthering it, making the detailed planning and control decisions needed for implementation, and following up and reappraising the results.

Each of the above phases of strategic planning involves one or more steps in which the organization's actual or expected performance must be evaluated in comparison with its intended performance or goals and objectives. In these areas a model which represents the essence of the organization's activities is likely to be a beneficial analytical tool. The specific applications for an evaluating model could be: in the first phase, to help analyse current performance; in the second phase, to help analyse data and to evaluate strategic alternatives; and in the third phase, to help plan implementation tactics. In a recent survey conducted by Gershefski it was found that company models were being used in many ways to help management in

planning and decision-making. The five most frequently mentioned uses were:

1. Evaluate alternative operating or investment strategies,
2. Provide revised financial projections rapidly,
3. Assist in determining feasible corporate goals,
4. Analyse the effect of interacting items, and
5. Determine sensitivity of earnings to external factors (13, p 5)."

These and many other model uses are really a part of those activities broadly defined as parts of the phases of strategic planning.

In evaluating alternative strategies that have been suggested in the planning process, for example, a model could be employed to predict probable results without committing the organization to extra activity. The model could be constructed to represent the essential features and functions of the organization for computer evaluation. Then, when the strategic planner wished to assess an alternative strategy he could do so by superimposing its features upon the existing organization model and operating the adjusted model in a simulation mode to determine what the probable effects would be over an extended period of time, if that alternative was actually chosen for implementation. By using this procedure he could evaluate several alternative strategies in a relatively short period of time in order to determine which ones would likely be best (within the organization's constraints) and thus should be selected for future implementation.

The above discussion of the potential for evaluation models assumes a particular concept of what such models should be like. In the following sections some terms will be defined in relation to how they are used for discussing models and then the concept of an organization model will be presented. The type of model introduced is an

evaluation model for which there should be a wide range of possible applications and great potential in many different types of organizations of all sizes.

Some Definitions of Model Terms

An organization model will be introduced as a tool that can be used to forecast conditions and results in a future time period or for a series of time periods. However, there are many combinations of types or natures of models that could be used for the same purpose. For example, if a model is to be of the analytical type it could be normative (or prescriptive) and deterministic in nature. On the other hand, a simulation type of model might be descriptive-predictive or normative-prescriptive and deterministic or stochastic in nature. This proliferation of terms tends to cloud the issue of what an organization model could be and is. To provide a clear understanding of the meanings of these terms in later sections the intended definitions will be outlined below.

An analytical model "automatically determines the best set of alternatives to reach a specified objective based on a given set of future conditions (Gershefski, 11, p 34)." Such a model "is based on explicit criteria, usually economic, which are expressed as mathematical functions of the controllable and uncontrollable variables which enter into the situation (Gordon, 16, p 45)." The optimum solution is obtained by mathematical manipulation of the model.

On the other hand, a simulation model is one that must be experimented upon using random sampling or trial-and-error techniques

to gather performance data for analysis. Random sampling techniques usually are used when the events or reactions in the model occur in accordance with some describable statistical probability distributions. Trial-and-error techniques might be used when the mathematical relationships among the variables are known but the model is too complex to solve analytically. Simulation should enable the selection of a satisfactory solution but cannot guarantee that it will be optimum.

Naylor, et al provide a distinction between descriptive and normative simulation models which will be used to provide definitions of these terms for both simulation and analytical models:

"When we use a computer . . . model for [descriptive] or positive analysis, we are concerned primarily with explaining how some particular system behaves. Conclusions or predictions implied by data generated by such a model must be subjected to direct empirical observation for either verification or refutation. Historical and/or predictive verification lends support to the model as a whole. . .

"On the other hand, the purpose of simulation [and analytical] models used for normative or prescriptive purposes is to recommend to someone . . . a policy or course of action that is expected to accommodate one or more of the person's . . . objectives concerning the behavior of the system (34, p 315)."

The remaining distinction to be made is between deterministic and stochastic models. Naylor, et al distinguish them as follows:

"In deterministic models . . . the operating characteristics are assumed to be exact relationships rather than probability density functions . . . [Whereas] those models in which at least one of the operating characteristics is given by a probability density function are said to be stochastic models (34, pp 16-17)."

Gershefski makes the distinction in this way:

"A stochastic model . . . automatically projects the results for a wide range of future conditions. A deterministic model, however, projects results for only a given set of conditions (11, p 35)."

These distinctions are complementary since the probability density functions in a stochastic model represent distributions of future conditions.

The Concept of an Organization Model

An organization model has been conceived as one that is developed from a top management viewpoint so that all areas of the organization are considered although some may be viewed in relatively little detail. It is a computer program, based on relatively simple mathematical equations, which simulates the physical operations, interactions and resulting financial activities of the organization. The model will include major blocks of activity for each major operating component of the organization together with the inputs and outputs needed to represent the essence of the manner in which the total organization functions. (This model concept was extracted from Gershefski, 11, *passim*.)

Using the definitions given in the previous section the key characteristics can be outlined for an organization model as currently conceived. In his study Gershefski found:

"Ninety-five percent of the models were of the case study simulation type. Only five percent were mathematical programming, or optimization models. Eighty-eight percent of the models were deterministic in nature. Twelve percent were stochastic in nature, i.e., did consider a probability distribution for each of the key factors (13, p 6)."

Thus, the most popular conception of the characteristics of an organization model appeared to be the same as that arising from the feasibility study for the Sun Oil Company model. The next three paragraphs are an outline of those characteristics and the rationale for accepting them

as detailed by Gershefski (11, pp 34-35).

An organization model should be of the case-study simulation type (where "case-study" refers to the ability to evaluate only one alternative in one computer run with the model). Such a model can be designed to predict expected future results given that a particular alternative is followed. The "optimum" cannot be selected from among several alternatives. However, such a model allows a great deal of flexibility since many types of functional relationships can be incorporated. Operating in a simulation mode an organization model can handle a hierarchy of management objectives which can be changed from time to time as the environment changes. It can also provide for ease of communication among departments and should require much less development time, and cost, than a comprehensive analytical model.

The organization model could be deterministic or stochastic in nature. A deterministic model, which can predict results for only one set of conditions at a time, provides some distinct development and operating advantages with some limitations. A series of runs with a deterministic model can produce results similar to a stochastic model within a range of conditions that top management sees as most likely to apply--albeit at considerably lower computational efficiency. However, a deterministic model is favored for its ease of development and potential for operating flexibility. In addition, top management planners working with such a model are free to exercise their judgement in the selection of operating conditions and are, therefore, more likely to accept the model and use it.

An organization model should be an information generator

wherever possible, rather than an information compiler, in order to restrict the volume of inputs needed for the model. Thus, the development of such a model should concentrate on determining the nature and types of forecasts needed for a viable model, rather than attempting to obtain the detailed historical information that a model would need to develop the forecasts. This should "be an easier type of model to implement since it makes fewer demands on operating departments (Gershefski, 11, pp 35-36)."

In summary, a computerized organization model is seen as a tool that top management can employ to evaluate strategic planning alternatives. The model represents the essential features of any particular organization, its operations and interactions, and results produced. The most appropriate type of organization model is likely to be one that operates in a case-study simulation mode, is deterministic and descriptive in nature, and is essentially an information generator. The next section will provide a review of the existence and use of such models.

The Existence and Use of Organization Models

Much information about the existence and use of computerized organization models was recently collected together in one volume as a result of a symposium on "Corporate Simulation Models" held at the University of Washington in Seattle on March 23-25, 1970 (Schrieber, 39). The resulting publication contains the text of the twenty-five papers presented covering theoretical aspects of modelling technology as well as reports on models used in a wide variety of organizations. The model applications were in airplane manufacturing, automotive retailing,

banking, business machines, chemicals, computer manufacturing, crude oil logistics, farm equipment, forest products, glass manufacturing, integrated oil company, large university, life insurance, pulp industry, research and development, sales and advertising, and telephone and telegraph. Most of the models of total corporate systems reported on are being used by large, well-known corporations in the United States (Schrieber, 39, *passim*). Summaries of these applications and those reported on through other sources such as the Operations Research Society of America National Convention in the fall of 1970 would not provide a concise picture of the existence, use and nature of organization models. However, two "state of the art" surveys were completed recently and provide aggregated information.

In the first survey Gershefski received replies from 323 corporations for a questionnaire sent out to determine the prevalence of corporate models, their advantages, nature of applications made, model development approaches, and the structural characteristics of corporate models (13). The major results from the survey indicate that:

"One hundred corporate models will be in use or under development by the end of the year [1969]. Models are or have been constructed for virtually all types of industries. . . . Models are being used in corporate planning and budgeting because of their ability to make consolidated financial projections with which to evaluate management alternatives. . . . The majority of corporate models are computer simulations which utilize case studies to determine the effects of different strategies (13, p 1)."

Among the companies responding, Gershefski found that the trend toward corporate model development was increasing at about the same rate as that of the commencement of formal planning but with a five-year lag in numbers (13, Tables 2 and 4). In addition, almost all of

the models reported on were financial in nature and projected reports such as income statements, balance sheets, capital expenditures, and statements of the sources and uses of funds and had the following technical characteristics:

"Sixty-five percent of the companies developed models which began by considering the total corporation but in very little detail. . . . The typical projection period was five years. . . . Seventy-two percent of the companies considered a year as the time period of interest. . . . Ninety-five percent of the models were of the case study, simulation type. . . . Eighty-eight percent of the models were deterministic in nature. . . . Ninety-four percent of the models were computerized. . . . Seventy-eight percent of the models were developed without the direct use of outside consultants (13, pp 4 & 6)."

Gershefski used a broad survey approach to discover the general characteristics of many corporate models then in use. On the other hand, Dickson et al were concerned with determining more about the trends in the technology of corporate model development and restricted their survey to twenty companies (7). As such their study did not include a large sample of models in use but did reveal significant information about the existence and use of some organization models. The twenty models examined all projected financial statements but a trend was found towards the built-in analysis of some financial factors such as "return-on-capital, net earnings-to-sales, etc. (Dickson, et al., 7, p 51)." The authors also found that:

1. None of the models used exception reporting for the control of key variables,
2. None had the capability to make on-line comparisons between model trials (i.e. the users make visual results comparisons).
3. Some made predictions of related facilities and personnel

- needs in addition to the financial results,
4. All of the models were deterministic in nature and most used the simulation or case study approach,
 5. Most of the models had a fixed structure for inputs but the trend (indicated by recently developed models) was towards models with a flexible structure that allow the user to specify variable values, rates of change, and changes in rates,
 6. Model functional relationships were determined in a variety of ways including percentage relationships, regression analysis and historical ratio analysis,
 7. There was a strong trend towards designing organization models with the user in mind, allowing flexibility for use by many different persons,
 8. Most of the effort was still being expended to develop models that evaluated alternatives rather than models that made an optimum selection from a set of alternatives,
 9. The majority of the models were developed using the "top down" approach which views the whole organization in relatively little detail. But the trend in divisionally decentralized firms was to build the overall model using the "bottom up" approach,
 10. The apparent trend was towards models that operated in an interactive mode rather than on a batch-processing basis, and
 11. The goal of corporate planning models was not to produce plans but to facilitate the planning process (The above information was summarized from Dickson, et al, 7, pp 51-68).

The results of the two surveys cited indicated that organization models were in fairly extensive and growing use particularly by large corporations in the United States. Other information not specifically recorded in the form of a quotable reference also indicates that several models, similar to the type reported in the surveys, were in use or under development in larger companies in Canada. Shell Canada, for example, used such a corporate model to evaluate the ramifications of changing conditions and for budget planning (Bridges, 5). The nature of the models being used by Canadian companies was not known. However, a specific and concise description of the development and use of the Sun Oil corporate financial model has been made by Gershefski (12). A summary statement about the Sun Oil model fitted the characteristics generally found to exist for the organization models in use. The existing models were chiefly financial in nature, deterministic in form, used a case-study type of simulation to evaluate alternatives and were constructed on a corporate-wide or "top down" basis.

The model developed for and used during this project had characteristics very much the same as those of the large corporation models reported on by the surveys. However, its purpose was quite different. The purpose of most of the existing models is to facilitate particular, on-going planning processes. The increasing use of corporate models indicates a growing acceptance of the approach among planners in multi-division corporations. Organization models have not been recommended for small firms (14, p 71).

This project was carried out to gather evidence intended to prove the value of the organization model concept and approach for any

organization. If proven valuable in a small company situation, this would increase significantly the scope of potential uses of the organization model approach. Also, previously developed models were proprietary in nature. Thus, the model development would add more by making details from the experience of one actual application generally available to others.

CHAPTER III

MODEL ADVANTAGES AND EVALUATION CRITERIA

This chapter reports on observations of the advantages of organization models and outlines the criteria used to measure the advantages of the model developed and applied to the strategic planning evaluation process.

Advantages of Organization Models

The recent increase in the use of computerized organization models by large corporations suggested that there were significant advantages that could be realized through their use. Many experiments have been conducted to determine advantages of the use of computer models per se as tools to aid in decision-making and problem-solving. The results of some of these experiments that are relevant to this project will be reported on below. However, a key source of information relating to the advantages of organization models in actual situations was Gershefski's "state of the art survey" results. He summarized the advantages as follows:

"When describing the advantages of a corporate model, one frequently finds he has merely summarized the reasons why one would use the computer and/or the techniques of operations research to assist in the solution of a problem. The advantages indicated below are based on numerous discussions with others who have been engaged in corporate modeling. (This writer's emphasis).

* Models provide answers rapidly at relatively low cost. Once developed, models enable management to experiment with a wide variety of forecasts and cases without tying up a lot of man-power.

- * Models are comprehensive and consider the effect of inter-related accounts. Consequently if one factor is changed it is possible to study how it reverberates and effects the entire company, e.g., the effect of a change in volume on the cost of sales.
- * Models follow a precise, documented procedure. The demands for precise coding of the computer program insure that the calculation procedure to be used is defined unambiguously.
- * Models help define management's need for information. As a matter of fact, the approach used to develop a corporate model is very similar to the method used to develop the requirements for an information system, e.g., the identification of key variables.
- * Models provide a communication link throughout the company. They make all departments within the company equally visible since numbers are cast in a similar framework and it is easy to see how the various parts make up the total.
- * Models enable one to assess the long term impact of short term decisions. This enables (and forces) management to consider the effect of strategies designed to increase only short term profits.

"The hard dollar benefits of a model are difficult to measure. It is true that manpower savings can be realized in the preparation of budgets and long range plans. This applies to both the initial projections and any revisions which are made.

"To a large extent, however, the value of the model is tied to the value of information and to the value of the planning process itself. These values are not easy to quantify (13, pp 3-4)."

The above summary was largely the result of subjective opinion unsupported by recorded objective data. Gershefski's survey did not accumulate a record of measured benefits (13, passim) and documented reports on other models indicate no measures were taken (Schrieber, 39, passim). However, opinions of the value of organization models have been strengthened by the results of Miller's experiments on the use of computer graphics for decision making. He concluded that:

1. Computer applications could largely eliminate the deteriorating effects of time on data through the rapidity of analysis,

and

2. Decision making was enhanced when the manager had a model that he could manipulate at will to determine what was likely to happen if particular actions were taken (30, pp 121-122).

A laboratory study was conducted recently by Ferguson and Jones at Harvard University using Massachusetts Institute of Technology computer facilities. During the experiments a number of managers developed production schedules for a simulated job shop using manual methods and using a computer simulation model accessed through a typewriter terminal. The development of production schedules in the experimental situation required the consideration of many interacting and interdependent variables. The researchers found that with computer assistance the participants:

1. Produced more profitable schedules,
2. Required significantly less time to evaluate each schedule alternative,
3. Were able to consider many more alternatives and find several feasible schedules in less time than they required to develop one manually (Ferguson and Jones, 9, p B-560).

In an extension to the same experimental job shop simulations Jones and others obtained similar results for both typewriter and graphical display computer terminals (21).

In an earlier experiment, Morton worked with three top level managers in the laundry division of a large electrical manufacturer to determine the benefits of an interactive, visual display device in helping the managers to make unstructured decisions (32). In this

experiment the managers were provided with direct access to the total (or global) data base on a central computer through the development of appropriate computer software to activate the remote visual display terminal. Morton did not provide the managers with a rigidly structured computer model for evaluations but enabled them to ask the computer for information and analyses. They were then able to search out problems at will during the processes that they followed to develop monthly production and marketing plans. The quantitative and qualitative results indicated that highly significant improvements were made to the planning process involved:

"The time spent in the planning cycle collapsed sharply, dropping from an elapsed time of three weeks to half a day. Similarly the amount of managerial time actually involved in meetings or working on data dropped from six days to half a day. . . .

". . . The shortened elapsed time results in a richer problem solving environment. . . . Under the old system, as time passed, the information on which decisions were being based was increasingly less current. The decision could be outdated before it was made. With the decision cycle reduced to a day, there is little chance for this to happen. . .

"The second major impact of the system was on the structure of the problem solving process. It changed from a segmented batch processing operation to an interactive mode of problem solving. . . . It was a decision oriented system, in which the response time was such that hunches could be followed up and alternatives tested as the problem solving process flowed from one stage to the next without any costly interruptions. . .

"The manager was best able to deal with the strategic issues concerning the identification of significant problems, key variables, and potential solutions (Morton, 32, p 79)."

The experimental results found by Ferguson and Jones, and Morton, indicate significant advantages for computer applications per se in complex planning processes. They did not impose, explicitly, formal structures to the situations. On the other hand, Miller worked with

similar devices providing participants with a simplified company model (imposing a formal structure) and obtained similar results (30, passim.). In all of these cases many of the gains accrued from the greatly reduced evaluation times resulting from the use of advanced interactive computer devices.

This research project was seen as being complementary to experiments such as the above. Here a computerized organization model was developed and applied to planning evaluations in an actual planning situation. The model imposed a particular structure upon the planning evaluation process but the structure was flexible in that it allowed the managers to select and enter specific values for variables, parameters and parameter change multipliers. The managers in the real situation were able to interact with the model through the typewriter (or teletype) terminal used to gain access to the computer. The computerized organization model was developed to serve specific purposes in a real planning situation. One of these was to improve the strategic planning process by formalizing and speeding up the evaluation procedures used. A further objective was, in the words of Kriebel, "to expand the decision analysis capability (25, p 8)" by making new types or forms of analysis and information available. This project was set up to measure the benefits or advantages of applying such a computerized organization model in a real situation.

Criteria for Evaluating the Organization Model

The research studies cited above indicate that some quantitative factors could be measured directly to determine advantages of applying

an organization model. These factors were used as the basis for the development of five criteria for evaluation purposes. The first two centred on an assessment of the speed of calculations and the last three on the comprehensiveness of evaluations that could be made using a computerized organization model.

The five criteria are listed below together with prior research results supporting their selection. The following prelude applies to each criterion as stated:

When compared to previous methods of computation, the application of a computerized organization model to evaluate strategic planning proposals should:

1. Reduce the cost of evaluations in terms of the manpower and computer time required.

This criterion was set up because most computer applications have been made with the promise of reduced time and manpower requirements at low incremental costs. Gershefski (11; 12; 13), Miller (30), Morton (31; 32; 33), Ferguson and Jones (9), Jones et al (21), and others have stressed the importance of increased computing speeds.

Shorter computation times were considered important for two reasons. First, McDonough's study of information economics (28) has indicated that the marginal cost of incremental information rises rapidly over time. Second, assuming rational behaviour on the part of responsible managers, time saved from evaluation tasks would likely be used in other tasks of value to an organization. The conclusion drawn was that a measure of increased computing speeds would be a key indicator of a model benefit.

2. Reduce the total elapsed time for the evaluation of plans in terms of the number of calendar days involved.

This criterion was developed primarily because of the work done by Morton (31; 32; 33). Morton found that the time needed for the marketing and production planning activity to which his Management Decision System was applied, contracted to 1 day from 22 (33, p 13). He stressed that the resulting short decision time meant that the nuances of a particular situation and the relevant data were always fresh in the minds of the managers involved. Morton's results were obtained using a highly sophisticated computer system that included a graphical display terminal for instantaneous response to analysis requests (33, p 13).

As an evaluation tool, a computerized organization model was considered to be capable of producing similar effects to those Morton observed. The elapsed time reduction was expected to be of less magnitude than the 1:22 ratio, because this project was to be carried out without the aid of a graphical display device. However, the conclusion drawn was that any reduction in the number of working days needed to complete a plan evaluation would benefit an organization by making executive time available for other activities.

3. Increase the number of relevant variables considered in the evaluations of strategic plans.

This is the first of three criteria developed to measure factors related to the comprehensiveness of the organization model evaluations. The other two concern the number of important effects predicted and the

number of alternatives evaluated. All three are representative of advantages realized in the group problem solving process in relation to problem solving by individuals (see Kelley and Thibault, 23, for a comprehensive summary of reports on these advantages).

A set of company managers, or executives, constitutes a group when they are working together to solve problems and develop plans. Such a group might generate many problem solution alternatives in a short span of time. However, hand evaluation methods could make it difficult to assess fully all of the ideas such a group could produce. In that event many of the potential advantages of group thought could be lost. The management group's decisions might be better than those of individuals while still not being the best possible. The element for potential improvement is increased comprehensiveness of evaluations.

Why is this important? A group without the capability to assess all of its suggestions is analogous to an unaided individual attempting to solve complex problems. Since 1924 laboratory experiments have reported advantages for group problem solving when all suggestions could be evaluated readily. Generally the experiments show that increased numbers of opinions, suggestions (or alternatives) and assessments enhance the accuracy of decisions. Gordon reported this result after experimenting with individuals and several group sizes in judging the order of various weights (17). Stroop's replication of Gordon's experiment showed a similar improvement in accuracy could be realized by cumulating many judgments from one person regarding the order of different weights (46). In another experiment Jenness found that the accuracy of individual judgemental decisions

was improved overall after discussing a range of opinions in a group (20).

Perhaps the most direct support for increased comprehensiveness leading to better decisions (from primary sources reviewed) was obtained by Shaw (42). She conducted an experiment that was "aimed to present individuals (and groups) with an actual problematic situation which would call for real thinking to arrive at a proper solution (Shaw, 42, p 491)." The groups performed significantly better than individuals. Shaw found that the groups generated a much larger number of suggestions (or alternatives), considered many more factors (or variables), and rejected five times as many incorrect as correct suggestions (or found more infeasibilities) (42, pp 501-503). She concluded, "Groups seem assured of a much larger proportion of correct solutions than individuals do. This seems to be due to the rejection of incorrect suggestions and checking of errors in the group (Shaw, 42, p 504)."

The above experimental results support the importance of added comprehensiveness. But they do not indicate why a management group wouldn't necessarily arrive at the best possible decision. Many elements influence the quality of decisions that are actually made in organizations. One crucial element is the human mind's limited ability to cope with the detail involved in working out solutions to highly complex problems. Newell, Shaw and Simon recorded protocols of people solving such problems by a cascading process that broke the situation down to a simple, solvable problem and then gradually built up towards solution of the overall problem (35). A similar process likely holds

for all problem-solving activity. However, the task of planning for an organization's development is analogous to the game of chess. There are so many alternatives to consider that it would be extremely difficult to assess them all in a finite span of time.

Observers of organizational decision making confirm that people appear able to deal with only limited amounts of detail. Cyert and March have reported that managers tended to commit themselves to particular courses of action after assessing only a small number of factors that could be relevant (6, *passim*). Simon formulated his principle of "bounded rationality (41, p 198)" after numerous observations indicated that the human mind, although highly comprehensive, could not visualize and assess all potential alternatives in complex problem solving situations. Simon has also maintained that a man's rationality (in the economic sense) is limited by his "skills, habits, and reflexes. . . values and conception of purpose. . . and the extent of his knowledge about things relevant to his job (40, p 40)." The above observations led to the conclusion that managers carrying out complex evaluations by hand would probably fail to consider all of the relevant factors in given situations.

On the other hand, an organization model should be "comprehensive and consider the effects of interrelated accounts (Gershefski, 13, p 3)." A computer model, of course, would be restricted to evaluating only those things for which it was programmed. However, if it included functional relationships for all factors that were important to a particular company's operations, the model would be capable of computing

values for all relevant variables at any time. Then when a manager entered an exogenous change to one variable value in an organization model, running the model would result in the computation of new values for all affected variables (as long as all relevant factors were incorporated in the model).

Certifying that any computer model incorporated all factors that were relevant to the calculations for which it was intended would not likely be possible. The difficulties of establishing a measurement standard would preclude such certification. The relevant variables criterion was developed to obtain evidence that the evaluations made by a computerized organization model would be more comprehensive than those made by a manager using hand evaluation methods. This would indicate a benefit arising from model use because the more comprehensive evaluations would serve to remind the manager of all of the foreseeable factors that were relevant to any particular plan he was proposing for implementation.

4. Increase the number of infeasibilities and/or previously unanticipated effects found at the plan evaluation stage before possible implementation of any plan.

This criterion was developed because limitations on the scope of human comprehension suggested that a manager might predict some, but not all, of the important effects that a particular plan would have in a company. A computerized model, if made fully comprehensive, would predict all the important effects that any plan would have on the operations (Gershefski, 13, p 4). Support for this view has been provided by other computer model experiments. For example, Ferguson

and Jones (9) found that their model helped managers develop more feasible production schedules than they could develop manually.

In a complex situation the undertaking of any change in a particular operation will normally have important effects upon many other, related operations. Man has been found to have a limited ability to predict the consequences of solutions proposed for particular problems in complex situations (Taylor, 47, p 70; and Feldman and Kanter, 8, p 615). In addition, a man's past experience has been observed to exert considerable influence upon his perception of factors important to later decisions (Taylor, 47, p 70).

The ability of an organization model to predict consequences would be limited by its formulation, or the experience embodied in it. The model was intended to incorporate important factors in all of the functional areas of the organization. To be so structured it would have to embody the expertise of several different managers as well as the researcher. Thus it was expected that the organization model would benefit the planning process by indicating consequences that the managers had not previously anticipated with respect to particular proposed plans.

5. Increase the number of alternatives that could be evaluated for the attainment of any particular planning objectives.

This final comprehensiveness criterion was established because Cyert and March (6), and others, have observed that managers tended to consider few alternatives before committing themselves to a plan of action. But, for example, Feldman and Kanter have maintained that:

"The only procedure which can guarantee that the 'best' path (to a problem solution) will be found is one which generates the entire decision tree, i.e., all alternative paths and the consequences of each terminal state for all relevant goals (8, p 615)."

The above statement was supported by the earlier work of Shaw (42) and complements the Cyert and March implication that the probability of achieving better decisions increases with the consideration of more alternatives. Observations of human behaviour have suggested that the quality of decisions is likely reduced because of the difficulties of generating new alternatives and estimating their consequences (Cyert and March, 6; Simon, 40; Taylor, 47; and Feldman and Kanter, 8).

Morton found that his Management Decision System enabled the involved managers to develop novel solutions (because they could consider more alternatives) that made them conclude the decisions they took were better (33, p 15). The greatest contributors to this result were probably the speed of data analysis and the comprehensive evaluations of alternatives enabled by the computer system Morton developed. That conclusion was based on assertions such as Taylor's that "in real life decisions occur in sequence and . . . information available for later decisions is often very much dependent upon the nature and consequences of earlier ones (47, p 70)."

The computerized organization model was expected to provide faster and more comprehensive evaluations of planning alternatives than a manager could using hand calculation methods. Therefore, it was thought that the model would enable the managers to evaluate more alternatives before selecting a plan to meet particular objectives.

This capability should be beneficial to any organization because it should increase the probability that the decision taken in a particular situation would be better than the one that might have been taken without the assistance of computer evaluations.

The above criteria describe the quantitative benefits that were expected to accrue to the organization selected for this project as a result of the application of a computer model that used mathematical equations to produce a representative picture of the manner in which it functioned. Measures of these benefits were obtained during model applications to test evaluations in the actual planning situation. The measurements used and their results are detailed in Chapters VIII and IX.

Some subjective criteria were also established to obtain overall assessments of the model's usefulness and value to the managers. The model was used during management group meetings to obtain one set of measurements. The model applications were considered as providing positive benefits (in relation to regular meetings with no evaluations) if the managers indicated that:

1. Any extra time taken to get evaluations during the meetings was worth while,
2. Evaluations during meetings were more useful,
3. They were confident in the accuracy of the projections,
4. Extra information provided was valuable, and
5. They had gained new ideas or insights as a result of the model usage.

After the model test applications had been completed the managers assessed the overall model usefulness and value. The model was considered appropriate to the purpose for which it was developed if the managers indicated that the accuracy of the forecasted statements was acceptable, the output was not difficult to read and understand, and there were no major information deficiencies to be corrected to make the model useful. Four further criteria were also applied. The model was considered to be of greater value than the previous hand evaluation methods if the managers indicated that:

1. The model enabled them to make new types of planning evaluations that were particularly useful,
2. The model evaluations enabled them to develop plans with increased values greater than the added cost of the model,
3. They would be willing to pay at least as much as the full monthly costs of the model to keep it available for future use, and
4. Any influence that the project and the model may have had on changing the planning processes in the company was beneficial.

Of necessity the subjective criteria applied were relative in nature. However, they were essential to determine whether a complex evaluation tool with a known fixed charge and variable operating cost could be worth while for a relatively small company. The results of the managers' assessments are reported in detail in Chapter VIII.

The criteria were developed as the means for assessing the effectiveness of the organization model in improving the evaluation of

CHAPTER IV

RESEARCH PROCEDURES

This chapter details the research procedures followed in selecting an organization for the project, determining its structure, analysing the strategic planning processes followed, developing and applying the computerized organization model, analysing the model's performance in the actual situation, and gathering assessments from other organizations.

The Criteria Used to Select an Organization

Since one object of this research was to develop an organization model and apply it in a specific organization the first step in the field research was to select an appropriate organization for the project. It should be possible to develop and apply an organization model in any industrial, commercial, governmental or institutional setting. However, since many of the existing models have been developed for large corporations (see Schrieber, 39) the most similar environment in which to develop and test a model would be found in an industrial or commercial organization. This was taken as the first criterion for selection.

The second selection criterion related to the existence and extent of formal strategic planning procedures in the selected company. The ideal situation would have been one where formal planning procedures were being used with machine-aided hand evaluation methods. There were two reasons for setting up this selection criterion. First, established

strategic planning proposals. They were not, in any way, intended as a means to assess the effectiveness or validity of the strategic plans developed during the model applications. The difficulties in measuring the contributions from planning per se were clearly stated in the results of a survey conducted for the Stanford Research Institute:

"Actually, not one company (in the survey) has been able to measure organized planning's contribution to corporate performance--at least not in the terms used for gauging operating performance. A number approaching one-half of the planners write the matter off flatly as 'unmeasurable'. The measures used by those who affirm measurability are subjective and indirect (44, p 9)."

In addition the results of strategic planning are usually felt over long time spans, and by the time measures could be applied to one specific planning choice many factors would probably have altered the results. In most situations environmental factors will likely be different from those anticipated, other interrelated plans will probably have been implemented, the original plan will likely have been changed, and so on, when the point has been reached where sufficient time has elapsed for before-and-after comparisons. Accordingly, no attempt was made to measure the effectiveness of the planning actually done in the chosen organization. The criteria were applied to obtain measures of the advantages gained from using a computerized organization model for evaluating the expected results of proposed plans prior to their possible implementation.

strategic planning procedures have been found to almost invariably precede the development of company models (Gershefski, 13, p 3). Second, much of the information needed to develop and operate an organization model would likely exist, or could be easily obtained when formal planning procedures were being used. As reported in Chapter V, however, the company selected for the project was doing a significant amount of planning but not using formally established procedures. This criterion was downgraded in favour of the degree to which the company met other criteria.

The third criterion was that the key people responsible for the strategic planning activities in the organization selected should be willing and able to co-operate closely with the researcher for the analysis of the company structure, the model development, and the application of the model for planning evaluations. The nature of the information required for the model development was such that the researcher had to be able to examine freely all details relevant to the company operations. However, it was decided that the company involved should have the right to rule on the disclosure of information in written documents including such things as whether the company's name and specific numerical data should be disguised. The researcher had decided that it would not be practical to attempt to camouflage the nature of the company's business or industry. The President of the company selected decided that a disguise was not necessary.

A fourth preferred, but not essential criterion, was that the company selected should have computer services available for two purposes. First, to provide the equipment essential to the model

development (alternatively this capability was available at the University of Western Ontario or could be rented commercially). Second, to provide the analysis capability to extract aggregated data to develop functional relationships for the model and to operate the model once developed. However, this criterion was overridden when the search for a suitable company revealed that firms of the size preferred for the project were not likely to have computer installations. In fact none of the six companies, of the desired size, contacted had computer installations.

The fifth criterion relating to the size of the company for the project was recommended by Professor Thain of the School of Business Administration at the University of Western Ontario. Professor Thain's theory, evolved from his experience, was that the "critical mass of strategic problems" at first increased very rapidly with the increasing size of a firm and then flattened out much like a learning curve. Beyond the turning point, when a firm was a "medium-sized, Stage II company", he felt the strategic problems increased in number only and not in importance and, therefore, only served to complicate the strategic planning process. Thus, centering the research in a large firm would only serve to increase the complexity of the situation to be dealt with while not adding to (and quite possibly detracting from) the ability to prove the worth of the organization model concept.

Accordingly, the firm desired for the project was a medium-sized, Stage II company. Thain has described such a company as follows:

"The distinguishing characteristic of Stage II is that it is a one unit enterprise run by a team of managers with functionally specialized responsibilities . . . [such as] marketing, production, control, finance and personnel.

"One unit means an internally dependent, unified product market business operation. This 'non-diversified', 'single' product or service unit buys, sells and operates on its own; it constitutes a single profit centre; its operating results are logically represented by one profit and loss statement and its financial condition by one balance sheet. . . .

"In a large, highly developed, complex Stage II company the group might include marketing, production, engineering, control, finance, personnel, labour relations, long-range planning and public relations. In addition each of these functional units might be further subdivided: e.g. marketing might include departments for sales, advertising, brand management and marketing research (49, pp 34-35)."

The above descriptions do not delineate clearly what constitutes a medium-sized company in the Stage II category. However, the firm desired for the project was one that did not have a proliferation of functional and service departments. Thus, the largest firm that could have been selected was one with the five basic functional departments possibly augmented by only one or two others such as engineering or corporate planning. The major considerations were that the company be a single-unit type of operation structured along functional lines. The company actually selected for the project might be classified as a small-sized, Stage II firm since it had formal functional divisions specified for finance-control, marketing and manufacturing (see Chapter V). However, it ranked as at least a medium-sized company in the plastics moulding industry in Canada with sales of approximately \$2,000,000 annually.

The sixth criterion for selection related to the success of the on-going organization. Success was taken as a relative criterion in accordance with the performance expectations of the top management and the performance of the industry as a whole. Two indicators considered

were the financial and product (or market) performance. Other indicators considered were organizational stability with respect to such things as structure, communications and internal relationships. The company selected had been a financial success in the past although it could not be rated as such in 1970, but it was considered (by the researcher) to have a high potential for success (see Chapter V).

The seventh criterion was concerned with the representativeness of the company. It was desired that the company be similar in basic functioning to a large number of firms in Canada. Initially, this criterion was interpreted to mean that the company should be a producer of a largely 'convenience' or replacement type of good or service, with a sales force selling mainly to middlemen for ultimate sales to customers (or direct to customers in the case of a service organization). However, the search for a suitable organization revealed that many relatively small firms in Southwestern Ontario did not produce such goods. A large number of manufacturing firms in this area produced products as components for larger companies manufacturing consumer goods. The organization chosen for the project was one such manufacturing firm (see Chapter V).

The eighth criterion related to the management atmosphere in the company to be selected. The desired atmosphere was one that tended to foster creativity, innovation and adaptability which were factors that Warren stressed as being important for successful planning (51, p 25). Such an atmosphere was considered most likely to exist in a company with a pattern of "management by suggested direction (Thain, 48, p 22)." According to Thain, where this pattern existed subordinates were fully

involved in company operations and participated in problem-solving activities. Authority and responsibility was delegated to lower management levels. In addition, the top management did not retain all of the decision-making powers but retained control of the overall strategy of the company. (The above description was extracted from Thain, 48, pp 22-23). This criterion was applied through the researcher's assessment of the apparent degree of managerial involvement in decision-making that affected any company's overall operations. Considered also was the apparent extent to which the management members worked as a unified group towards the attainment of common objectives.

The Procedures Followed to Find Candidate Organizations

The procedure used to find and analyse alternative companies for the project was first to obtain names of companies that might be of a suitable size. Names were obtained from a directory produced by the London Chamber of Commerce (27) and from personal contacts made by the writer. An approach was then made by letter to the top management of several companies to see if they would be willing to discuss the project with the researcher. A copy of the information sent to each company is included as Appendix A. When a favourable response was received an initial interview was set up to determine whether it was likely that the management would be receptive to the project and whether it was likely that the company would be suitable for the project. When a tentative agreement to proceed was reached, the researcher conducted an initial examination of the company. The purpose of the initial examination was to determine the size, management structure, products or

services, marketing and operating organization, financial position, extent of planning, and so on, in the company in relation to the selection criteria. This examination revealed the conceptual problems likely to be involved, how the research would have to be approached, and the scope, dimensions, data mass, etc., that would be involved in the particular situation. This process was continued until a company was found that satisfied most of the criteria. As the search for a suitable organization was carried out the most important criteria became the management's willingness to co-operate, company size, formal authority structure, and the apparent managerial atmosphere. The greatest amount of difficulty was experienced in finding a company where the managers would be willing to co-operate fully and make even the most confidential information available to the researcher.

Examination of the Company Structure and Planning Activities

The examination of the company structure and its planning activities was the first step in the research preparation for the model development. In the chosen company situation this phase really began with the initial interviews conducted to determine the extent to which the organization appeared to satisfy the selection criteria. The purpose was to develop a comprehensive picture of the company structure and its planning activities as seen by the top managers or strategic planners. The results of this preliminary analysis, for which the procedures will be outlined below, are reported in detail in Chapter V.

The procedures followed consisted mainly of personal interviews with the company's top management group and with individual managers to

get their descriptions of the company and its operations. However, some initial recorded data was also gathered such as the organization chart, copies of year-end financial statements, and samples of the kinds of information that the managers used for evaluating plans. These interviews, and a tour of the company's plants, also provided descriptions of the manufacturing operations and processes, marketing activities and the distribution methods for its products. The interviews were also used to get the managers' perceptions of the importance of planning to the company and the manner in which the planning activities were carried out. This interview process provided the basis for the descriptions of the strategic planning situation and its structure detailed in Chapter V. It also helped determine the approach taken in developing the model.

Development of the Organization Model

The initial proposal was that the model should be developed with characteristics similar to the company model developed for the Sun Oil Company (Gershefski, 11). This approach was taken because the major characteristics for the Sun Oil model were selected as a result of a feasibility study that required twenty man-months (11, p 34) and it was hoped that a major feasibility study could be avoided in this situation. Early in the field research it became apparent to the researcher that the type of model proposed was highly suitable to the actual situation selected. As detailed in Chapter VI the planners in the company used financial accounting projections in evaluating proposed plans. Their mental model of the organization considered the essential features, operations, interactions, and results of proposals in accordance

with the way they were reflected in the financial accounting statements. They evaluated one proposed alternative at a time using single-point estimates as if future conditions were known for certain. Then the managers attempted to incorporate the effects of possible changes in conditions on the profitability of any plan. The approach taken by the managers was very similar to the one described in Chapter II for a deterministic model operated in a case-study simulation mode. This was the same type of model as the one developed for Sun Oil (Gershefski, 12).

The scope of the model was set to be intentionally very broad in relation to the organization to view all aspects of the operations as they were seen from the top management viewpoint. Accordingly only aggregated data was used in the model development to consider only the most important components and functions required to represent the company's operations. The data base used to determine the major financial components and functions was a five-year set of the company's audited financial statements. The contents of the statements were augmented through descriptions obtained during interviews with the managers. Interviews and current operating records were also used to establish the functional relationships necessary to represent the physical operations of the manufacturing facilities.

The procedures used to establish the basic model structure and the key functional relationships were patterned after those used at Sun Oil as summarized below:

"A detailed analysis of the income statement provided the framework for all subsequent steps in the development of equations for the model. . . . An attempt was made to relate

the costs and revenues with the level of activity by means of an equation or series of equations. . . .

"The results of this analysis were summarized in terms of a large Input-Output diagram. . . . This diagram provided a broad conceptual framework which showed how the various functions of the company were interrelated and how the key variables affected performance within each area. A complete set of simple algebraic equations was thus developed to project and consolidate all costs and revenues. . . .

"There are no set rules for developing the equations for the model; a company's circumstances usually dictate the appropriate form. However, multiple regression analysis proved to be very useful for this purpose. . . . Generally, ten years of historic data were used to determine the regression coefficients. . . .

"In addition to [the above] types of equations, relationships were used to show the construction period required for capital investments (Gershefski, 11, pp 37-41)."

The above quotations were cited because they served as the basis for the approach taken to develop the model in this project and because they contrasted in some important ways to the techniques used. In this project the financial statements also provided the basic framework for analysis and regression analysis was used to develop some of the functional relationships. However, only five years of historic data was available and only simple regression analyses proved to be useful. A multiple regression analysis computer routine was used but no apparent causal relationships could be established between any dependent variable and two or more independent variables. In addition a "large Input-Output diagram" was not used to establish the interrelationships. The researcher found that a series of schematic diagrams indicating the interrelationships of items in the financial accounting statements were much easier to work with as they did not have to be developed on large spread sheets. The diagrams actually

used are included as Appendix B. Besides showing the interrelationships these schematics were very useful for determining the sequence of model calculations.

No attempt was made in this model to develop relationships for the construction period required for capital investments. Instead calculations of the physical operating needs were made to predict when capital investments such as additional equipment or plant space would be required. This was done through an analysis of the manufacturing methods and products to develop a common product unit that could be used to convert the dollar sales forecasts to production volumes. The common product unit was also applied in an analysis of machine loading hours to establish a standard form of production rate parameter. Relationships between production hours, volumes, equipment, and space needs were then developed to provide the desired predictions for capital investment needs. The details of these analyses are reported in Chapter VI.

Validating the Model

Validating the model was the next phase undertaken before applying it to planning evaluations in the real situation. As mentioned above five years of historical data was used to develop functional relationships for the model. By the time the computer programs were developed a sixth complete year of actual results and a forecast for the next operating year were available for use in validating the model. The first step in the validating procedure was to use the functional relationships developed for the model to estimate results for the sixth

year. Comparisons were then made and when significant differences were found assignable causes were sought out and the functional relationships modified where necessary.

After the initial validation the sixth year results were used as the base for the model to develop a forecast for the next operating year. The procedure followed was to compare the model's forecast with the one previously made by the managers and to modify the model where necessary to obtain a forecast that coincided with the managers' expectations. This procedure was found to be very useful in determining where logical errors had been made in the programming of the model and in revealing important conditions that had changed relative to the historical information used to develop the model and its parameters. A major contribution to the use of the above procedures for validating the model was provided by the work of Jay W. Forrester in industrial dynamics. He found that gaining acceptance of his models was relatively easy when the model results coincided with the managers' expectations and perceptions of their company's operations (10, Chapter 4). This researcher also found that by the time the validation process was completed the computerized organization model had been accepted by the managers involved and they were anxious to proceed with the test applications.

The Model Testing Procedures

The model testing procedures were designed to obtain objective and subjective measures of the benefits accruing from the organization model. In the actual situation there were no records of past planning

evaluations that could be used to make before-and-after comparisons for model applications. During the winter of 1970-71, however, the managers were developing plans for the immediate and long-term future of the company. Continuing planning developments were used for applications of the model to obtain objective measurements of its performance for comparison with the manager's hand evaluation performance.

The procedure followed was to make parallel evaluations for five planning proposals and record the results. The manager responsible for making evaluations was the Controller. For each parallel application the Controller first prepared his evaluation by hand with the aid of an adding machine and recorded the actual time taken. He then carried out the same evaluation using the model (with assistance from the researcher for the model operation) and the time taken was recorded for:

1. Preparation of data in the form required,
2. Entering parameter changes and running the model, and
3. Obtaining the desired print out of results.

For each test situation the comparative times required were recorded only for the evaluation of the initial alternative. The evaluations of subsequent alternatives were made using the model only and the times required were compared with the Controller's estimate of the time he would need to revise his initial hand evaluation. The other comparisons made were for the number of relevant variables considered by the Controller and by the model, and the number of important effects discovered to result from the proposed plan. A relevant variable was considered to be one for which the value changed as a

direct result of the particular planning proposal. Important effects discovered were factors such as additional equipment, space, or labour needs, and so on. The key consideration was the number of important effects predicted by the model evaluation that had not previously been predicted by the Controller or other managers. The actual test situations used and the results of the tests are reported in detail in Chapters VIII and IX.

Some subjective measures of the model's benefits were obtained as a result of applications during sessions with the management group. These were sessions during which the managers were meeting to consider problems of current concern. In these cases as particular ideas were expressed they were entered into the model as parameter changes for a new run and results were printed out for effects on key variables. The time added to the meetings for the evaluations was recorded and each manager recorded his feelings about the usefulness of these meetings relative to others where no evaluations were made. Each manager was asked to record his feelings about:

1. The time added to the meetings in relation to the benefits he felt were gained,
2. The usefulness of conducting evaluations during meetings,
3. The confidence he had for the model's projections,
4. The value of any new information he obtained, and
5. Any new insights or ideas he obtained as a result of the model's evaluations.

The assessments of the managers were then consolidated to obtain a comprehensive picture of their feelings about the meetings.

and the model evaluations. These results are reported in detail in Chapter IX.

Evaluating the Model's Usefulness

The advantages of the computerized organization model for making specific planning evaluations were obtained as a result of the test applications. However, these results did not provide an assessment of the overall usefulness of the model as seen by the managers. Thus a series of subjective evaluations were still needed to complete the assessment of the model's benefits.

The first step taken here was to have each manager answer a series of questions after he had reviewed a set of statements produced by the model relevant to a particular planning proposal. The purpose of the questions was to get each manager's assessment of:

1. The accuracy of the statements,
2. The clarity and ease (or difficulty) with which the statements could be read and understood,
3. Desired information omitted from the computer print out,
4. The usefulness of the model information for making planning decisions,
5. The ways in which he felt the information could be particularly useful to him, and
6. The ways in which he felt he could apply the model for particular decisions or planning situations.

The managers were also asked to assign values to a particular type of plan developed by each of several planning methods. They were

first asked to assign relative weights to the worth of the plan if developed by each method. Then the managers were asked to estimate the amount of money they would be willing to pay for the plan in each case. The managers were next given reports of the time required for the test applications, the potential cost savings, and a forecast of the work that would be needed to maintain the model in an up to date condition. Then they were each asked to provide an estimate of the amount of money that they would be willing to pay, on a continuing basis, to obtain the advantages of having the model available for all future planning evaluations.

Each manager was also asked in an interview to outline the changes that had taken place within the company since the research began in April 1970. The interviews concentrated on changes that had taken place in relation to planning procedures and the relationships among the members of the management group. The managers were asked to indicate how much influence they felt the research project had in bringing about any planning process changes. Of concern also was whether the managers felt perceived changes were improvements with respect to the overall operations of the company. The consolidated results of the above assessments are included in Chapter IX.

The above evaluation procedures were followed to gather information about the value of using the organization model approach in one relatively small company. This information was intended to fulfill the primary purpose of the project. A further survey procedure was then undertaken to obtain an assessment of general characteristics of other organizations in which a similar application might be expected to succeed.

Assessing the Model's Potential in Other Organizations

The field research project results indicate a high degree of success, but the project described only the one particular organization to which the model was applied. The question then arose as to whether executives in other companies might conclude that such a model could be useful to them. Also, was there a particular set of company characteristics that might engender success or failure of similar applications? A survey was undertaken to seek some answers (the results are reported in Chapter X).

As a first step in this procedure, the researcher wrote an article describing the project and its results. Publication was made in a periodical intended for business managers (Nobbs, 37). This article provided the basis for managerial assessments of the model and its application results.

Next, companies were selected for the survey. Seven small firms had previously been contacted as potential project participants during March 1970. One of these was chosen for the project and the others were of a similar size and management structure. By the summer of 1971, though, only five of the six other companies remained in operation. One had ceased to exist as a separate entity early in 1971 when it was incorporated as part of a major division of an international conglomerate.

The presidents of each of the five remaining companies were then contacted by letter and sent a copy of the researcher's Business Quarterly article (37). After they had time to receive and review the information, the researcher telephoned each president and arranged an

interview at his convenience.

The basic purpose of the interviews was to obtain the executive's assessments of the model and project results. However, information was also gathered about the nature and characteristics of each company. The interviews were open-ended although the questionnaire included as Appendix L was used to record information after the sessions. As reported in Chapter X, the results varied but some patterns emerged.

The executives' assessments included perceptions of the general usefulness of the organization model approach used, the likelihood that similar applications might be useful to particular organizations, and indications of interest in replications of the research project. In all cases the researcher was told that the president's assessment was being given after reviews and comments by fellow executives. The interviews provided some comparative base to isolate company characteristics that might foster successful applications of models similar to the type used in this research.

CHAPTER V

A STRATEGIC PLANNING SITUATION AND ITS STRUCTURE

This chapter describes the application of the selection criteria to the company selected for the study, the bases for the selection, the structure of the company, its planning processes, plan evaluation procedures and the potential for development of an organization model in the selected situation.

The Application of the Selection Criteria

The selection criteria used in determining the suitability of any organization as a subject situation for the research project are detailed in Chapter IV. The organization size criterion was considered to be very important. It was felt that the organization chosen would have to be large enough to have functional divisions (such as marketing, production, etc.) and to need at least product and facilities planning to ensure future profitability. On the other hand, the organization had to be small enough so that all operations could be classified as belonging to a single entity with one set of objectives. The extent to which other criteria were met by any organization considered for the project was to be judged in relation to the apparent extent to which they could be met by organizations of a similar size. The information on which to base that judgement was accumulated during the process of contacting potential project candidates.

In the search for an organization to participate in the project,

nine companies with computer installations were contacted. The responses indicated that they were all larger organizations than desired for the project. The nine companies all had multiple major divisions each divided along functional lines, and produced many different types of goods and services--it is not known whether they had formalized strategic planning procedures. Seven small companies were also contacted--none had computer installations and only one was using a computer service. Six of the small companies were in the Stage II, 'single' product unit category (previously defined in Chapter IV), while one (with a time-shared computer service) was a smaller operation strictly under the control of the owner-president. None of these seven smaller companies appeared to have formalized strategic planning procedures. The organization chosen was selected from among these seven firms. Details on why the other six were eliminated are included in Chapter X.

The Organization Selected

The organization selected as the subject for this research project was Kemp Products Limited. It was a relatively small company that manufactured moulded plastics products with annual sales of approximately \$2,000,000. The company was privately held and was established in 1948, by the two men who were the President and Chairman of the Board, to manufacture novelty items such as swizzle sticks. By 1970 novelty items represented a very small proportion of production and sales. The major product lines were automotive parts, television and stereo parts, sports equipment, refrigerator and washer parts, tape dispensers, and food containers such as milk jugs and ice cream dishes. The company manufactured a range of products made by

the processes known technically as injection and blow moulding and was continually seeking new products.

As a relatively small, industrial organization Kemp Products met the size, structure and management criteria for the project. The organizational structure was set up along functional lines for finance and control, marketing, and manufacturing with department (or function) heads who had full responsibility for and authority over their operations. Kemp Product's strategic moves were controlled by the President with the consensus of the Chairman of the Board; but all of the five top managers were involved in problem-solving, decision-making and planning for the organization. The company also appeared to be very representative of many small manufacturing organizations at least in Southern Ontario. Most of its sales came from custom products produced for larger manufacturers while the balance was from small proprietary products.

A key factor in the selection of this company was the degree of eager and willing co-operation promised for the project. The Kemp managers were impressed by the potential uses for computer models in their company, were anxious to learn what a computerized model might do for the company, and were very willing to make their time available and to discuss even the most intimate details of the company's operations. In April 1970 year-end records of financial, marketing and production data were available for a five-year historical period.

The company's shortcomings were in the areas of computer services, formal strategic planning and financial success. As was the case in many small companies Kemp Products did not have a computer

installation or make use of a shared computer service. Because the company was in a tight financial position at the time the managers were reluctant to consider the possibility of providing the computer service for the project. Thus in selecting Kemp Products for the project the decision was taken to utilize a computer service that could be provided through the University of Western Ontario.

In April 1970 Kemp Products did not have an established set of formalized strategic (or long-range) planning procedures. However, the managers did recognize that such planning was necessary in their industry because of the pressures of economic conditions, and rapidly changing products and technology. They were using informal planning procedures that consisted largely of irregularly scheduled meetings of the top management group to develop and evaluate strategic moves. The managers' main concerns were for evaluating the profit and growth potentials of proposed projects. Major objectives and goals were not recorded in writing but were commonly held by the five top managers in the company. However, sufficient planning was being done to enable good subjective evaluations of changes resulting from the project, and to get some objective measurements of the times required for evaluations.

With an average income after taxes of approximately 3% of gross sales over the five years prior to 1970, Kemp Products' performance was only slightly below average for the plastics moulding industry generally. However, Kemp Products was financially unsuccessful in 1970 for two main reasons. First, most of the products it made were sold to manufactueres of consumer durable goods for which sales were declining because of prevailing economic conditions. Second, as

the patent holder and major producer of milk jugs in Canada, Kemp had set up a separate blow moulding plant in 1965. By 1969 the market for returnable milk jugs had been saturated in Canada and sales declined to the very low level needed to replace jugs that were damaged or not returned to the dairies. Thus the blow moulding plant was operating at a fraction of its capacity. The company was attempting to reverse this condition by producing new types of blow moulded products. In 1970 the emphasis among the Kemp managers was on developing new products and markets that would not be dependent upon the sales of consumer durables. Therefore, with respect to the financial success criterion, Kemp Products was selected for the project largely on the basis of its future potential.

In general Kemp Products appeared to be a very good organization in which to carry out the research project. The managers' primary interests coincided with a major purpose of the project in the development of a company model from the top management view point as a tool to aid in strategic planning--the type of planning that was of greatest importance to the company in 1970. In addition the company was in a position where profitable projects were needed and many alternatives were being considered. Thus it appeared that there would be ample opportunities to test the model through applications in current planning evaluation situations.

The Structure and Nature of the Company

Kemp Products' formal authority structure, the nature of its products and its financial control structure were characteristic of a

Stage II organization. In April 1970 the formal authority structure had the functional breakdown depicted in Figure 1. The company's products were of one generic type--moulded plastics--although more than one moulding process was used. Finally, the financial control structure was such that the company constituted a single profit centre, its operating results were logically represented by one profit and loss statement, and its financial condition was logically portrayed by one balance sheet. The above were all characteristics cited by Thain for a Stage II company (49). Like any small industrial organization Kemp Products was very vulnerable to fluctuations in demand for its one type of product. At the same time the company's small size, capital limitations and plastics moulding technological expertise deterred diversification into other types of products.

Skinner and Rogers described five basic techniques that were used for moulding relatively small plastic products--injection, blow, extrusion, and compression moulding; and casting of liquid resins (43, p 90ff). Kemp Products used the injection and blow moulding techniques. These manufacturing processes had been instrumental in determining the operating structure of the company as it existed in April 1970. From 1948 to 1965 Kemp Products used only the injection moulding process for which its initial plant and warehouse were established. In 1965 the company developed and patented two and three quart returnable plastic milk jugs to be manufactured through the blow moulding process. In 1966 a separate manufacturing division was set up in a new plant (two blocks from the injection moulding plant) to manufacture the milk jugs. The milk jugs, although light in weight, were costly to ship

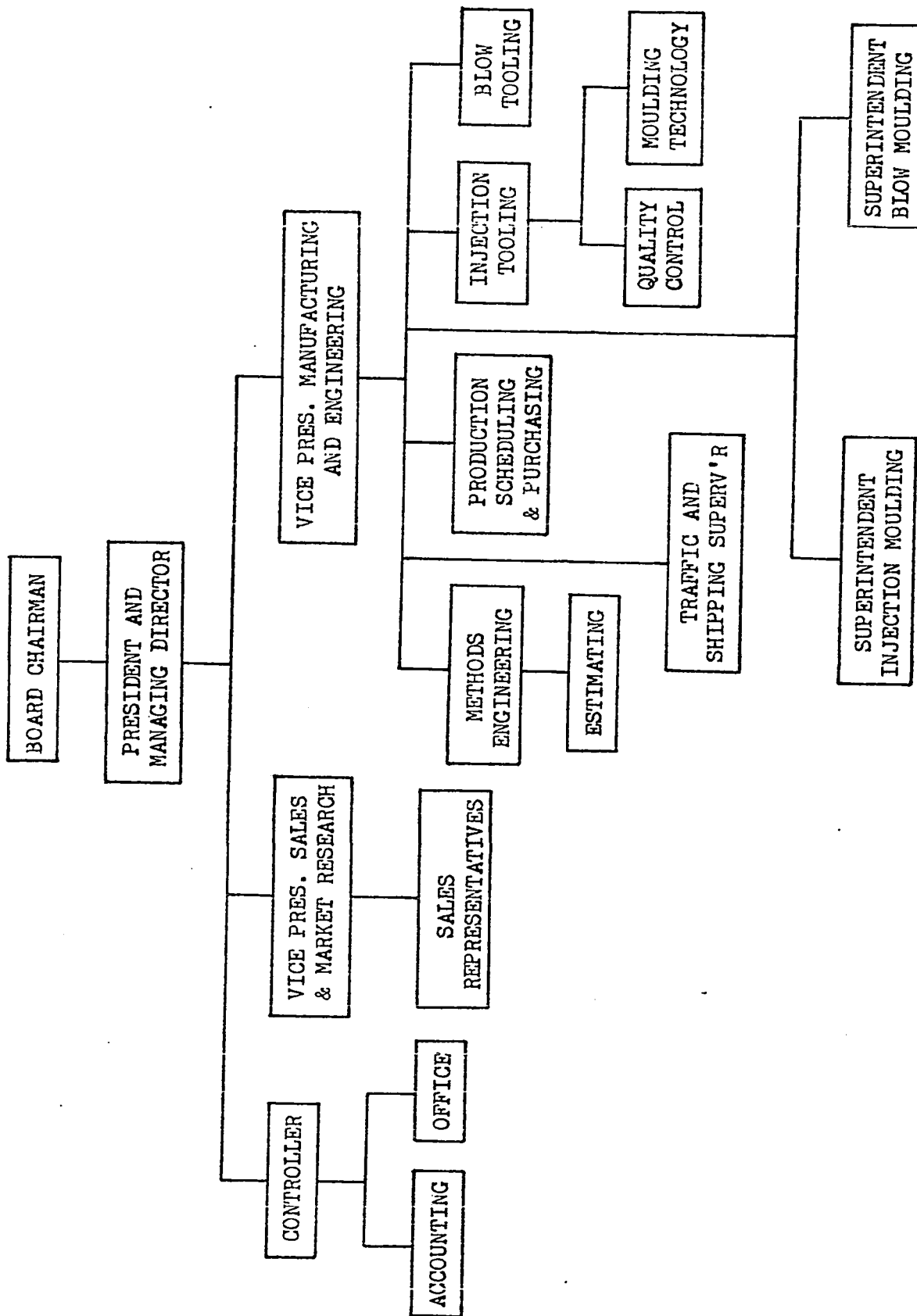


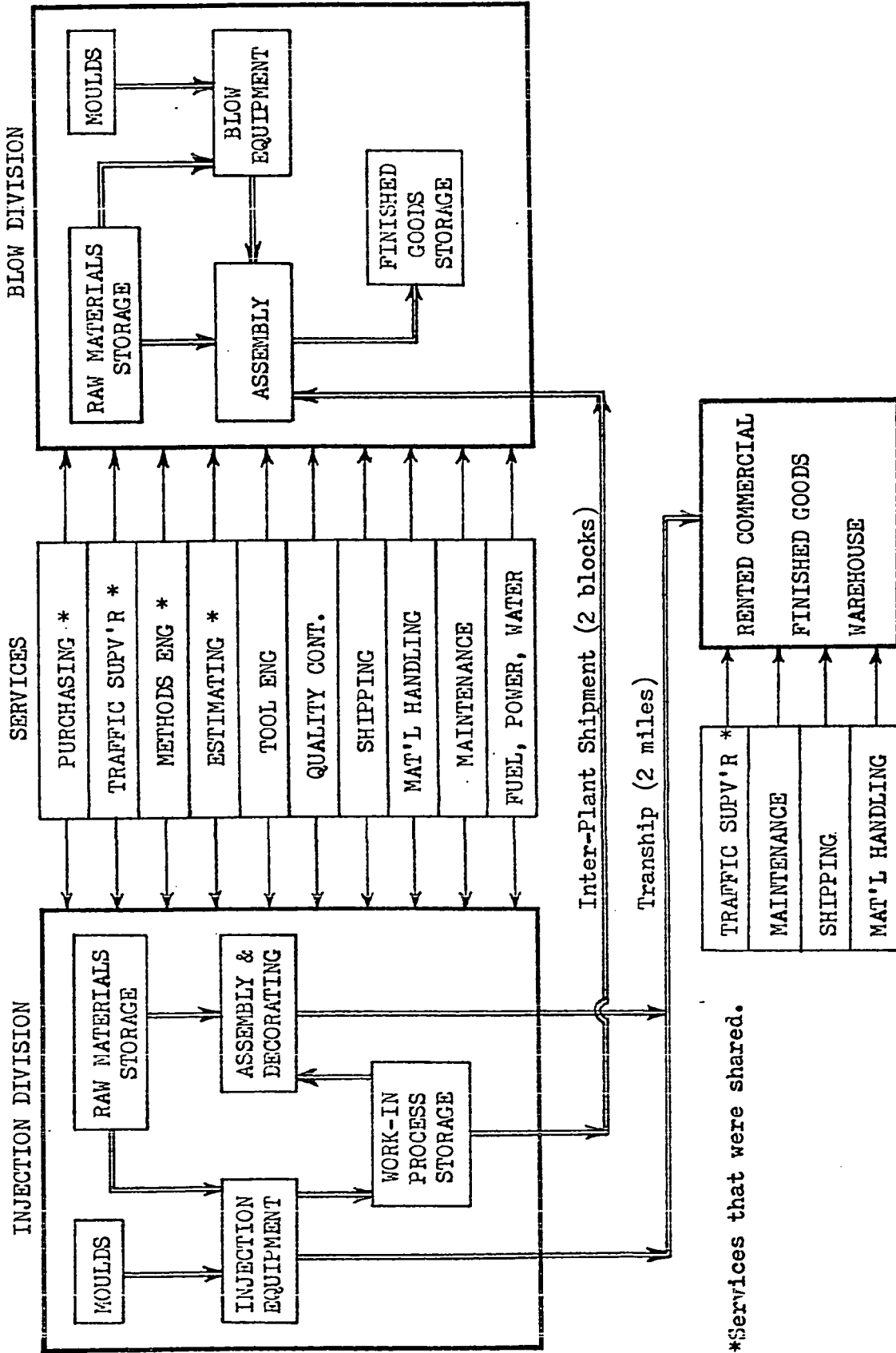
Fig.1.--The company's head office organization chart

long distances because of their bulk. Therefore, licensing arrangements were made for other manufacturers to produce the milk jugs in other parts of Canada and in the United States. The Canadian licensing was administered through the Kemp Products head office. However, a subsidiary office organization, Kemp Products Inc., was set up in Chicago to administer the licensing in the United States and to market limited quantities of the milk jugs produced in Southwestern Ontario.

By 1968 the volume of injection and blow moulding sales had expanded to the point where more finished goods warehouse space was needed. The decision made at that time was to lease rather than build a larger warehouse as an addition to either of the plants. The nearest warehouse space available for leasing was located two miles from the plants.

The result of these events was that in April 1970 Kemp Products major operations were administratively and physically separated as shown in Figure 2. This schematic indicates the relationships between many of the company's operations. It also depicts a relatively small company, physically structured in such a way that many service functions were provided in two or three separate locations rather than being shared in one location. Since the profit performance had been poor for two successive years the managers were giving serious consideration to restructuring the physical organization.

At the end of June 1970 the Kemp managers decided to modify the physical structure as quickly as possible. Effective July 20, 1970 the organization was converted from one with two manufacturing plants to one with a single plant. The decision taken was to eliminate the blow



*Services that were shared.

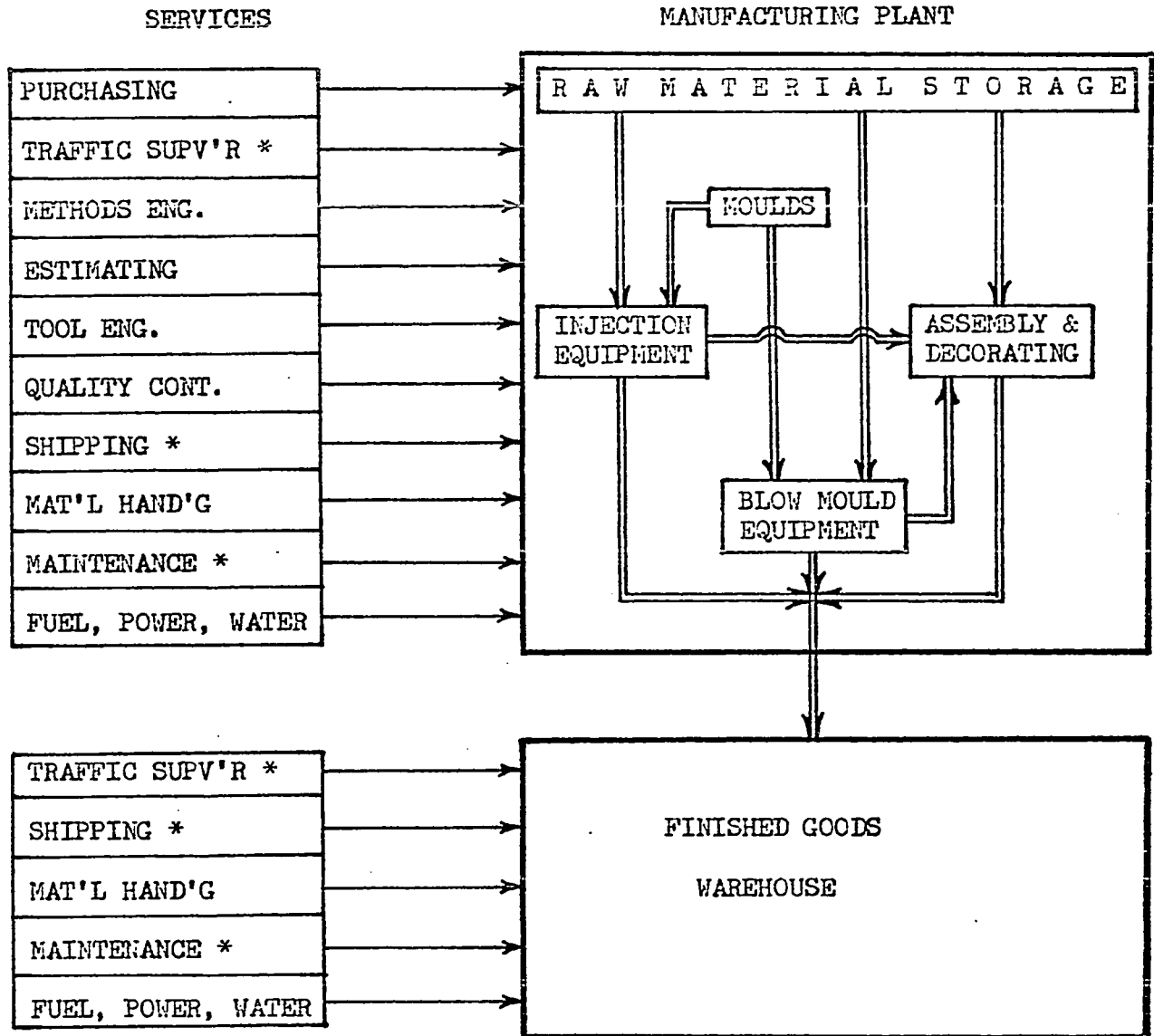
Fig.2.--The company's separated operations in 1970

moulding division as a separate plant because of:

1. The high fixed cost of operating it,
2. A blow moulded product sales level (expected to continue indefinitely) at less than one-third of the sales needed for a break-even operation, and
3. The company's lack of cash as a result of generally lower sales during Canada's economic decline.

As a result of this decision most of the blow moulding equipment was moved to the main plant and crowded into the available floor space (no funds were available for even a small plant expansion). A number of operators and other personnel equal to all but four of the number in the blow moulding plant were deleted from the operations. Thus, twenty-two junior employees from both plants were laid off and one superintendent was placed in charge of all moulding operations. Since the blow plant was held on a lease with four years to run it was converted to the finished goods warehouse effective September 30, 1970 upon expiration of the commercial warehouse lease. The resulting physical organization was as depicted in Figure 3 with very little duplication of services.

Combining the manufacturing facilities under one roof had to be accomplished with a minimum financial outlay because of the company's short cash position and the manner in which fixed assets had been obtained. Throughout its history Kemp Products had relied on lease-purchase arrangements to obtain fixed assets. Both plants had been provided on this basis as had all of the major pieces of equipment such as moulding presses. In 1970 the company's investment in



* Services that were shared.

Fig.3.--The company's combined manufacturing operations in September 1970

fixed assets was, therefore, low relative to the total value of fixed assets under its control. While reducing the risk and capital investment by shareholders this strategy had left the company with only a small capital reserve upon which to draw for major fixed asset changes in the future. This factor made the company more vulnerable under the poor economic conditions of 1970 with pressures against industry and consumer spending and credit.

Three important operating factors presented few problems for Kemp Products and were handled on a day-to-day basis by the department heads concerned--labour, raw materials and mould supplies. The personnel involved in the manufacturing operations were largely unskilled labour of which there was a surplus in the local area. Only the maintenance, machine setup, mould repair and quality control services required skilled personnel. An abundance of raw materials and supplies was also available. Large quantities of resins were produced in Ontario and elsewhere and there were several producers of other supplies, such as cartons, in the area. Moulds were manufactured by several local firms. In relation to these important factors the company was not very vulnerable to demand changes, strikes, and other possible occurrences. It would only be vulnerable to a possible strike by its own employees' union.

The Organization's Planning Processes

The organization did not have any formally structured planning processes except those used for the scheduling of production operations. Kemp Products had been using an established procedure on an annual basis

for sales forecasting and the preparation of operating budgets. However, the intent of this research project was to concentrate on the development and application of a computerized organization model that could be used as an evaluation tool in strategic planning.

The managers in the organization recognized the importance of planning to ensure success. Some of their knowledge of its importance stemmed from the realization that much of the lack of profitability in 1970 had resulted from insufficient or poor planning in the past. As the research project commenced in April 1970, the managers were attempting to rectify and offset the past planning deficiencies. However, the planning processes being used were still very informal in nature.

The planning in the organization was being directed towards informally held objectives or goals. One objective had always been to produce the best quality product possible at a reasonable and competitive price--an objective that resulted in a lower profit rate but increased good will and tended to foster customer loyalty. Another objective was to expand the sales volume profitably in order to obtain the necessary underwriting to get the capital (by acquisition, merger, or public issue) to expand the operation to a \$15,000,000 sales level in a relatively short time. It was felt that this objective could be attained if the sales of plastic products could be increased by 250% in three years while earning an after tax income equal to 5% to 6% of gross sales. The President and the Chairman felt that capital required for further expansions could then be generated easily.

The planning operation consisted of informal, small group meetings held to discuss and develop ideas whenever time could be taken from the day-to-day operating problems. The people most often involved in the meetings were the President and the Vice-Presidents of Manufacturing and Marketing when the topic to be discussed was a new product or process idea. The President and Controller met whenever the topic was related to how some project might be financed. The Chairman of the Board could become involved in any of the meetings. The results of these meetings were sets of unwritten and largely uncoordinated plans of action for a new product, process or some other idea.

In spite of the abilities of the managers to develop fairly accurate cost estimates and sales forecasts as a result of their experience in the business the plans developed usually were not evaluated fully. The peripheral effects on related processes and products that would result from adding a new product would be estimated in the short-run. However, the long-term total effect on the company would not likely be estimated and the costs of unforeseeable events such as market or production failures were not predicted. In addition, no estimates of the costs (or gains) to the company from delaying (or speeding up) the introduction of a new product were made. Thus, the plans of action and budgets for any new developments were not set down clearly; were subject to numerous, unevaluated changes; and often were delayed because the managers' attentions were diverted by operating problems.

An example of a plan that was implemented without a full

evaluation of the consequences was the establishment of the blow moulding plant in late 1965. The potential sales at that time indicated that milk jugs could be produced, on a highly profitable basis, in a separate plant. However, no predictions were made regarding the period over which the high sales level might be maintained. The operation was highly profitable for two years until sales began to decline because the Canadian milk jug market was saturated. By 1969 Kemp Products was going into a loss situation because of the high fixed cost of maintaining the blow moulding plant at a production level much lower than its capacity. The company needed a blow moulding facility to produce replacement milk jugs for its dairy customers but had no other plans for the plant. The managers then found that there was not a sufficient demand for other blow moulded products, that they could produce profitably with the equipment required for the milk jugs, to return the operation to a profitable level. A more comprehensive evaluation in the early planning phase might have predicted this eventuality and suggested an alternative to the separate plant as well as contingency plans to avoid the losses the company suffered in 1969 and 1970.

A new product planning and introduction example also related to the milk jugs. The initial jugs were designed to withstand a washing temperature of 170 degrees Fahrenheit. Sometime after their introduction the dairies discovered that by raising the washing temperature for bottles and jugs they could realize significant savings in the amount of caustic soda used. It was then discovered that the plastic milk jugs were shrinking in service and Kemp Products had to develop a

new jug to withstand the higher washing temperatures. A new process was discovered to preshrink the milk jugs. If all had gone according to plans the new jug would have been in production by November 1969. However, production did not commence until late in March 1970 and none of the managers could say precisely why the delay occurred. The apparent cause was a lack of control during the introduction of the new process to keep the project on schedule. The key point here was that the sales of milk jugs had dropped to zero while the dairies waited for the new, preshrunk jug. In addition the total market for returnable milk jugs was considerably reduced by greater emphasis being placed by the dairies on a new alternative--plastic bags. The loss to Kemp Products was not evaluated by the managers but it was certainly greater than the loss of five months' sales needed to try and keep the blow moulding plant operating profitably. One of the managers expressed the feeling that the company lost not only the balance of any new milk jug market that had existed but probably also a significant proportion of the sales they would have otherwise made in replacement jugs in the future. These losses played a significant part in the closing of the blow moulding plant in July 1970.

In summary, the company's managers had come to recognize the importance of more formal and stringent planning to ensure success. By April 1970 the managers were beginning to consider concrete steps to take in developing procedures for viable planning but the planning was still being done on an informal basis. Past planning had resulted in fluctuations between success and failure on an unpredicted basis as in the case of the blow moulding plant.

Potential for an Organization Model

The potential for the development and use of a computerized organization model appeared to be very encouraging at Kemp Products for several reasons. First, the company was relatively small and operated with a management group that was functionally specialized. Thus, all aspects of the company could be viewed relatively easily as one system. Second, although only informal strategic planning was being done the managers were very aware of a need for more planning in the company and its importance for future success. As a result, they were beginning to devote time to the development of formal planning procedures in April 1970. Third, the managers were very willing to co-operate and provide any and all details required for the research project. Fourth, Kemp Products manufactured small products of only one kind (i.e. moulded plastics) and diversification was an unlikely prospect. Finally, the managers were very interested in learning more about the ways that computer models could be applied, even in a small company, to help them perform their functions.

CHAPTER VI

THE ORGANIZATION MODEL AND ITS DEVELOPMENT

This chapter describes the organization model and the procedures followed to develop it. Included is the selection of the computer service and the nature of the model, the determination of the model's components and important functional relationships, the logic of the model, and a report on the development trials. Results of the model framework analysis, data analyses, flow diagrams, and the computer programs appear in the appendices.

The Computer Service Selected

Since Kemp Products did not have a computer installation a computer service had to be provided from another source. The time-shared computer service being used by the School of Business Administration at the University of Western Ontario was chosen for the project. The time-shared feature enabled the operation of a computer model in the interactive mode recommended for decision-making situations (for examples see Boulden and Buffa, 4; Godin, 15; Jones and Engvold, 21; and Miller, 30). The computer service could also be accessed, as in this project, through a terminal located at the field research site.

The Nature of the Model

The nature of a computerized organization model had to be determined from the type of information considered for developing

plans in the real situation if it was to be understood and accepted by the managers involved (for example, see Little, 26). At Kemp Products most of this information was in financial accounting form--the income statement, balance sheet, and costs and expenses statements. The major criteria used by the managers to accept or reject a planning proposal were its effects on manufacturing gross profits and after tax income expressed as percentages of gross sales. Accordingly, the framework for many basic operations in the model had to be the financial accounting statements in order to provide estimates that would be familiar to the managers.

Many of the financial accounting results in any manufacturing organization arise directly from physical operating activities. At Kemp Products the Manufacturing Vice-President was responsible for determining the facilities and capital equipment needs, and estimating the operating costs expected for proposed plans. As of April 1970 he relied on "gut feel" in making many of the facilities estimates but he felt that more consistent and reliable methods should be used if they could be developed. The Manufacturing Vice-President had all of the information he needed to estimate labour, materials, supplies and equipment costs on a product-by-product basis and could make aggregate estimates by cumulating the individual ones. However, he expressed a desire to have some means for predicting the inventory and manufacturing space and work force needs in advance in relation to the product volumes represented by the total dollar sales forecast. The desired manufacturing estimates and the physical production operations and flows thus had to provide the framework for a major subsection of the

model.

In preparing planning estimates the Kemp Products managers were primarily concerned with annual results. Accordingly the time unit used in the model was one year. The most reliable record of the company's operations extended back to its fiscal year 1964-65. Since the Kemp Products fiscal year ended on May 31, five complete years of annual historical data were available at the start of the project. This did not provide sufficient data to develop a stochastic model based on statistical distributions of event occurrences. It was decided, therefore, that the model would have to be deterministic in nature (that is, it would have to make evaluations on the assumption that all relevant conditions were known for certain).

The President of Kemp Products confirmed that a deterministic model would provide estimates suitable to his needs. The estimates used by the managers were of the deterministic, point-estimate type based on expectations about future conditions that might affect the company. The President also felt that a computer model that could be manipulated to provide a set of predicted results from the best possible, expected, and worst possible conditions that might hold for any given planned project would provide him with a much better basis for making decisions. As of April 1970 his planning decisions were based on a single evaluation of expected results for the one to three alternatives that might be considered in any particular situation. Thus a computerized organization model capable of evaluating a range of possible conditions for a few alternatives with a minimum number of changes in inputs would suffice (Jones reached a similar conclusion;

22, p 82; and 21). This capability could be provided by a deterministic model operating in an interactive mode.

A final consideration in selecting the basic nature of the model was the forecasting time horizon. The President pointed out that the nature of the plastics moulding industry was such that technological change made it infeasible to predict conditions for more than five years into the future. Thus the model was set up with a maximum time horizon of five years.

In summary, the initial stage of development research indicated that a computerized organization model of the Kemp Products company should be based largely on financial accounting information supplemented by information about physical manufacturing requirements. The model should be deterministic in nature operating with a one-year time unit and a five-year forecasting horizon. In addition, the model should operate in a mode that would provide a capability to make a range of deterministic predictions with a minimum of input changes.

The Model's Major Components

The paper published by Gershefski describing the Sun Oil model recommended a separate model component for each major area of activity in the company (12). The initial research at Kemp Products indicated that a model of this relatively small organization should contain five main types of activities--sales, production, manufacturing costing, administration and financial accounting. The information to be generated by model components based on the above activity classes would be largely financial in nature, except in production, to correspond to

the Kemp planning evaluations. It was found that two types of support activities would be needed to unite the five operating components into a total model, and to enable the interactive use of the model in decision-making and problem-solving. The supporting activities were needed for model parameter changing and the reporting of results (for a related example see Jones, 22, p 83ff). The above types of activities were the basis on which the seven interrelated major model components shown in Figure 4 were developed.

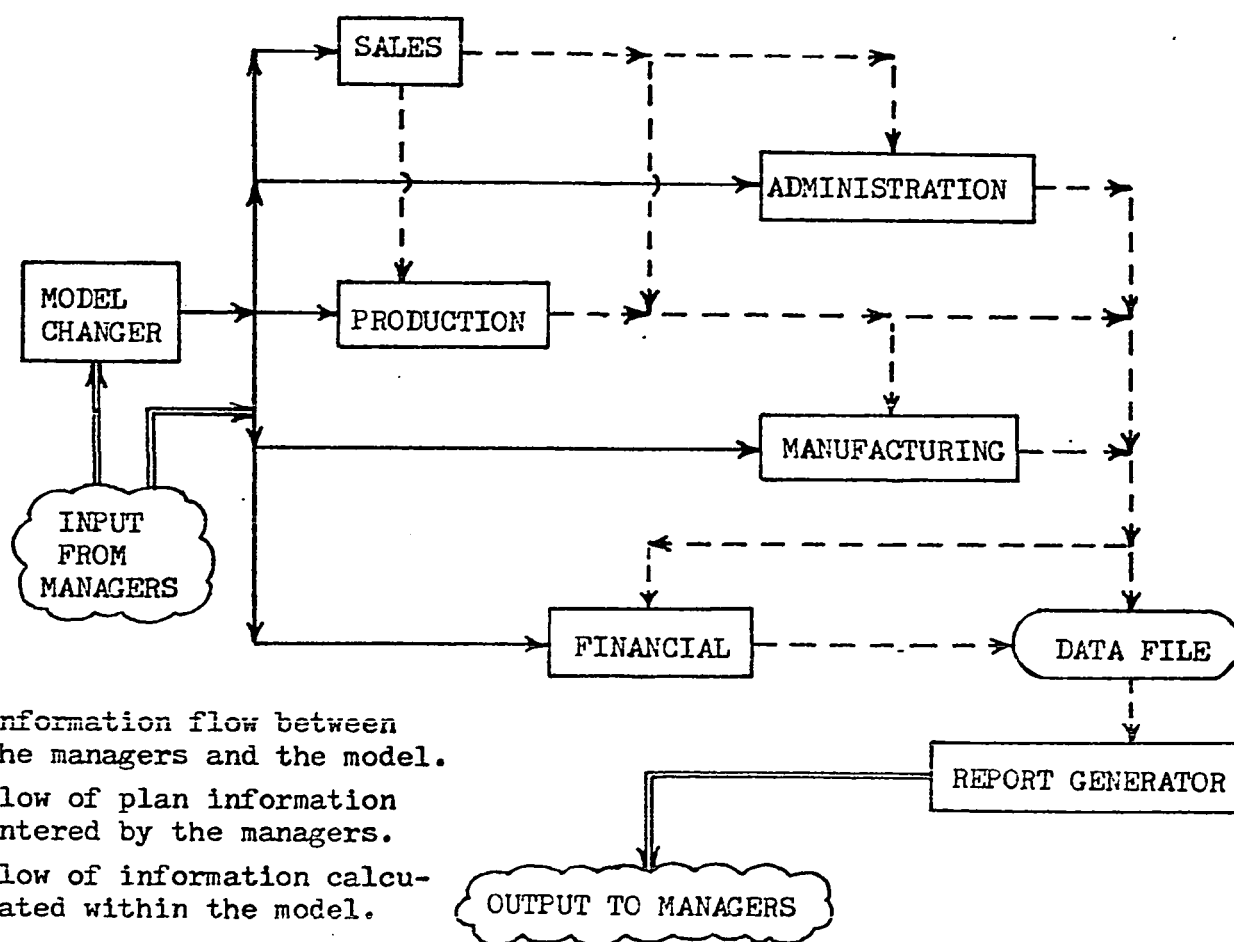


Fig.4.--The organization model components

The "Input from Managers" indicates that the model was designed to operate with a "permanent" set of parameter changes for accepted plans while also allowing the manager to enter changes to any component while the model was running. The data file indicated was for the storage of results during the model operation and for output printing.

The grouping of activities for each of the components depicted in Figure 4 was determined on the basis of activity types and computational necessity. The schematic indicates the precedence ordering for the computations except that while "Administration" could be evaluated any time after "Sales" it followed "Manufacturing" in the working model. The sales and administration components were relatively small and could have been combined in one program. They were separated in accordance with the company practice, and to clarify the model structure for the user. The remaining components had to be separated to keep each computer program within the 12,000 character core capacity of the computer being used. Wherever possible a sales, production, or other type of activity was placed in the appropriate component. However, some activities were placed in one component to reduce the number of variables in another component and in the total model. Others were programmed into a component (other than the one their activity type would indicate) in order to reduce the total number of variable values that would have to be carried between the sales, production, manufacturing, and administration components as status variables. The activities represented by each major model component and the interactions of components are summarized in Figure 5.

In all cases the activities within a component did not include

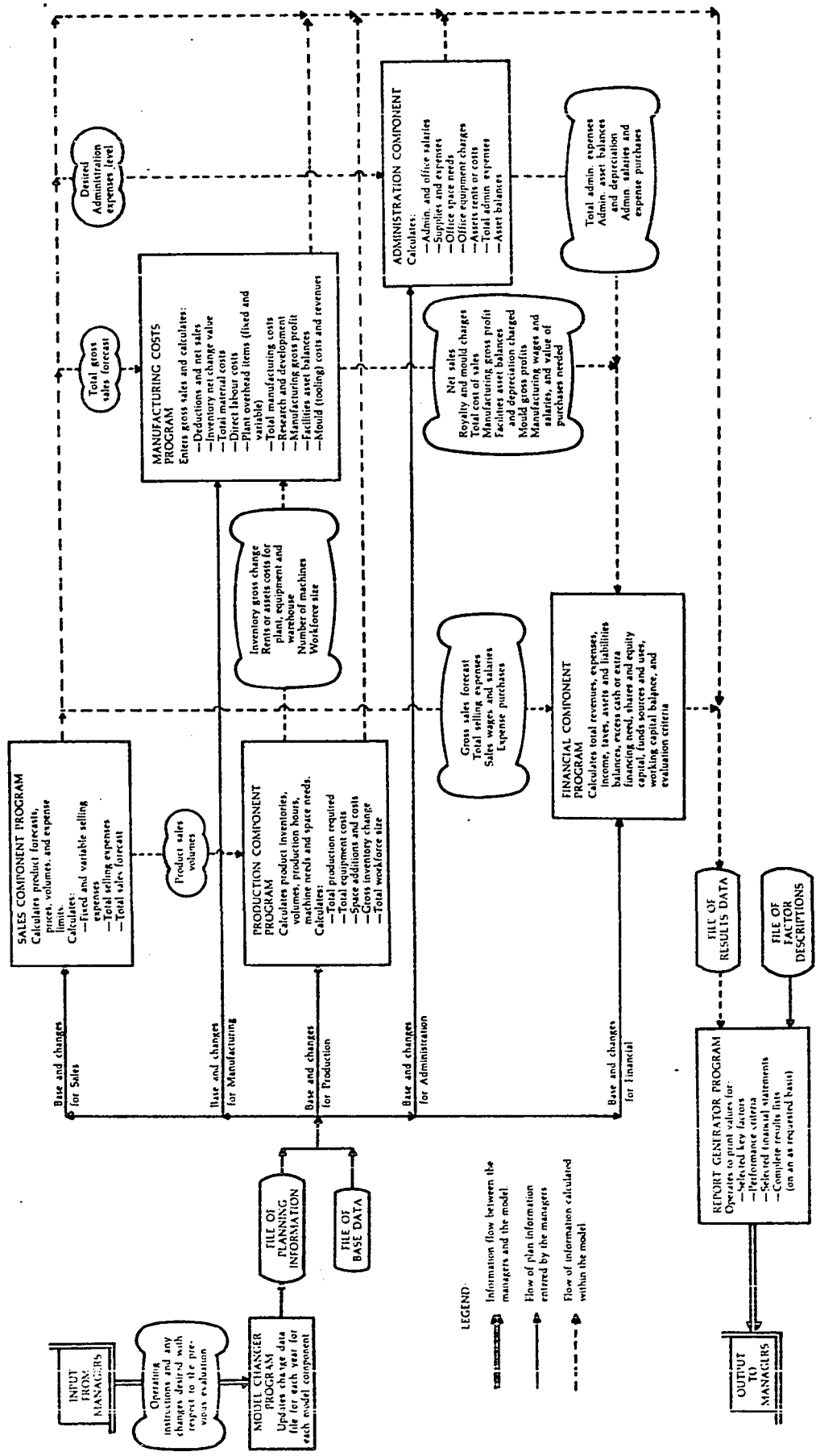


Fig.5.--Summary of the major model component activities and their interactions

predicted alterations to management policies. The components were set up so that the user could obtain predictions of results using one set of policies. He could then revise the policies to get different results for comparison. Thus a plan that could be evaluated by the model might be a proposed new set of operating policies. Factors influencing the formulation, nature and operation of each major model component are described below.

1. The Sales Component

The contents of the sales component were based largely on activities carried out by the sales personnel at Kemp Products (such as forecasting and pricing) and the expenses incurred to support the sales activities. The company's sales forecasts were made on a percentage growth and lump-sum change basis because the sales consisted almost entirely of custom products produced on a contract basis for manufacturers of other products. Kemp's actual total forecast was built up from forecasts of individual customer needs. The forecasting technique used in the model was very similar to the company's except that the model used product groups to reduce the number of individual forecasts. In computing forecasts and prices for the product groups this component worked with the managers' predictions of sales and price change rates and any lump-sum changes that they expected would arise from product additions or deletions in any year.

Two types of calculations for cost control by the managers were added at the President's request. These were calculations for the desired selling and administration expense levels based on the gross sales forecasted for each product group. The desired expense

levels could be varied for each product group but the total of the individual levels was used to determine the differences between predicted and desired expense levels. This information was desired for use in determining whether corrective action might be needed to reduce costs or to change management expectations. The administration desired expense total was carried forward to the administration component to determine the differences.

Selling expenses for salaries and travel costs were estimated from the number of salaried sales personnel and the salaries and expense rates determined by the management. The remaining expenses for commissions, freight-out, and advertising were estimated as proportions of gross sales. The appropriate cost levels and rates were determined from an analysis of historical expenses in relation to sales. The sum of these items was then the predicted total selling expenses for any year. The above forecast, price, and selling expenses items were the ones considered in planning evaluations carried out by the managers at Kemp Products.

2. The Production Component

The activities included in the production component were largely those required to estimate the physical manufacturing facilities needs. Most of these needs had not previously been predicted or evaluated by the Kemp managers except on a product-by-product or as required basis. The function of this component (and the main reason for adding it to the model in its present form) was to provide estimates that the Manufacturing Vice-President felt would be desirable to augment his contribution to the planning evaluations. Included were estimates by

product groups for inventories, production volumes and hours, machine numbers, plant, and warehouse space needs; and overall estimates of the total production volume, machines, plant space required, inventory change values, warehouse space needed, and the number of operators required. This component also predicted when machine, plant, and warehouse additions would be needed.

Some manufacturing costs information was estimated in this component and carried forward to the manufacturing component in the form of status variables. These were estimates of building and equipment rents, assets levels, and inventory change values. Equipment rents were included in the production component because equipment needs were determined on a product group basis and the rents and purchase prices were different for each type of machine used for each particular product group. The manufacturing component dealt only with the aggregated equipment estimates. Since the space and inventory unit quantity estimates were determined in the production component it was only necessary to add appropriate parameters to get cost estimates. It would have been necessary to add more variables as well as cost parameters to compute the same estimates in the manufacturing component.

3. The Manufacturing Component

The activities in the manufacturing component were those needed to produce estimates for the company's manufacturing and mould costs statements. The activities included were those being used by the Kemp Products management for planning evaluations. The results produced by the manufacturing component were almost entirely financial in nature

and included items such as gross and net sales, material and direct labour costs, net inventory change value, overhead cost items, total costs, gross profit, and net asset balances. The overhead cost items included supervisor and service salaries, supplies and maintenance costs, utilities costs, building and equipment rents and depreciation, employee benefits, and engineering costs. In addition, this component updated the numbers of supervisory and service personnel, the wage and salary rates, research and development costs, and prepaid mould expenses.

4. The Administration Component

The administration component contained the activities needed to estimate costs for the company's general and administrative expenses statement. The estimates corresponded with those made and used by the managers and were almost entirely financial in nature. They included administrative and office salaries, supplies and services, travel costs, equipment and building rents and depreciation, and total expenses. The administrative component also compared the predicted with desired expense levels, updated the numbers of administrative and office personnel (per management decisions), and determined office space requirements.

5. The Financial Component

The financial component was comprised mainly of the activities needed to convert the estimates from the other operating components into year end income, balance sheet, and funds statements. The calculations made were to determine totals for revenues, expenses, taxes, net assets, liabilities, funds sources and applications, and working

capital. This component also estimated the availability of excess cash or the requirement for additional financing that should result from following specified plans with specified financial policies.

As of April 1970 the Kemp Products management relied on the income statement and a cash flow statement in evaluating plans. The financial component did not carry out the cash flow calculations because the Controller did not feel that this was essential. He also felt that the added information provided by the balance sheet and funds statements would be much more beneficial. The writer felt that the balance sheet should be added to the usual Kemp Products estimates to recognize and provide easy estimating manipulation of the numerous capital sources available to the company. This addition built in capabilities for the managers to test assets and liabilities policies that could well affect the profitability of the company. The President and Controller both felt that the balance sheet was a highly desirable addition for planning evaluations.

6. The Model Change Component

A model change component was found to be necessary to reduce the amount of time that any user would have to spend entering parameter changes for any run of the model. Its function was to create and update a file of data on changes the model user wanted to make in parameters during any run. The model change component enabled selective entry of changes for all variables and parameters in all of the five operating components for all years to be forecasted. It operated in such a way that changes, incorporated in all of several model runs, only had to be entered once. Additional changes could

then be made at any later time, as the managers determined what they should be, when evaluating alternative ways of dealing with any particular situation. The file of data prepared by this component was read by each of the other components to make the specified changes during each model run.

7. The Report Generator Component

Some form of flexible report generating routine has been recommended for other models to allow the user to specify the kinds of information he wanted to receive during problem-solving sessions (for example, Gershefski, 12; and Jones, 22). The nature of the report generator and its operation had to be selected in relation to the model developed and the computer service used. The model of Kemp Products normally computed 359 variable values for each forecasted year. Since the teletype terminal printed at the rate of 10 characters per second, the complete print-out of all 359 variables for up to 6 years (including the base year) with descriptive comments required 60 or more minutes. Therefore, it was highly desirable that the output be restricted to a few key variable values for making choices during the evaluation runs to select among alternatives for any proposed plan. This restriction greatly reduced the time between model runs. Once a particular plan was accepted for implementation the report generator could be operated by a clerk to obtain the complete statement of predicted results.

The report generating component was capable of providing the values for the base year and all forecasted years when and as requested by the model user for:

- (a) Selected key variables,
- (b) Selected performance criteria variables,
- (c) Any complete financial statement(s) or the production conditions or status variables statement, and
- (d) A complete sequential listing of all variable values for any specified model component--all components could be specified on a one-at-a-time basis.

The report generator worked with a permanently established data file of all variable names and a data file for results computed by the other model components. The data files gave the model a capability found desirable by Ness--the ability to make changes without generating a proliferation of long printouts (36, p 17). The results from any model run were available for printing until such time as they were modified by a subsequent run.

The Use of Data Files With the Model Components

As mentioned above data files facilitated the operation of the report generating component. However, the real need for data files arose because of the computer core capacity limitation. The complete set of computer programs for the organization model was approximately five times larger than the longest program that could be loaded into the 12,000 character computer core. At the same time the final aggregate company results could not be determined until all of the interdependent model components had been run. Therefore, a data file was needed to retain results computed by each component and make them available while the remaining components were being run. Descriptive

variable definitions were stored on another data file in a sequence that corresponded to the results file.

Since working program storage was limited and it was a very time consuming procedure to feed data into the computer from a teletype terminal, a permanent data file was used to store the base variable and parameter values for computer access. A separate data file was also used to store variable and parameter changes for model runs. In all cases the data files were structured so that a limited number of values were accessed at any particular time to reduce the working storage needs for each program in the model.

The Determination of Important Functional Relationships

1. The Sales Forecasting Methods

The Kemp Products sales forecasts were actually made on a percentage growth and lump-sum change basis for custom and other products. The total forecast was built up from forecasts of individual customer needs. All of the company's sales representatives were responsible for determining the future year's expected demand for each customer they served. Customers usually provided predictions which were decreased (or increased) by the sales representatives according to whether particular customers were usually optimistic (or pessimistic) in estimating their needs. Each sales representative then met with the Marketing Vice-President who reviewed and cumulated the predictions. The President and the Marketing Vice-President met to review the representatives' forecasts and adjust them for general economic trends and any potential new product sales that had not been included. The

result was a sales forecast that was broken down on the basis of sales representatives and contract customers.

The actual company sales forecasts were broken down in such a way that several product groups could be included in each part of the forecasts. For modelling purposes (as detailed later) production volumes were broken down into product groups on the basis of moulding machine types and sizes. Any major contract customer could buy products produced by several types of moulding machines. Therefore, the company's sales forecasts had to be reconstituted into product groups for use in the model. This restructuring of the forecasts was accomplished using an analysis of past production records for all products produced. The analysis provided an initial product mix by machine type in relation to major customers. The proportions of each customer's sales produced on each type of moulding machine were then used to convert the company's sales forecasts to ones compatible with the model.

The sales forecasting routine used in the model was set up to predict increases by much the same method as the managers used. For any particular product group in the model sales were forecasted for any year on a percentage change basis in relation to the prior year's actual sales or forecast. The rate of sales growth or decline could be changed for any year in accordance with the managers' judgements. Each forecasting equation also contained a parameter that enabled the entry of lump-sum dollar forecast changes. A lump-sum type of forecast change could arise from a new product addition or the discontinuing of sales of an old product. The sales forecasts developed in this manner

became the starting point for all of the remaining model calculations in each year of operations evaluated.

2. The Financial Relationships

Since most of the variables in four components of the model were financial in nature, the first step taken in determining the important functional relationships was to outline the framework represented by the financial statements of the company. This was done by developing a series of schematics depicting the major items in the statements, their subcomponents, and the individual account items forming the subcomponents. The schematics are included as Appendix B. The flow arrows indicate which items were combined to form the key elements in each financial statement. Each schematic starts with a particular final result and then rolls back down the page to individual account entries. When read down the page each schematic indicates the reverse precedents order needed to compute the final result.

A computer data file of the historical financial results was then set up for the five most recent years of operation. The audited financial statements from 1965 through 1969 were used as recorded except that adjustments were made for accounting changes that had been introduced during that five year period. In addition some of the less significant individually reported results were combined into larger, single items. For example, on the income statements the individual items "interest and exchange" and "discounts and insurance" were combined into one total as "other expenses". In general items were combined if the Controller did not consider them to be important by themselves, they were similar in nature, and their individual values were

less than 1% of gross sales. The combinations made are indicated in Appendix B by the asterisks for items not separate in the model.

The next step was to determine, through a series of interviews with the managers of the organization, which factors were likely to be variable in relation to others; and which factors were fixed or subject to change according to management decisions or policies. It was found that only a small number of the financial cost items could be considered as completely variable, some could be considered partially variable and the majority could only be considered as fixed by negotiation, policy or operating decisions. For example, in the manufacturing cost statement only the raw materials, direct labour, employee benefits and net sales could be considered as variable. Factory and mould supplies, and repairs and maintenance could be considered partially variable; and the remaining eleven major cost items could only be considered as fixed by some form of decision made by the company or imposed upon it. Imposed (or exogenous) decisions fixing costs were factors such as utilities rates and municipal taxes.

For the variable items, a series of simple linear regression analyses were then conducted to determine whether consistent functional relationships could be established to relate them to other factors. Initially, generally accepted statistical significance levels were used to accept regression equations. A functional relationship was to be accepted from the regressions if the index of determination was greater than .95 and if the student's 't' statistic was significant at the .95 level or higher (for three degrees of freedom). Even so it was found

that some apparently acceptable regression equations would produce cost estimates that varied from the actual costs by as much as \$25,000. This absolute error was equivalent to 2.5% of the company's annual sales and could have a significant effect on profit estimates if incorporated in the model. The results of the analyses for financial variables, and the cost estimates produced by the equations in relation to the historical recorded costs, are included as Appendix C and D. The conclusion from the analyses was that only two of the regression equations could be accepted for inclusion in the model:

1. Material costs as a function of the sum of gross sales plus the gross value of the inventory change in any year, and
2. Employee benefits as a function of the sum of all salaries, wages and direct labour costs for any year.

The two apparently variable items for which significant regression equations were developed and then discarded for estimating were:

1. Direct labour as a function of the sum of gross sales plus the gross value of inventory change in any year, and
2. Net sales as a function of gross sales.

An examination of the direct labour costs as a result of the wide differences between estimates and the actual costs indicated that several factors could cause major fluctuations. One source of variation would be wage rate increases that were not immediately offset by price and/or productivity increases. The regression equation suggested that changes of this nature were likely offset although there may have been a lag. But a very large source of variations was discovered when

the estimates were projected forward to 1970. Declining sales for one group of products had brought about process changes and the production of some new, marginal products that greatly increased the labour content and significantly reduced the overall labour productivity. The operation during this period allowed the direct labour costs to rise to approximately \$100,000 higher than the historical trend predicted in relation to gross production value. Then a change in management policy early in the 1970-71 fiscal year reversed this trend by eliminating the marginal operation. In other words management decisions were responsible for a major decrease in productivity followed by a major increase in labour productivity that induced wide variations in labour costs. Since the managers were most concerned about forecasting costs for the next year in the future, and since wage rates were established by two- or three-year union contracts, it was concluded that a more accurate estimate could be made by using an overall productivity value and the production volume to estimate the number of workers needed and then multiplying that figure by the weighted average wage rate to obtain the total cost figure.

The percentage variation between the estimated and actual net sales values was very small. However, the difference between gross and net sales resulted from management decisions regarding policies for paying royalties and writing off the mould (or tooling) development charges. The net sales differences were very large in relation to these exogenously controlled variables. The conclusion taken was that the model estimates would be more realistic and acceptable to the managers if the royalties and mould charges were estimated in a way

that incorporated the managers' judgements. Thus the managers' estimating procedures were used in preference to the regression equation for determining the net sales estimates in the model.

For the partially variable cost items, functional relationships were developed from the Controller's established estimating procedures or by establishing patterns of consistent and discrete changes of one item in relation to another. For example, several income items such as licensing fees, technical and service fees, and sundry income were estimated by the Controller at the previous year's level plus or minus any discrete change that he judged likely to occur. Functional relationships for such items were incorporated in the model exactly as stated. The Controller used percentages established by management policy to determine depreciation and amortization charges in relation to net book value. For other items such as supervisory salaries, service wages, and equipment and building rents estimates could be developed only on the basis of the average annual wage or rent rates (usually negotiated between the managers and another party) and the total number of people, pieces of equipment, or floor space (usually a result of management decisions regarding operations). These functional relationships were incorporated in the model as stated above and similar ones were developed for the remaining financial items.

3. The Production Relationships

The most important aspects of the production relationships were the determination of ways to estimate the machine and space requirements, and the development of a common product unit. The procedures followed to obtain these factors are described in detail in the next

two sections. Once the product unit was established and a production rate unit developed from it for each of the six classes of production equipment used by the company, the balance of the production relationships were obtained from the company's operating policies. For example, the level of finished goods inventory resulted directly from the policy set by management in relation to sales. The sales forecast and inventory policy then determined what the production volume predicted would be, which in turn determined what the equipment and plant space requirements would be, and so on. As stated previously, the average total number of operators needed was assumed to depend upon the production volume and the estimated average labour productivity. The managers felt that this reasoning was a sound basis on which to estimate the labour requirements for the forecast in any year.

Since equipment and space requirements were estimated in the production component of the model, parameters were included to estimate their annual costs in this component. This meant that the production functions were the most expedient ones for incorporating the ability to test equipment and building addition policies. In 1970 the Kemp Products policy was to obtain equipment on a lease-buy basis and to rent all building space (accumulating building assets only from leasehold improvements). However, the managers felt that it would be desirable if they could evaluate the possible benefits from a policy of buying all future equipment and building additions and/or purchasing the ones already held. Therefore, a duplicate set of quantity-cost relationships were added to the production component to allow for the possible evaluation of purchase alternatives.

4. Machine and Space Requirements

The importance of space requirements for production was stressed by the Manufacturing Vice-President. He said that he would like to be able to plan ahead for storage space needed for inventories in relation to production volumes and the sales pattern but did not have any standards or method for estimating space needs. The Manufacturing Vice-President indicated that similar types of moulding machines produced parts similar in volume so that it might be possible to use production volumes and sales flow rates to estimate space requirements in some manner.

The Manufacturing Vice-President described the manufacturing procedure as being very similar regardless of the type of machine used to produce any product. Any machine could produce three categories of products for which the flows would be as depicted in Figure 6:

- (a) Products finished and packaged at the machine,
- (b) Products cured and then decorated and/or assembled, or
- (c) Products decorated and/or assembled without curing.

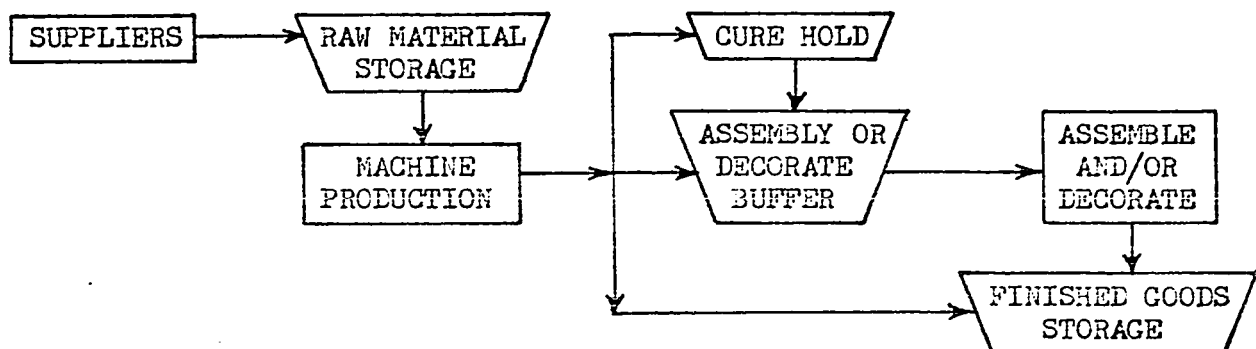


Fig.6.--The product manufacturing flow patterns

The Manufacturing Vice-President felt that the rates of flow

would vary largely with respect to the type of machine being used to produce any product. A plastics moulding machine of a given type and tonnage in pressing capability was particularly suited to producing products within some given size range. The Kemp plant operated with five different sizes of injection moulding machines and one type of blow moulding machine in 1970. In the future new types of products could require the use of new types of moulding machines but the basic process flows would likely remain the same.

The expressed concern was for estimating raw materials, work-in-process, and finished goods inventory space. However, it was found that the Manufacturing Vice-President had been using rule-of-thumb space allocations in the past when expanding the plant for new machine additions, and that this procedure had always ensured that sufficient space was provided for raw materials and work-in-process inventories. The major difficulties had arisen in predicting when a new machine would be needed, and in predicting when the capacity of the finished goods warehouse would be exceeded. Thus it appeared that estimates of machine numbers and inventory volumes would be adequate to predict plant and warehouse space needs for aggregate planning purposes. The researcher felt that the necessary estimates could be made only if a common product unit could be established to convert from sales forecasts to production and inventory volumes at least for each of the six types of machines.

The procedure followed to obtain the common product unit for each type of machine is described in the next section. The base unit used for all products and machine types was the pallet. All machine

and assembly line output was packaged in cartons which were stacked on pallets for moving and storage. The pallets all took up approximately the same amount of floor space and held approximately the same volume of finished goods. Using the pallet as a base unit enabled the development of a "weighted average selling price per pallet" and a "weighted average hours per pallet" production rate for each type of machine. Applying these parameters in conjunction with a sales forecast and finished goods inventory for products produced by each type of machine resulted in estimates of the total production hours per machine type and the total inventory in pallets. These figures, in turn, could be used to estimate the number of machines needed and the resulting plant and warehouse space needs.

The Manufacturing Vice-President felt that this method of estimating the space needs should work very well, however, he pointed out that the number of machines of any type needed would not correspond directly with the number of production hours forecast. First, under the most desired operating conditions machines were loaded to a maximum of 4500 of the total 5760 hours available per year on a three-shift, five-day week basis. The balance of the time was used for set up, preventive maintenance and breakdown repairs. However, machines were normally loaded to a maximum of 5000 hours per year on a tighter maintenance schedule before consideration would be given to the addition of new machines.

Second, the forecasted production hours were developed for each machine type for the most efficient production of products whether the loadings would exceed the maximums or not. If the forecast was for

production in excess of the 5000 hour load limit for all machines of one type and sufficient free capacity existed on machines of a very similar type the overload would be shifted to the second set of machines to forestall machine additions. In practice the loads could be shifted between the second and third, and between the fourth and fifth machine types without any significant loss in production efficiency or output rates.

The total plant floor space included areas for production machines, assembly equipment, work-in-process and raw materials inventories, tool storage and repair, aisleways, washrooms, and a cafeteria. The managers felt that the total space needs would increase proportionately with the total number of production machines. The President suggested, however, that the plant space needed for the addition of any particular type of machine should be estimated on a basis scaled according to its production rate for output volumes. At higher output rates the volumes of raw materials used, work-in-process inventory, and assembly throughput all increased, as well as the total number of workers needed to complete processing of the products. The Manufacturing Vice-President felt that the existing plant space was the amount needed for an efficient operation with eleven injection moulding machines (the number that Kemp Products had in Operation in April 1970), but that as many as three more machines could be added in the same space for one or two years without disrupting production significantly in order to postpone a plant addition. The parameters developed to estimate total plant space needs were then based on the weighted average hours per pallet for each machine type and the "desired" and "crowded"

operating conditions. These parameters were used in the model to estimate when plant additions should be required and to estimate the amount of any addition on the basis of particular types of new machines to be added.

In July 1970 the crowded type of plant space conditions became an actuality when three blow moulding machines were moved into the main plant after the blow moulding plant was shut down. Floor space allocations were reduced for production machines, assembly equipment, and storage to avoid a plant building addition during a period when the company lacked the capital for a building addition. However, any future need for production equipment additions would mean that the plant would have to be expanded. The decision rules suggested above for machine and plant space additions were incorporated in the organization model in order to estimate the years in which the fixed operating costs should increase.

At Kemp Products the warehouse floor space needed depended upon the average number of pallets in storage, delivery fluctuations, and the method of storage. The Shipping Supervisor reported that on an overall basis the average inventory occupied about 80% of the available storage space while the balance was needed for delivery fluctuations. Approximately three-quarters of the products could be stored on pallets stacked two high in double rows of racks with access aisles between the rows. The remainder of the inventory could be stored one or two pallets high with no aisles--these were large volume products that could be shipped on a last-in first-out basis because there was no colour variety and so on. The area parameters for esti-

mating warehouse space on the basis of the number of pallets were developed using the inventory count and warehouse space available as of May 31, 1970. The model used these parameters to estimate the warehouse space needed for any planned level of inventory. The total warehouse floor area was estimated by adding fixed areas for shipping and receiving and for the shipping office.

5. The Development of a Common Product Unit

An essential factor for estimating aggregate production rates, volumes, and costs was a common product unit (see Holt, et al., 19). The Kemp managers felt it would be difficult, if not impossible, to find a common unit for moulded plastics products. The products varied greatly in size, weight, production rates, and so on. As far as the managers knew no consistent weight-volume or other type of relationship had ever been developed for moulded plastics products. Carton weights were suggested as a possible common unit but the Shipping Supervisor's records showed that each of the fifty different cartons used could hold a wide range of weights of product.

A tour of the finished goods warehouse provided an initial idea for a common volume unit. Products were moved to the warehouse and stored on the same pallets that they were stacked on at the production machine or after decorating and/or assembly. The Shipping Supervisor pointed out that virtually all pallets required the same amount of floor or storage rack space and contained cartons piled to one common height. This suggested that a common product unit might be the volume of one pallet. However, since the volume of each pallet was very close to constant the basic unit chosen for analysis was the "pallet" without

regard to volume.

The following data was gathered for initial analysis for many of the injection products forecasted for production in 1970-71 (data was not available for previous production years):

- a) The machine type on which the product would be produced,
- b) The forecasted number of pieces to be produced,
- c) The forecasted production hours for the product,
- d) The number of pieces packed in each carton, and
- e) The number of cartons of the product that could be stacked on each pallet.

The computer was then used to develop three sets of preliminary calculations for products in each of the five injection moulding machine categories (information for products in the sixth category, blow moulding, was not gathered for the preliminary analysis):

- a) The arithmetic mean, variance, and standard deviation of hours per pallet for all products in each category,
- b) A weighted average hours per pallet based on the total number of pallets to be produced and the number of pallets of each product,
- c) And a weighted average hours per pallet based on the total number of production hours and the number of hours of production for each product.

For the last two sets of calculation an estimated number of total production hours was also computed using the weighted average hours per pallet and the total number of pallets to produce.

The detailed results of these calculations are contained in

Tables 15, 16 and 17 in Appendix F. In each case the analysis indicated that variation in hours per pallet among products was so large that the arithmetic mean could not be used as an estimator. The weighted average hours per pallet based on production hours was found to produce extremely distorted estimates of total production hours in each category. However, the production rate developed using pallets of each product resulted in exact estimates of the total production hours in each category. The conclusion taken was that, on an aggregate basis the weighted average hours per pallet (developed on the basis of product pallets) for each machine type could be used to estimate production hours from a forecast of the total pallets to be produced. The weighted parameters developed in this manner would be reasonably accurate estimators as long as the mix of products produced by the machines in any category did not change significantly.

Forecasting the total production hours, however, could only be accomplished by converting the sales forecast developed at Kemp Products from dollars into pallet units. In actual practice, the manufacturing staff used detailed product sales forecast information to determine the number of pieces to produce and to estimate the production hours for each product. The product information was totaled to estimate total machine loadings in hours, and no forecast was made of the number of pallets to be produced. For aggregate planning purposes it would be desirable to have a unit to convert from dollar sales to total pallets since a way had been found to convert from pallets to production hours. This suggested an analysis to determine whether a weighted average selling price per pallet could be used to estimate

pallets for production.

The information on pieces, hours and pallets was then gathered for all products to be produced in 1970-71 including blow moulded products. At the same time the usual machine type used to produce each product was checked and recorded to ensure the accuracy of the machine allocations. The selling price per one thousand pieces and the 1969-70 year end inventory in thousands of pieces was also recorded for each product.

A computer analysis was then conducted to determine by machine type:

- a) The forecasted total production hours,
- b) The forecasted total production pallets,
- c) The weighted average hours per pallet based on total pallets,
- d) The sales value of the forecasted production,
- e) The weighted average selling price per pallet based on the total pallets to be produced,
- f) The number of pallets in the year-end inventory,
- g) The selling value of the year-end inventory,
- h) The weighted average inventory sales value per pallet based on the total pallets in inventory,
- i) The estimated total production hours determined from the product of (b) and (c) above,
- j) The estimated sales value of production determined from the product of (b) and (e) above,
- k) The estimated inventory sales value determined from the product of (f) and (h) above, and

- 1) The estimated inventory sales value determined from the product of (f) and (e) above.

The last two values were computed on the basis of the inventory sales value per pallet and the selling price per pallet, respectively, to determine whether the inventory distribution of pallets in each category was significantly different to the forecasted sales distribution. It was decided that if the difference in the estimates was within the range of plus or minus 5% it would be considered insignificant. However, a larger difference would mean that the inventory distribution should be investigated to determine whether the difference was due to any unique conditions. If so, it would be necessary to determine whether the pallet value parameters could be reconciled, or which price per pallet should be used to estimate future inventory values.

The results of the calculations made are summarized in Table 18 of Appendix F for the six machine categories. In summary, the results were excellent for the production and sales computations. The estimates made with the weighted averages were accurate in all cases. In addition, the sum of the production sales value across the five injection machine types differed from the aggregate sales forecast by only \$9,835. Given the 1970-71 sales forecast of \$1,460,000 the difference, or error, amounted to only 0.674%. The difference could have arisen from inaccuracies in the detailed production hours forecasts or from a planned intention to draw the finished goods inventory down by \$10,000 relative to sales value. Therefore, it was concluded that forecasts of sales by machine type could be used to estimate the

number of pallets to produce which could, in turn, be used to estimate the production hours for sales. The remaining factor that would alter production hours was any change in finished goods inventory.

The results of the inventory calculations indicated that the actual distribution of products in inventory was significantly different from the desired distribution based on the sales forecast. The Controller stated that the year-end inventory was most likely quite different from the desired average inventory position because several products had been produced in large volumes in anticipation of later sales. The company followed this procedure in order to allow for a more flexible production schedule during periods in which monthly sales would be higher than the production capacity. The President stated that he would want the inventory kept in line with management policy in 1971 and the future. From these statements it was concluded that the inventory volume in pallets should be entered as the actual at the price suggested by the inventory distribution. However, for future estimates the volume should be based on the sales distribution and the resulting weighted average selling price in conjunction with the desired inventory policy.

In summary, a basic product unit of one pallet was used to develop weighted average prices and production rates. These were then used to estimate the number of pallets and production hours for the sales forecast, and inventory need in each machine category, in predicting future results using the Kemp Products model.

The Organization Model Logic and Computer Programs

The computer model developed for the Kemp Products organization consisted of seven, separate computer programs and one major subroutine. Flow diagrams and program listings are included in the appropriate section for each component in the Model Users' Guide (Appendix G). The programs have been developed in a way intended to allow relatively easy manipulation of the model while keeping within the programming and working limitations of the time-shared computer service used for the project. The following subsections outline the factors that were given major consideration in the development of the final programs.

1. The Model User

The model user was considered in selecting the nature of the organization model to promote understanding and acceptance of the results. In developing the computer programs the model user had to be considered from the point of view of the ease with which he could access the model, enter changes, run the model, and obtain results. Since none of the Kemp managers had any knowledge of computer programming their contact with the model (beyond the coding necessary to access the computer) had to be limited to the input of parameter changes and requesting of output results in the form of normal english instructions. Therefore, the model was set up so that it could be manipulated, without a knowledge of computer programming, by a user following a set sequence of simple operating procedures.

To avoid confusion for the user the program names and variable descriptions were stated in terms commonly used by the managers. The names and descriptions had to be limited in length so every attempt was

made to make the abbreviations visibly and phonetically similar to the actual terms used. The model contained a relatively large number of variables (359 in total) most of which had two parameters that could be changed as desired by the model user. Accordingly, the variables and parameters have been set down in coded sequences for reference purposes. The complete list of codes and descriptions is included in the Model Index (Appendix H). The operating procedure and the coded variable lists provided the model user with all of the information needed to manipulate the model and obtain output values.

2. Computer and Programming Restrictions

The working capacity and programming restrictions of the time-shared computer service used had major effects on the model programs. First, the computer working capacity (or core storage) was limited to 12,000 characters or 6,000 words. Not all of the core capacity was available for a program to run at any time as some of the capacity was needed for operating instructions and storage of computed values. The maximum size of program that could be run was approximately 4100 words of static storage. Therefore, the model had to be broken down into several separate programs, which was done on the basis of the functional areas incorporated in the model. The actual programs used, with the major subroutine attached where appropriate, were seven in number (static storage word totals are enclosed in brackets after each name): Model Changer (1525), Sales (1463), Production (3465), Manufacturing (2515), Administration (1875), Income (4096), and Report Generator (3866). The model changer component was separated to run in isolation from the model operating programs to load and modify the data file of parameter changes.

Second, the BASIC programming language limited matrices to two dimensions. In the sales and production programs the product group variables really had three dimensions--the variable number, the product group number, and the forecast year. The third dimension was provided with a two-dimensional matrix by programming each component to compute one year at a time and store the results on a data file before calculating values for any subsequent year. An offshoot of this approach was that the remaining variables in all of the components became single-dimensioned arrays, and the total amount of working storage needed for each program was reduced to one-fifth of what it otherwise would be with a five-year forecast.

Finally, the total disk file storage available for the model was limited by the facilities of the computer service and the monthly cost of storage. The total storage allocated for the programs and data was 480 sectors or 31,000 words. Therefore, the program and data file lengths had to be limited to have enough capacity for the total model requirements, and to reserve some extra for ancilliary calculating programs. This was done in part by attempting to get efficient programs for each component. But a major 2,200 word saving in total storage was realized by the use of the AMEND program shown in the appendices which was used by the five operating components to make parameter changes during each model run.

3. The Variables in the Model

In developing the programs it was found that four classes of variables were needed--product, operating, internal, and status. The company used six different types of machines that varied greatly in

performance. Product variables were needed to compute sales, prices, volumes, inventory, hours, and equipment and space needs for each type of machine. Allowance was made for the addition of two more product groups (to a total of eight) in the sales and production components. Variables were also needed to compute aggregate company results for each component with the use of assignable parameters. These variables were classified as operating variables. Internal variables were needed for each component to accumulate aggregate results without the use of assignable parameters. This class of variable was developed to save on storage space when parameters were not needed. Because the model was run in separate program segments some variables had to be transferred in such a way that they could be modified in more than one component with or without the use of assignable parameters. These have been classified as status variables and consist of items such as building and equipment assets balances, total wages, and so on. The product, operating, and status variables had to be programmed into the model in such a way that they could all be modified in accordance with the managers' judgements regarding condition changes. The potential for such modifications was provided through the use of changeable parameters.

4. Parameters in the Model

The initial intention was to program the model with equations that were all of one type such as $Y = a + b * X$ as was suggested by Gershefski (11). However, it was found that two more parameters were needed for each equation to enable the entry of modifications. An extra parameter was needed to enter changes to the rate parameter 'b', while a second was needed to enter exogenous changes to the dependent

variable 'Y' indicated in the example equation. In other words, the general equation became $Y = a + (b + c) * X + d$.

After the analysis to develop functional relationships it was found that a maximum of three equations in any component would require the parameter 'a'. This parameter was virtually eliminated by programming special equations with a fixed parameter as required. The 'c' type of parameter was eliminated from permanent storage in the model components through the use of the model changer and the amending subroutine. As a result most of the equations in the model were of the type where $Y = b * X + d$.

The above procedure followed to eliminate parameters resulted in the sacrifice of generality in the statement of many functional relationships. Restrictions on the storage and computer working space were instrumental in encouraging this procedure. The model had 359 main variables of which 75 were of the internal type without parameters. This meant that the elimination of one type of parameter resulted in a saving of 568 words of storage space (the amount needed for 284 numbers). In total the storage needs were reduced by about 1,120 words by the reduction in the number of parameters directly assignable to the product, operating, and status variables.

5. The Use of the Base Year

The starting point for all calculations by the model was the 'base year' which was the set of values determined for each variable from the latest, audited year-end results of the company. The base year of variable values was stored on one data file along with the initial values of all of the slope or rate parameters associated with

the product and operating variables. Initial values for parameters to make exogenous changes to dependent variables were not stored on a data file--they were automatically set to zero before the calculations commenced for any forecasted year.

The base year data was needed to provide the starting point for the calculation of the first and subsequent forecasted years of operation. The base year values were stored on a separate, permanent data file so that the year-by-year calculating procedure could be used while ensuring that base values could not be changed by any of the model components. Then at the start of any run each model component always loaded the same set of base data from the permanent file. During each run new values were computed to replace the base values in the operating storage locations and the parameters were modified in accordance with the user's instructions. At the end of each forecasted year the calculated results were saved on a separate data file and the program returned to make further parameter changes and to update the variable values for the next forecasted year. Although each new run of the model changed the contents of the results data file, the base year variable and parameter values were isolated so that they could only be modified by a programmed routine that was not related to the running of the model.

6. The Structure of the Data Files

In developing the model programs it was found that four data files were desirable. Accordingly a data file was set up for variable definitions (to use in output reporting), for the base year variable and parameter values, for the parameter change values, and for the

results data. The information on each file, except the change values file, was stored sequentially for each of the five operating components in the order of product, operating, and internal variables. The status variables information was stored separately in sequence since it had to be accessible to all components and was not specific to any one component. The parameter change values were stored on a file where blocks of space were reserved for each of the five years of the model's forecasting horizon. Within each year the ordering was random because the change values were associated with particular parameters in particular components by six digit number codes. The numerical codes are listed for each parameter in the Model Index (Appendix H).

Since a computer data file could not be expanded or contracted without rearranging the data stored on it, four data files were desirable to keep the size of each file down. This meant, for example, that if it was found that more storage space was needed for possible parameter changes for each year, that file could be expanded without necessitating changes in the other data files. It also meant that if the contents of any one data file were inadvertently destroyed at any time the amount of data that would have to be restored was greatly reduced.

7. The Sequence of Calculations

The flow of calculations within the model had to be determined from the sequence necessary to produce the intermediate and final results. First, the flow needed between the functional components had to be established. Since the aggregate level of the company's operations was determined from the level of the sales, the first model component had to produce the sales forecasts for each product group. The

forecasts were used to determine the levels of desired selling and administration expenses and the product volumes. The sales component estimated the selling expense values, the administration component estimated the administration expense values, and the production component estimated the facilities and labour needs for manufacturing. Thus the manufacturing costs estimating component had to follow the production component in the sequence. The sales, production, manufacturing, and administration components all had to precede the financial component which calculated the income and balance sheet items. The network for the sequence of components for calculations is shown in Figure 7. Administration followed manufacturing in the actual sequence of programs.

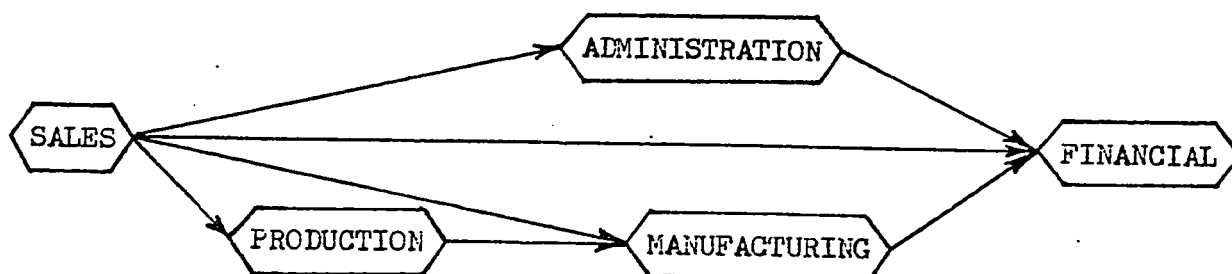


Fig.7.--The model components calculating network

The sequence of calculations within each component was determined largely on the basis of the flows indicated in the Appendix B schematics of the major items within the financial statements. However, the ordering of items in the programs was not necessarily identical where a group of separate items was not interdependent. In each component there were some variables that were not shown in the schematics. For example, in the sales component the desired expenses levels, product

prices, and product volumes had to be estimated. These product variables all followed the forecasting variables and preceded the calculation of aggregate selling expenses estimates. The production component was not included in the Appendix B Schematics. Its sequence of calculations was indicated in the flow diagram included in the Model Users' Guide description of the program in Appendix G. The production calculations followed a sequence from volumes, to hours, to machine load shifts, to new machine needs, to plant and warehouse space needs, and finally to the workforce size. The calculating sequences indicated by the flow diagrams for the components resulted from an item-by-item consideration of the interdependence of variables.

In summary, the factors given major consideration in the development of the final model programs were the model user, the computer and programming restrictions, the types of variables needed in the model, the types of parameters needed, the use of a 'base year' for estimating, the need for and structuring of data files, and the sequence of calculations necessary between and within the model components.

The Use and Modification of Regression Equations

Regression equations were developed to represent some functional relationships in the organization model. The equations were developed as simple, linear regressions from five years of historical company data. They were accepted for use in the model on the basis of the student's 't' statistic and the index of determination (R^2). The validity of such equations in use was based on the assumptions

that future conditions would remain similar to historical conditions, and that any changes in future conditions would be random and unpredictable. In other words, the predictions made using such regression equations (once accepted) would be considered as valid unless it could be shown that future conditions would differ significantly from historical ones.

The procedure used to establish the basis for indicating likely changes in conditions was as follows. First, the five regression equations developed (two of which are not actually included in the model) were used to compute estimated values, differences, percentage differences, and mean absolute differences and percentage differences for the five years of historical data. These calculations were taken as estimates of the most likely ranges of estimating errors for the equations under conditions similar to the recent past. The results of these calculations are shown in Table 9 of Appendix D. The equations appear in order as predictors of:

1. Material costs from gross production value,
2. Manufacturing employee benefits from total manufacturing wages,
3. Administration employee benefits from total administration wages,
4. Direct labour costs from gross production value, and
5. Net sales value from gross sales.

The same equations were then used to estimate values for the most recently completed year of the company's operations--fiscal 1969-70 which ended on May 31, 1970. Estimating errors larger than those made

previously were taken as indicators that the regression equations should be re-established through full analysis, and/or that conditions had changed and the equations should be changed to bias the estimates in the direction indicated (when an assignable cause was found to exist). The results of these estimates are shown in Table 10 of Appendix D. Only the Net Sales equation was found to provide a good prediction of the 1970 actual value.

Accordingly new regression equations were developed using the full six years of available data. Net Sales was included as part of the set. The results of the regression analyses are contained in Appendix E. The new equations were then used to develop another set of estimates and errors for the six years. In Tables 9 to 11 of Appendix D the mean absolute percentage differences between the actual and estimated values in each set of calculations was taken as an overall measure of the estimating error for each equation. These indicators were used as the basis for comparison between the equations developed using six years and five years of historical data. An increase in the mean absolute percentage differences was taken as an indicator that conditions had likely changed in 1969-70 and assignable causes should be determined if possible. The new set of calculations for the six years of data is shown in Table 11 of Appendix D. The changes in the mean absolute percentage differences are indicated in Table 12. Only the Net Sales results indicated no significant change in conditions.

A further indicator that conditions had likely changed was the difference in estimates made for 1970 by the two different sets of

regression equations. It was predetermined that if the regression coefficients developed for the six years of data resulted in a 5% or greater, change in the 1970 estimate (relative to the estimate from the five-year equations) for any variable, this would be taken as an indicator that conditions had likely changed and assignable causes should be sought. The percentage changes in estimates are shown in Table 13 of Appendix D. Only the Materials Costs and Net Sales estimates did not indicate a conditions change. However, because of the indication from the changes in mean absolute percentage differences causes of condition change were sought out for Materials Costs as well as the two benefits equations. Direct labour costs changes were not investigated here because it was previously determined that labour costs should be estimated from productivity and average wage information. The investigation revealed that three changes in conditions should result in a continuing percentage reduction in the actual material costs:

1. The packaging process and material recovery processes had been altered in the blow moulding operation. The Manufacturing Vice-President estimated that the changes would result in a continuing saving of 20% to 25% of blow material costs.
2. The purchasing agent reported that one material for injection moulding had decreased in cost from 15¢ to 14¢ per pound. This material represented approximately 30% of the total used in injection moulding.
3. The purchasing agent also reported that another material,

which accounted for 5% of the injection material,

had decreased in cost from 21¢ to 18¢ per pound.

Since blow moulded products accounted for 30% of total sales in 1969-70, when the above reductions were weighted on the basis of their percentages of total costs they amounted to a total reduction of 9% in material costs. A saving that would remain in effect unless conditions were to change again.

In the case of the manufacturing employee benefits the Controller reported that in 1969-70 vacation pay increases resulted in an approximate increase of 10% in total benefits paid. He also pointed out that a similar increase would occur for the 1970-71 fiscal year in accordance with the existing union contract. Regarding the administrative employee benefits the Controller pointed out that executive salaries charged to administration had been increased by at least \$30,000 without any corresponding change in benefits paid (the total administration salary increase was \$52,000 in 1969-70). Thus the level of benefits paid was reduced greatly in 1969-70 and would continue at the new low level in relation to total administration salaries.

All of the changes found to be assignable causes of estimating error were thus of the continuing percentage type that would result in a shift in the slope and origin intercept values for the three regression equations considered. Therefore, the equations were modified by multiplying the regression coefficients by the appropriate percentages. Material costs and administrative employee benefits coefficients were

decreased while those for manufacturing employee benefits were increased.

A new set of estimates for 1969-70 were then run for the materials and benefits cost equations. The modified coefficient values and the estimate results are contained in Table 14 to Appendix D. All three of the estimates were very close to the actual values in the company for 1969-70. The new coefficients were then incorporated into the model as developed except that those for the manufacturing employee benefits were further modified for 1970-71 and future years in accordance with the Controller's statement. The model was programmed so that similar coefficient changes could be entered at any time that they were found to be appropriate.

The Model Debugging Trials

The procedures for debugging the model initially took two approaches once the model was developed and running on the computer. First, a sample set of data consisting of ones (1s) for every base variable and base parameter value was entered for trial runs. The purpose of the resulting trials was mainly to check the report generating routine for statement form and content, and for syntax errors. However, a side benefit of these trials was the indication of some major program errors in other components of the model. For example, it was discovered that the calculation of taxes, interest, and adjustments to the income and balance sheet statements were not being carried out as intended. As a result of the initial set of trials many changes were made to the report generating routine and

several changes were made in other programs to produce estimates in the desired form.

Next the base data (for fiscal 1969-70) was gathered for all of the variables and parameters and entered on the appropriate data file. Then the second set of trials of the model were begun. The purpose of these trials was to check for errors in the base data and in the programming of the five operating components of the model. The basic criterion used to detect program errors was the degree of correspondence between estimates produced by the computer model for fiscal 1970-71 and estimates produced by the company managers. There were generally three types of estimating errors discovered:

1. Minor differences of one or two thousand dollars (or units) resulting mainly from computational accuracy and rounding-- these differences were not corrected,
2. Major differences ranging from three thousand to millions of dollars (or units) resulting from incorrect data base values (recording or data input errors) which were corrected by altering the data base, and
3. Major differences caused by programming errors in various model components. These were corrected by amending the computer programs.

The procedure followed was to run the model and then print out statements of results for the one-year forecast. The results were then compared with the Kemp estimates for 1970-71 (consisting of proforma manufacturing, sales, administration, and income statements) and other key values that were computed. For example, the Kemp

managers had not estimated the average labour force size for 1970-71. However, given the average worker salary and the estimated direct labour costs the number of workers could be determined to compare with the model estimate. Where necessary for checking model accuracy estimates not made by the Kemp managers were produced through the use of a conventional slide rule. Programming or data changes were determined from the comparisons after each run. This procedure was continued correcting one set of major errors in data and/or programs at a time and then rerunning the model until only minor estimating differences remained. The final computer model results were then reviewed with the managers to verify the estimates and to determine that variable values not estimated by the Kemp managers were in accord with their intuitive expectations for 1970-71.

The initial trials were all made on the basis of a one-year forecast. When the managers agreed that the model results were accurate the model was ready for testing in actual planning evaluations. However, by November 1970 the managers were considering planning proposals that would take effect in the 1971-72 fiscal year. Consequently, the next step was to run the model for a further set of trials forecasting for more than one year before the model test applications were actually begun. A procedure similar to the above one-year trials was followed except that the checks were based on the consistency of projections and information carry-over since there was no Kemp management forecast with which to make comparisons. This set of trials indicated several syntax and logical programming errors in the transferring of computed values from one forecast year to the next. The programming

errors discovered were corrected in preparation for the model test applications.

The above debugging procedures eliminated the majority of the base data and programming errors in the model. However, the actual model checking was continued on into the model applications phase. The procedure followed during the applications was to check for and investigate any apparently anomalous estimates produced. This checking also indicated some errors in programming that were corrected for subsequent model applications.

CHAPTER VII

ANALYTICAL FORMULATION OF THE MODEL

This chapter describes how the development influenced the choice of variable and parameter categories, the symbolic notation used and the model equations. Definitions are presented for the detailed formulation of one model component followed by a summary of the types of functional relationships used and comments on their transformation into the model computer programs.

Background to the Analytical Formulation

In planning the analytical formulation of the organization model, consideration was given to calculating efficiency and flexibility. Gershefski's work (11) had suggested that few different types of functional relationships should be needed. If this was so, calculating efficiencies could be realized by using one symbolic notation for all variables and another notation for each different type of parameter. The variables and parameters could be distinguished by using subscripts such as $X(1,t)$ and $X(2,t)$ where the '1' and '2' might specify "sales forecast" and "selling expenses", respectively, while 't' specified the time period. Then the same equation might be used to compute values for both variables simply by changing the first subscript number.

The above procedure could have been used if every type of variable only had to be calculated once in each forecast time period. However, as detailed in Chapter VI, it was necessary to develop some

variables on a product group basis. One example was the "product sales forecasts". Such variables would need three subscripts and could be designated $Y(1,m,t)$ and $Y(2,m,t)$ for "product sales forecast" and "product selling price" where 'm' specified the particular product group.

The three-subscript approach might have been used where $m = 1$ when a variable was not related to a product group except that it was prevented by the computer service chosen. The programming language available was BASIC which permitted only a maximum of two subscripts. Also, the computer had a relatively small core capacity that made it necessary to restrict the size of variable matrices. As a result of these constraints, the decisions taken were:

1. To eliminate the time dimension in the computer programs by calculating and storing one year's results at a time.
2. To eliminate the product group dimension except when necessary for particular variables.
3. To avoid, as much as possible, the establishment of unused parameter categories for variable values that could be computed from fixed relationships.

The above decisions, combined with the need to develop separate computer programs for each model component, led to the establishment of four variable categories and ten parameter categories. These variable and parameter categories will be defined in the next two sections in relation to the symbolic notation used in the analytical formulation and the organization model equations.

The Variable Categories and Symbols

The four categories of variables were termed product, operating, internal accumulating and status variables. These classifications were selected on the basis of functions performed within the model and the types of relationships used to calculate variable values.

The "product" category was established for variables whose values had to be calculated for each product or machine group. The "operating" category was established for variables needed to calculate aggregate company results. Variables in these categories were formulated for calculation through relationships subject to exogenous changes. They could be associated with up to four assignable parameters.

The "internal accumulating" category was also established for variables needed to represent aggregate company results. However, variables in this category were formulated for calculation on an accumulation basis or by fixed relationships. They could not have assigned parameters. Variables in all of the above categories were defined separately in each model component.

The "status" category was established for variables whose values had to be transferred between model components and could require modification in two or more components. Variables in this category were formulated for calculation through any type of functional relationship with or without the use of assignable parameters. Their definitions were the same for all components of the model.

The following symbolic notation was used for variables in the model and in the analytical formulation:

1. P(I,L)--where the 'P' designated any variable in the product category. The 'I' designated the number of the variable in that category in any particular component of the model. Thus, P(1,L) could be "Product Sales Forecast" while P(2,L) was "Product Desired Selling Expenses", and so on for other variables. The 'L' designated the product group for which any variable value could be calculated in a given year. This category was used only in the SALES and PRODUCTION components of the model.
2. F(I)--where the 'F' designated any variable in the operating category*. The 'I' designated the number of the variable in that category in any particular component of the model. Thus, F(1) could be "Total Selling Expenses" while F(2) was "Number of Salaried Sales Personnel", and so on for other variables. The variable definitions differed from component to component.
3. T(I)--where the 'T' designated any variable in the internal accumulating category*. The 'I' designated the number of the variable in that category in any particular component. Thus, T(1) could be "Total Expenses Minus Desired" while T(2) was "Percent of Difference Over Desired", and so on for other variables. The variable definitions differed from component to component.

*In the FINANCIAL component the 'F' and 'T' notations were reversed after the initial computer program development. This happened when it was found that the proposed operating variables could be calculated from fixed relationships. At the same time it became evident that the proposed internal variables would have to be modifiable through exogenous changes. The variable roles were interchanged without revising the symbolic notations.

4. S(I)--where the 'S' designated any variable in the status category. The 'I' designated the number of the variable in that category. Thus, S(1) was "Desired Selling Expenses Sum" while S(2) was "Desired Administration Expenses Sum", and so on. S(1) and S(2) referred to the same variables in all components of the model. This condition held for all status variables.

The Parameter Categories and Symbols

As stated above, decisions taken during the formulation resulted in the establishment of ten parameter categories. Three were used in combination with variables in the product category, four were used in combination with operating variables, and three were used in combination with status variables.

At the start of the project it was expected that most functional relationships would be of the simple, linear type ($Y = a + bX$) as was suggested by Gershefski (12). There would then be two basic types of parameters--intercept and rate (or ratio) coefficients. However, after the analysis to develop the functional relationships only a maximum of three equations, in any model component, were found to require the intercept 'a'. Thus, the basic form of most functional relationships became $Y = bX$ which could be linear or proportional in nature.

Further parameter types had to be added to attain necessary model flexibility for the entry of exogenous changes. One type was added to enable the entry of changes to the rate (or ratio), 'b'. In most cases this type of parameter enabled a discrete change giving the

functional form $Y = (b + c)X$. However, where an intercept coefficient existed two parameters of this type would be needed in the functional form $Y = (a + c') + (b + c)X$. This form was not used for reasons stated below.

The other type of modifying parameter was added to enable the entry of exogenous changes to the dependent variable 'Y'. Discrete changes could thus be added in the forms $Y = (b + c)X + d$ and $Y = (a + c') + (b + c)X + d$. Since d was an effective change in the intercept value a means was sought to eliminate the c' parameter. The conclusion taken was that if c was entered as a percentage change to the intercept and rate parameters $Y = a(1 + c) + b(1 + c)X + d$ would provide estimates similar to those attainable from $Y = (a + c') + (b + c)X + d$. This choice eliminated the possible c' change parameter.

Thus a maximum of four different types of parameters were needed for the model. Three categories of variables had been established where functional relationships could require modification through exogenous changes. A total of twelve categories of parameters could have been needed to distinguish those associated with particular variable categories. However, it was found that intercept parameters had to be used only for some functional relationships developed for variables in the operating category. This reduced the total to ten parameter categories.

The symbolic notation used for the parameter categories was keyed to the notation used for the variable categories. Therefore, the 'I' and the 'L' subscripts had meanings identical to those described above for the variable notations. The following symbolic notation was

used for parameters in the model and in the analytical formulation in reference to particular variable categories:

1. For functional relationships used to evaluate variables in the product category;
 - A(I,L)--where the 'A' designated a rate (or ratio) parameter for the P(I,L) variable calculation.
 - B(I,L)--where the 'B' designated a parameter used to enter exogenous changes to the corresponding rate (or ratio) parameter.
 - C(I,L)--where the 'C' designated a parameter used to enter exogenous changes to the corresponding P(I,L) variable.
2. For functional relationships used to evaluate variables in the operating category;
 - H1, H2 or H3--where the symbol designated an intercept parameter for the particular equation in which it appeared.
 - D(I)--where the 'D' designated a rate (or ratio) parameter for the F(I) variable calculation (or a T(I) variable calculation in the FINANCIAL component).
 - E(I)--where the 'E' designated a parameter used to enter exogenous changes to the corresponding rate (or intercept and rate) parameter.
 - G(I)--where the 'G' designated a parameter used to enter exogenous changes to the corresponding F(I) variable (or T(I) variable in the FINANCIAL component).
3. For functional relationships used to evaluate variables in the status category;

U(I)--where the 'U' designated a rate (or ratio) parameter for the S(I) variable calculation.

V(I)--where the 'V' designated a parameter used to enter exogenous changes to the corresponding rate (or ratio) parameter.

W(I)--where the 'W' designated a parameter used to enter exogenous changes to the corresponding S(I) variable.

The symbolic notations defined for the variable and parameter categories was used in the analytical formulation of the model equations. The next section contains a complete record of the equations developed to accomplish the updating of parameter values and calculation of variable values in all of the operating components of the model. Subsequent sections contain detailed definitions of the functional relationships used in the SALES component of the model and describe how they were transformed into the computer program.

The Organization Model Equations

The organization model equations are listed below for the operating components of the model. The equations for any component describe the set of calculations that had to be made for each forecast year. In all equations, the first subscript value enclosed in the parentheses designates the number of the variable, in a particular category, in the specified model component. This is the 'I' subscript described above. The maximum number of variables in any category differs between components, except for the status variables where $I = 1$ to 15. Variables and parameters in the product category have

double subscripts. The second subscript is designated by the letter 'L' and indicates that the variable would be evaluated for all product groups where $L = 1$ to 8 in each forecast year.

The equations are listed in the current time mode for one year's evaluation. A subscript 't' is, therefore, implied. Where the subscript 't-1' appears it refers to the variable or parameter value determined in the previous forecast year.

Many of the equations contain exogenous change parameters designated by $B(I,L)$, $C(I,L)$, $E(I)$, $G(I)$, $V(I)$, or $W(I)$. Any values these parameters might have would be entered by the managers using the model and could not be altered by the model calculations. Therefore, they appear as exogenous additions to the model equations.

The complete list of variable and parameter definitions is included in the Model Index (Appendix H) for each component. In the index, the specific variable number in its category in the particular model component appears enclosed in parentheses in the "PROGRAM SYMBOL" column. The exception is that the symbolic notation was not used in the index for the rate (or ratio) change parameters $B(I,L)$, $E(I)$, and $V(I)$. Definitions for these parameters appear opposite a "PARAMETER CODE NO." ending in '.3' among the parameters grouped with any variable. These symbols were omitted from the index because they did not appear in the computer programs as permanently recorded values. However, they were an integral part of the analytical formulation.

1. The Sales Component Equations

The definitions of variables and parameters in the Sales Component Equations are included in the section beginning on page 171, "Detailed Sales Component Functional Relationships". The functional relationships in that section are listed in the same sequence as in this subsection.

Product Sales Forecasts and Expense Levels

$$A(1,L) = A(1,L)_{t-1} + B(1,L)$$

$$P(1,L) = A(1,L) \times P(1,L)_{t-1} + C(1,L)$$

$$A(2,L) = A(2,L)_{t-1} + B(2,L)$$

$$P(2,L) = A(2,L) \times P(1,L) + C(2,L)$$

$$A(3,L) = A(3,L)_{t-1} + B(3,L)$$

$$P(3,L) = A(3,L) \times P(1,L) + C(3,L)$$

Product Prices and Pallets Forecast

$$A(4,L) = A(4,L)_{t-1} + B(4,L)$$

$$P(4,L) = A(4,L) \times P(4,L)_{t-1} + C(4,L)$$

$$P(5,L) = P(1,L) \times 1000/P(4,L)$$

Accumulate Forecast and Expenses Sums

$$S(1) = \sum_{L=1}^8 P(2,L)$$

$$S(2) = \sum_{L=1}^8 P(3,L)$$

$$S(3) = \sum_{L=1}^8 P(1,L)$$

Sales Salaries and Travel Costs

$$F(2) = F(2)_{t-1} + G(2)$$

$$D(3) = D(3)_{t-1} + E(3)$$

$$D(2) = D(2)_{t-1} \times D(3)$$

$$F(3) = D(2) \times F(2) + G(3)$$

$$D(4) = D(4)_{t-1} + E(4)$$

$$F(4) = D(4) \times F(2) + G(4)$$

Commissions, Freight and Advertising Costs

$$D(5) = D(5)_{t-1} + E(5)$$

$$F(5) = D(5) \times S(3) + G(5)$$

$$D(6) = D(6)_{t-1} + E(6)$$

$$F(6) = D(6) \times S(3) + G(6)$$

$$D(7) = D(7)_{t-1} + E(7)$$

$$F(7) = D(7) \times S(3) + G(7)$$

Total Selling Expenses and Comparisons

$$F(1) = \sum_{I=3}^7 F(I)$$

$$T(1) = F(1) - S(1)$$

$$T(2) = T(1) \times 100/S(1)$$

Cumulate Salaries and Purchases

$$S(13) = F(3) + F(5)$$

$$S(14) = F(4) + F(6) + F(7)$$

End of the Year's Evaluations

2. The Production Component Equations

Equivalences: $Q(4,L) \equiv P(4,L)$ computed in SALES component

$Q(5,L) \equiv P(5,L)$ computed in SALES component

Exogenous Warehouse and Plant Space Changes

$$F(5) = F(5)_{t-1} + G(5)$$

$$F(2) = F(2)_{t-1} + G(2)$$

Set Production Hours

$$F(7) = F(7)_{t-1} + G(7)$$

$$D(8) = D(8)_{t-1} + E(8)$$

$$F(8) = D(8) \times F(7) + G(8)$$

$$D(9) = D(9)_{t-1} + E(9)$$

$$F(9) = D(9) \times F(7) + G(9)$$

Pallets for Inventory and Inventory Change

$$P1 = P(1,L)_{t-1}$$

$$A(1,L) = A(1,L)_{t-1} + B(1,L)$$

$$P(1,L) = A(1,L) \times Q(5,L) + C(1,L)$$

$$P(2,L) = P(1,L) - P1$$

Desired Warehouse Space and Production Hours

$$A(13,L) = A(13,L)_{t-1} + B(13,L)$$

$$P(13,L) = A(13,L) \times P(1,L) + C(13,L)$$

$$P(3,L) = P(2,L) + Q(5,L)$$

$$A(4,L) = A(4,L)_{t-1} + B(4,L)$$

$$P(4,L) = A(4,L) \times P(3,L) + C(4,L)$$

Gross Value of Inventory Change

$$P(2,L) = P(2,L) \times Q(4,L)/1000$$

Changes in Machines Leased, Available and Needed

$$P(5,L) = P(5,L)_{t-1} + C(2,L)$$

$$P(8,L) = P(8,L)_{t-1} + C(8,L)$$

$$P(9,L) = P(4,L)/F(8)$$

$$P(10,L) = P(4,L)/F(9)$$

Lease Record Number and Machines Off Lease

$$P(6,L) = P(6,L)_{t-1} + C(6,L)$$

$$n = P(5,L)$$

If $n = 0$ the evaluation advances to Cumulate Inventory Values, Warehouse Space and Production Hours.

Otherwise, establish the vector, $R = (r_1, r_2, \dots, r_n)$

$$\text{where } r_1 = \text{Int} (P(6,L)/10^{n-1})$$

and recursively calculate

$$r_i = \text{Int}((P(6,L) - \sum_{j=1}^{i-1} r_j \times 10^{n-j})/10^{n-i})$$

for $i = 2, 3, \dots, n$

$$\text{Then, } P(5,L) = \sum_{i=1}^n q_i \text{ where } q_i = 0 \text{ if } r_i = 1$$

$$\text{and } q_i = 1 \text{ if } r_i > 1$$

$$P(7,L) = n - P(5,L)$$

$$P(6,L) = \sum_{i=1}^n (r_i - 1) \times 10^{n-i}$$

Cumulate Inventory Values, Warehouse Space and Production Hours

$$T(1) = \sum_{L=1}^8 P(1,L)$$

$$T(2) = \sum_{L=1}^8 P(3,L)$$

$$T(4) = \sum_{L=1}^8 P(13,L)$$

$$S(4) = \sum_{L=1}^8 P(2,L)$$

Convert Machines Needed to an Integer and Find Number to Add

$$P(10,L) = \text{Int} (P(9,L) + .8999)$$

$$P5 = P(10,L) - P(8,L)$$

If new machines are purchased the evaluation proceeds to Update Equipment Assets.

Otherwise, increase the lease record number and rent.

$$P(6,L) = P(6,L) \times 10^{P5} + \sum_{I=1}^{P5} 5 \times 10^{P5-I}$$

$$P(5,L) = P(5,L) + P5$$

$$A(5,L) = A(5,L)_{t-1} + B(5,L)$$

$$S(8) = S(8) + A(5,L) \times P(5,L) + C(5,L)$$

Update Equipment Assets

$$A(7,L) = A(7,L)_{t-1} + B(7,L)$$

$$S(12) = S(12) + A(7,L) \times P(7,L) + C(7,L)$$

$$A(9,L) = A(9,L)_{t-1} + B(9,L)$$

$$S(12) = S(12) + A(9,L) \times P5 + C(9,L)$$

Add New Machine Values When Purchased

$$A(10,L) = A(10,L)_{t-1} + B(10,L)$$

$$S(12) = S(12) + A(10,L) \times P5 + C(10,L)$$

$$A(12,L) = A(12,L)_{t-1} + B(12,L)$$

$$P(12,L) = A(12,L) \times P(8,L) + C(12,L)$$

Cumulate Number of Machines and Plant Space

$$S(9) = \sum_{L=1}^8 P(8,L)$$

$$T(3) = \sum_{L=1}^8 P(12,L)$$

Update Other Asset and Equipment Rent

$$S(12) = S(12) + W(12)$$

$$U(8) = U(8)_{t-1} + V(8)$$

$$S(8) = S(8) + U(8)$$

Determine Plant Space Needs

$$D(1) = D(1)_{t-1} + E(1)$$

$$F(1) = D(1) \times T(3) + G(1)$$

$$T(5) = T(5)_{t-1} + G(2)$$

If $F(2) \geq F(1)$ no plant additions are required and the evaluation advances to Compute Plant Rent and Effects of Exogenous Assets Change.

Otherwise, compute plant space addition

$$T(5) = T(5) + T(3) - F(2)_{t-1}$$

$$F(2) = F(2) + T(5) - G(2)$$

If plant additions are to be purchased the evaluation advances to Increase Building Assets.

Otherwise, increase rented plant area

$$F(3) = F(3)_{t-1} + T(5)$$

$S(10) = S(10)_{t-1} + W(10)$ and the evaluation advances to Compute Plant Rent and Effects of Exogenous Assets Change.

Increase Building Assets

$$U(10) = U(10)_{t-1} + V(10)$$

$$S(10) = S(10)_{t-1} + U(10) \times T(5) + W(10)$$

Compute Plant Rent and Effects of Exogenous Assets Change

$$F(3) = F(3) - G(3)$$

$$U(6) = U(6)_{t-1} + V(6)$$

$$S(6) = U(6) \times F(3) + W(6)$$

$$D(3) = D(3)_{t-1} + E(3)$$

$$S(10) = S(10) + D(3) \times G(3)$$

Compute Warehouse Space Needs

$$D(4) = D(4)_{t-1} + E(4)$$

$$F(4) = T(4) + D(4)$$

$$T(6) = T(6)_{t-1} + G(5)$$

If $F(5) \geq F(4)$ no warehouse additions are required and the evaluation advances to Compute Warehouse Rent and Effects of Exogenous Assets Change.

Otherwise, compute warehouse addition

$$T(6) = T(6) + F(4) - F(5)_{t-1}$$

$$F(5) = F(5) + T(6) - G(5)$$

If warehouse additions are to be purchased the evaluation advances to Increase Warehouse Building Assets.

Otherwise, increase rented warehouse area

$$F(6) = F(6)_{t-1} + T(6)$$

$S(11) = S(11)_{t-1} + W(11)$ and the evaluation advances to Compute Warehouse Rent and Effects of Exogenous Assets Change.

Increase Warehouse Building Assets

$$U(11) = U(11)_{t-1} + V(11)$$

$$S(11) = S(11)_{t-1} + U(11) \times T(6) + W(11)$$

Compute Warehouse Rent and Effects of Exogenous Assets Change

$$F(6) = F(6) - G(6)$$

$$U(7) = U(7)_{t-1} + V(7)$$

$$S(7) = U(7) \times F(6) + W(7)$$

$$D(6) = D(6)_{t-1} + E(6)$$

$$S(11) = S(11) + D(6) \times G(6)$$

Determine Number of Workers

$$A(2,1) = A(2,1)_{t-1} + B(2,1)$$

$$A(3,L) = A(3,L)_{t-1} + B(3,L) \text{ where } L = 1, 2, \dots, 8$$

$$A(3,L) = A(3,L) \times A(2,1) + C(3,L) \text{ where } L = 1, 2, \dots, 8$$

$$S(5) = \sum_{L=1}^8 P(3,L)/A(3,L)$$

End of the Year's Evaluations

3. The Manufacturing Component Equations

Update Numbers of Salaried People

$$F(29) = F(29)_{t-1} + G(29)$$

$$F(30) = F(30)_{t-1} + G(30)$$

Update Wage and Salary Rates

$$D(31) = D(31)_{t-1} + E(31)$$

$$F(31) = D(31) \times F(31)_{t-1} + G(31)$$

$$D(32) = D(32)_{t-1} + E(32)$$

$$F(32) = D(32) \times F(32)_{t-1} + G(32)$$

$$D(33) = D(33)_{t-1} + E(33)$$

$$F(33) = D(33) \times F(33)_{t-1} + G(33)$$

Compute Salaries and Direct Labour Costs

$$F(16) = F(29) \times F(31) + G(16)$$

$$F(17) = F(30) \times F(32) + G(17)$$

$$F(28) = F(33) \times S(5) + G(28)$$

Compute Royalties, Mould Charges and Net Sales

$$F(3) = S(3)$$

$$S(15) = S(15)_{t-1} + W(15)$$

$$D(5) = D(5)_{t-1} + E(5)$$

$$F(5) = D(5) \times S(15) + G(5)$$

$$S(15) = S(15) - F(5)$$

$$D(4) = D(4)_{t-1} + E(4)$$

$$F(4) = D(4) \times F(4)_{t-1} + G(4)$$

$$F(6) = F(3) - (F(4) + F(5))$$

Compute Gross Production Value and Net Inventory Change

$$T(1) = F(3) + S(4)$$

$$D(9) = D(9)_{t-1} + E(9)$$

$$F(9) = D(9) \times S(4) + G(9)$$

Compute Material Costs

$$H1 = H1_{t-1} \times (1 + E(27))$$

$$D(27) = D(27)_{t-1} \times (1 + E(27))$$

$$F(27) = H1 + D(27) \times T(1) + G(27)$$

Compute Supplies, Maintenance and Miscellaneous Costs

$$H3 = H3_{t-1} \times (1 + E(18))$$

$$D(18) = D(18)_{t-1} \times (1 + E(18))$$

$$F(18) = H3 + D(18) \times T(1) + G(18)$$

$$D(19) = D(19)_{t-1} + E(19)$$

$$F(19) = D(19) \times F(18) + G(19)$$

$$F(18) = F(18) - F(19)$$

$$F(20) = F(20)_{t-1} + G(20)$$

Update Building, Warehouse and Equipment Rents

$$F(21) = S(6)$$

$$F(22) = S(7)$$

$$F(23) = S(8)$$

Compute Utilities and Employee Benefits

$$D(24) = D(24)_{t-1} + E(24)$$

$$F(24) = D(24) \times S(9) + G(24)$$

$$H2 = H2_{t-1} \times (1 + E(25))$$

$$D(25) = D(25)_{t-1} \times (1 + E(25))$$

$$F(25) = H2 + D(25) \times (F(28) + F(16) + F(17)) + G(25)$$

Compute Building and Warehouse Depreciation and Assets

$$D(12) = D(12)_{t-1} + E(12)$$

$$D1 = D(12) - t$$

$$T(2) = (S(10)/D1) + G(12)$$

$$S(10) = S(10) - T(2)$$

$$T(3) = (S(11)/D1) + G(12)$$

$$S(11) = S(11) - T(3)$$

$$F(12) = S(10) + S(11)$$

Compute Equipment Depreciation and Assets

$$D(15) = D(15)_{t-1} + E(15)$$

$$F(15) = D(15) \times S(12) + G(15)$$

$$D(12) = S(12) - F(15)$$

$$F(13) = S(12)$$

Compute Engineering Consulting and Total Overhead

$$D(26) = D(26)_{t-1} + E(26)$$

$$F(26) = D(26) \times F(26)_{t-1} + G(26)$$

$$F(10) = \sum_{I=14}^{26} F(I)$$

Compute R & D Costs, Cost of Sales and Gross Profits

$$D(11) = D(11)_{t-1} + E(11)$$

$$F(11) = D(11) \times F(11)_{t-1} + G(11)$$

$$F(7) = F(10) + F(27) + F(28) - (F(9) + F(11))$$

$$F(8) = F(6) - F(7)$$

Compute Mould Division Inventory and Purchases

$$F(2) = G(2)$$

$$D(36) = D(36)_{t-1} + E(36)$$

$$F(36) = D(36) \times F(36)_{t-1} + G(36)$$

$$F(35) = F(36) - F(2)$$

Compute Mould Revenue and Net Income

$$D(34) = D(34)_{t-1} + E(34)$$

$$F(34) = D(34) \times F(36) + G(34)$$

$$F(37) = F(34) - F(36)$$

Compute Engineer Salaries, Travel Cost and Total Expense

$$D(38) = D(38)_{t-1} + E(38)$$

$$F(38) = D(38) \times F(38)_{t-1} + G(38)$$

$$D(39) = D(39)_{t-1} + E(39)$$

$$F(39) = D(39) \times F(38) + G(39)$$

$$F(40) = F(38) + F(39)$$

Compute Mould Gross Profits

$$F(1) = F(37) - F(40)$$

Cumulate Wages and Purchases

$$S(13) = S(13) + F(16) + F(17) + F(25) + F(26) + F(28) + F(38)$$

$$S(14) = S(14) + (F(27) + F(36) + F(39)) + \sum_{I=18}^{24} F(I)$$

End of the Year's Evaluations

4. The Administration Component Equations

Update Personnel Numbers

$$F(15) = F(15)_{t-1} + G(15)$$

$$F(16) = F(16)_{t-1} + G(16)$$

Compute Salaries and Travel Costs

$$D(6) = D(6)_{t-1} + E(6)$$

$$D(15) = D(15)_{t-1} + E(15)$$

$$D(6) = D(6) \times D(15)$$

$$F(6) = D(6) \times F(15) + G(6)$$

$$D(7) = D(7)_{t-1} + E(7)$$

$$D(16) = D(16)_{t-1} + E(16)$$

$$D(7) = D(7) \times D(16)$$

$$F(7) = D(7) \times F(16) + G(7)$$

$$H_i = H_i_{t-1} + G(8)$$

$$D(8) = D(8)_{t-1} + E(8)$$

$$F(8) = H1 \times F(15) + D(8) \times (F(15) + F(16))$$

Compute Supplies, Telephones, Legal and Sundry Costs

$$D(9) = D(9)_{t-1} + E(9)$$

$$F(9) = D(9) \times F(9)_{t-1} + G(9)$$

$$D(10) = D(10)_{t-1} + E(10)$$

$$F(10) = D(10) \times F(10)_{t-1} + G(10)$$

$$D(11) = D(11)_{t-1} + E(11)$$

$$F(11) = D(11) \times F(11)_{t-1} + G(11)$$

$$D(12) = D(12)_{t-1} + E(12)$$

$$F(12) = D(12) \times F(12)_{t-1} + G(12)$$

Compute Office Space Needs

$$H2 = H2_{t-1} + G(19)$$

$$D(19) = D(19)_{t-1} + E(19)$$

$$F(19) = H2 \times F(15) + D(19) \times (F(15) + F(16))$$

$$T(3) = T(3)_{t-1} + G(17)$$

$$F(17) = F(17)_{t-1} + G(17)$$

If $F(17) \geq F(19)$ no office additions are required and the evaluation advances to Compute Office Rent and Effects of Exogenous Assets Change.

Otherwise, compute office space addition

$$T(3) = T(3) + F(19) - F(17)$$

$$F(17) = F(17) + T(3) - G(17)$$

$$F(18) = F(18)_{t-1} - G(18)$$

If office additions are to be purchased, the evaluation advances to Increase Office Building Assets.

Otherwise, increase rented office area

$F(18) = F(18) + T(3)$ and the evaluation advances to Compute Office Rent and Effects of Exogenous Assets Change.

Increase Office Building Assets

$$D(3) = D(3)_{t-1} + E(3)$$

$$F(3) = F(3)_{t-1} + D(3) \times T(3) + G(3)$$

Compute Office Rent and Effects of Exogenous Assets Change

$$D(13) = D(13)_{t-1} + E(13)$$

$$F(13) = D(13) \times F(18) + G(13)$$

$$D(18) = D(18)_{t-1} + E(18)$$

$$F(3) = F(3) + D(18) \times G(18)$$

Compute Office Equipment Assets, Rents and Numbers

$$F(2) = F(2)_{t-1} + G(2)$$

$$D(20) = D(20)_{t-1} + E(20)$$

$$F(20) = D(20) \times F(20)_{t-1} + G(20)$$

$$F(21) = F(21)_{t-1} + G(21)$$

$$F(13) = F(13)_{t-1} + F(20)$$

Compute Office Building and Equipment Depreciation

$$D(5) = D(5)_{t-1} + E(5)$$

$$D1 = D(5) - t + 1$$

$$F(5) = F(3)/D1 + G(5)$$

$$F(3) = F(3) - F(5)$$

$$D(4) = D(4)_{t-1} + E(4)$$

$$F(4) = D(4) \times F(2) + G(4)$$

$$F(2) = F(2) - F(4)$$

Compute Employee Benefits and Administration Expenses

$$H3 = H3_{t-1} \times (1 + E(14))$$

$$D(14) = D(14)_{t-1} \times (1 + E(14))$$

$$F(14) = H3 + D(14) \times (F(6) + F(7)) + G(14)$$

$$F(1) = \sum_{I=4}^{14} F(I)$$

Compute Expenses Difference and Percentage

$$T(1) = F(1) - S(2)$$

$$T(2) = T(1) \times 100/S(2)$$

Cumulate Salaries and Purchases

$$S(13) = S(13) + F(6) + F(7) + F(14)$$

$$S(14) = S(14) + \sum_{I=8}^{13} F(I)$$

End of the Year's Evaluations

5. The Financial Component Equations

Equivalences: $T1 \equiv F(1)$ computed in SALES component.

$Q(1)$ to $Q(15) \equiv F(1)$ to $F(15)$ computed in MANUFACTURING component.

$R(1)$ to $R(5) \equiv F(1)$ to $F(5)$ computed in ADMINISTRATION component.

Proforma Income Statement Items

Update Gross Sales to Gross Profits

$$F(1) = Q(3)$$

$$F(2) = Q(4) + Q(5)$$

$$F(3) = Q(6)$$

$$F(4) = Q(7)$$

$$F(5) = Q(8)$$

Update Selling and Administration Expenses

$$F(6) = T1$$

$$F(7) = R(1)$$

Compute Expenses and Operating Profits

$$F(8) = F(6) + F(7)$$

$$F(9) = F(5) - F(8)$$

Compute Bank Notes and Debt Interest

$$F(38) = F(38)_{t-1} + G(34)$$

$$F(39) = F(39)_{t-1} + G(35)$$

$$D(46) = D(46)_{t-1} + E(46)$$

$$T(46) = D(46) \times T(46)_{t-1} + G(46)$$

$$D(5) = D(5)_{t-1} + E(5)$$

$$T(5) = D(5) \times (F(32)_{t-1} + T(46))/2 + G(5)$$

$$F(32) = T(46)$$

$$D(6) = D(6)_{t-1} + E(6)$$

$$T(6) = D(6) \times (F(38) + T(40)_{t-1}/2) + G(6)$$

$$D(7) = D(7)_{t-1} + E(7)$$

$$T(7) = D(7) \times (F(39) + T(41)_{t-1}/2) + G(7)$$

Compute Exchange, Discounts, Insurance and Other Expenses

$$D(8) = D(8)_{t-1} + E(8)$$

$$T(8) = D(8) \times T(8)_{t-1} + G(8)$$

$$D(9) = D(9)_{t-1} + E(9)$$

$$T(9) = D(9) \times T(9)_{t-1} + G(9)$$

$$D(10) = D(10)_{t-1} + E(10)$$

$$T(10) = D(10) \times T(10)_{t-1} + G(10)$$

$$F(10) = \sum_{I=5}^{10} T(I)$$

Compute R & D Expenses, Amortization and Adjustments

$$T(45) = G(45)$$

$$T(31) = T(31)_{t-1} + Q(11) - T(45) + G(31)$$

$$D(11) = D(11)_{t-1} + E(11)$$

$$T(11) = D(11) \times T(31) + G(11)$$

$$T(31) = T(31) - T(11)$$

$$T(12) = G(12)$$

$$T(13) = G(13)$$

$$F(11) = T(11) + T(12) + T(13)$$

$$F(12) = F(9) - (F(10) + F(11))$$

Compute Other Income Items

$$D(14) = D(14)_{t-1} + E(14)$$

$$T(14) = D(14) \times T(14)_{t-1} + G(14)$$

$$D(15) = D(15)_{t-1} + E(15)$$

$$T(15) = D(15) \times T(15)_{t-1} + G(15)$$

$$D(16) = D(16)_{t-1} + E(16)$$

$$T(16) = D(16) \times T(16)_{t-1} + G(16)$$

$$T(44) = G(44)$$

Compute Other Income and Pre-Bonus Income

$$F(13) = Q(1) + T(44) + \sum_{I=14}^{16} T(I)$$

$$F(14) = F(12) + F(13)$$

Compute Administration Bonus

If $F(14) < 0$ no administration bonus and $F(15) = T(17) = 0$, and the evaluation advances to Compute Before Tax Profits and First Part Taxes.

Otherwise, calculate bonus

$$D(17) = D(17)_{t-1} + E(17)$$

$$F(15) = T(17) = D(17) \times F(14) + G(17)$$

Compute Before Tax Profits and First Part Taxes

$$F(16) = F(14) - F(15)$$

$$D(18) = D(18)_{t-1} + E(18)$$

$$T(18) = D(18) \times T(18)_{t-1} + G(18)$$

$$\text{If } T(18) < |F(16)| \text{ let } T(19) = T(18)$$

$$\text{Otherwise, } T(19) = |F(16)| \text{ and } T(20) = 0$$

$$D(19) = D(19)_{t-1} + E(19)$$

$$T(19) = D(19) \times T(19) + G(19)$$

Compute Balance of Taxes

If $T(20) = 0$ the evaluation advances to Compute Taxes Recoverable.

$$\text{Otherwise, } T(20) = |F(16)| - T(18)$$

$$D(20) = D(20)_{t-1} + E(20)$$

$$T(20) = D(20) \times T(20) + G(20)$$

Compute Taxes Recoverable

If $F(16) > 0$ the evaluation advances to Compute Income Taxes Payable.

$$\text{Otherwise, } F(17) = -(T(19) + T(20))$$

$T(25) = T(19) + T(20)$ and the evaluation advances to Compute After Tax Income.

Compute Income Taxes Payable

$$F(17) = T(19) + T(20)$$

$$T(25) = 0$$

Compute After Tax Income

$$F(18) = F(16) - F(17)$$

Proforma Balance Sheet Items

Compute Accounts Receivable

$$D(22) = F(22)_{t-1} + E(22)$$

$$T(22) = D(22) \times F(1) + G(22)$$

$$D(23) = D(23)_{t-1} + E(23)$$

$$T(23) = D(23) \times F(1) + G(23)$$

$$D(24) = D(24)_{t-1} + E(24)$$

$$T(24) = D(24) \times T(24)_{t-1} + G(24)$$

$$F(20) = T(22) - T(23) + T(24)$$

Compute Payments Due from Others

$$D(26) = D(26)_{t-1} + E(26)$$

$$T(26) = D(26) \times T(26)_{t-1} + G(26)$$

$$D(27) = D(27)_{t-1} + E(27)$$

$$T(27) = D(27) \times T(27)_{t-1} + G(27)$$

$$D(28) = D(28)_{t-1} + E(28)$$

$$T(28) = D(28) \times T(28)_{t-1} + G(28)$$

$$F(22) = T(26) + T(27) + T(28)$$

Update Taxes Recoverable and Inventories

$$F(21) = T(25)$$

$$F(23) = F(23)_{t-1} + Q(2) + Q(9)$$

Compute Prepays and Recoverable Deposits

$$D(29) = D(29)_{t-1} + E(29)$$

$$T(29) = D(29) \times T(29)_{t-1} + G(29)$$

$$D(30) = D(30)_{t-1} + E(30)$$

$$T(30) = D(30) \times T(30)_{t-1} + G(30)$$

$$F(24) = S(15) + T(29) + T(30)$$

$$D(32) = D(32)_{t-1} + E(32)$$

$$T(32) = D(32) + T(32)_{t-1} + G(32)$$

$$F(25) = T(32)$$

Compute Cash Balance and Total Current Assets

$$D(21) = D(21)_{t-1} + E(21)$$

$$T(21) = D(21) \times T(21)_{t-1} + G(21)$$

$$F(19) = T(21)$$

$$F(26) = \sum_{I=19}^{25} F(I)$$

Compute Total Depreciation and Fixed Assets

$$T(34) = Q(14) + Q(15) + R(4) + R(5)$$

$$T(35) = -F(29)_{t-1}$$

$$F(29) = Q(12) + Q(13) + R(2) + R(3)$$

$$T(35) = T(35) + F(29)$$

$$F(28) = F(28)_{t-1} + T(34)$$

$$F(27) = F(29) + F(28)$$

Cumulate Total Assets

$$F(31) = F(26) + F(29) + F(30)_{t-1} + T(31)$$

Compute Accounts Payable and Accrueds

$$D(36) = D(36)_{t-1} + E(36)$$

$$T(36) = D(36) \times S(14) + G(36)$$

$$D(37) = D(37)_{t-1} + E(37)$$

$$T(37) = D(37) \times S(13) + G(37)$$

$$F(33) = T(36) + T(37)$$

Compute Royalties, Dividends and Other Payables

$$D(38) = D(38)_{t-1} + E(38)$$

$$T(38) = D(38) \times Q(4) + G(38)$$

$$D(42) = D(42)_{t-1} + E(42)$$

$$T(42) = D(42) \times T(42)_{t-1} + G(42)$$

$$D(39) = D(39)_{t-1} + E(39)$$

$$T(39) = D(39) \times T(42) + G(39)$$

$$F(34) = F(17) \times .2 + T(38) + T(39)$$

$$\text{If } F(17) < 0, F(34) = F(34) - F(17) \times .2$$

Compute Mortgage and Debenture Payments Due

$$D(40) = D(40)_{t-1} + E(40)$$

$$T(40) = D(40) \times T(40)_{t-1} + G(40)$$

$$D(41) = D(41)_{t-1} + E(41)$$

$$T(41) = D(41) \times T(41)_{t-1} + G(41)$$

$$F(35) = T(40) + T(41)$$

Cumulate Current Assets

$$F(36) = \sum_{I=32}^{35} F(I)$$

Compute Deferred Taxes and Long-Term Debt Balances

$$F(37) = T(37) = T(37)_{t-1} + G(37)$$

$$F(38) = F(38)_{t-1} - T(40)$$

$$F(39) = F(39)_{t-1} - T(41)$$

$$F(40) = F(38) + F(39)$$

Compute Common Shares Capital and Retained Earnings

$$D(43) = D(43)_{t-1} + E(43)$$

$$T(43) = D(43) \times G(42) + G(43)$$

$$F(41) = F(41)_{t-1} + T(43)$$

$$F(42) = F(42)_{t-1} + F(18) - T(39) + G(4)$$

Compute Equity and Total Liabilities

$$F(43) = F(41) + F(42)$$

$$F(45) = F(36) + F(37) + F(40) + F(43) + F(44)_{t-1}$$

Check for Excess Cash or Financing Need and Adjustments

$$F(31) = F(31) - F(30)_{t-1}$$

$$F(45) = F(45) - F(44)_{t-1}$$

If $F(31) - F(45) = 0$ statement balances, no adjustment is needed and the evaluation advances to Calculate Profit Percentages of Gross Sales.

Otherwise,

$$F(30) = (F(45) - F(31) + F(45) - F(31)) / 2$$

$$F(44) = (F(31) - F(45) + F(31) - F(45)) / 2$$

Compute Extra Interest Earned or Paid

$$D(48) = D(48)_{t-1} + E(48)$$

$$T(48) = D(48) \times F(30) / 2 + G(48)$$

$$D(49) = D(49)_{t-1} + E(49)$$

$$T(49) = D(49) \times F(44) / 2 + G(49)$$

Adjust Income Statement for Interest Effects

Revise Other Expenses, Other Income and Pre-Bonus Income

$$F(10) = F(10) + T(49)$$

$$F(12) = F(12) - T(49)$$

$$F(13) = F(13) + T(48)$$

$$F(14) = F(14) + T(48) - T(49)$$

Revise Administration Bonus

If $F(14) \leq 0$, $F(15) = T(17) = 0$ and the evaluation advances to Revise Before Tax Income, Taxes and After Tax Income.

Otherwise, $F(15) = T(17) = T(17) + D(17) \times (T(48) - T(49))$

Revise Before Tax Income, Taxes and After Tax Income

$$B2 = (F(14) - F(15)) - F(16)$$

If $|F(16)| > T(18)$, $B3 = D(20) \times B2$

Otherwise, $B3 = D(19) \times B2$

$$F(16) = F(16) + B2$$

$$F(17) = F(17) + B3$$

$$F(18) = F(18) - B3$$

Adjust Balance Sheet for Interest Effects

If $F(17) \geq 0$ the evaluation advances to Cumulate Total Assets.

Otherwise, revise taxes recoverable and current assets

$$F(21) = F(21) - B3$$

$$F(26) = F(26) - B3$$

Cumulate Total Assets

$$F(31) = F(26) + F(29) + F(30) + T(31)$$

Revise Retained Earnings, Equity and Total Liabilities

$$F(42) = F(42) - B3$$

$$F(43) = F(43) - B3$$

$$F(45) = F(36) + F(37) + F(40) + F(43) + F(44)$$

Calculate Profit Percentages of Gross Sales

$$T(1) = F(5) \times 100/F(1)$$

$$T(2) = F(9) \times 100/F(1)$$

$$T(3) = F(16) \times 100/F(1)$$

$$T(4) = F(18) * 100/F(1)$$

Compute Funds Sources and Uses, and Working Capital

$$F(46) = F(18) + T(34)$$

$$F(47) = T(35) + F(35) - (G(40) + G(41)) + T(39)$$

$$F(48) = F(46) - F(47)$$

$$B6 = F(49)_{t-1} + F(48)$$

$$B9 = F(26) + F(30) - F(36)$$

$$B6 = B9 - B6$$

$$F(46) = F(46) + B6$$

$$F(48) = F(48) + B6$$

$$T(33) = B6$$

$$F(49) = B9$$

End of the Year's Evaluations

Detailed Sales Component Functional Relationships

As shown above, the five operating components of the organization model all had similar analytical formulations. Accordingly, this section will describe in detail, only the SALES functional relationships with complete variable and parameter definitions. The descriptions appear in the calculating sequence used in the model.

The relationships were evaluated in the SALES component for the variables in the product, operating and internal accumulating categories (in that order) with necessary status variable accumulations interspersed. The selling expenses statement schematic in Appendix B indicates the sequence needed to calculate operating variable values. Variables in the product category were placed first in the sequence because several operating results were dependent upon the product sales forecasts.

The calculations for all variables were made one year at a time for the forecast of $N(1)$ years--where $N(1) = 1$ to 5. The formulations shown below are for calculating the current year's values only. Thus, a subscript 't' is implicit except when a 't-1' is used to designate a variable or parameter value calculated in the previous year. In operation the computer model stored the set of values for each year as it was calculated. The following functional relationships were developed for the SALES component:

1. Product Variables--calculated for L product (or machine) groups where $L = 1$ to 8. The maximum number of groups used during the project was seven;

(a) Product sales forecasts (in thousands of dollars)-- $P(1,L)$

$$A(1,L) = A(1,L)_{t-1} + B(1,L)$$

$$P(1,L) = A(1,L) \times P(1,L)_{t-1} + C(1,L)$$

Where

$A(1,L)$ was the product sales growth rate relative to the previous year,

$B(1,L)$ was a permanent discrete change in the sales growth rate,

$C(1,L)$ was a permanent discrete change in the sales forecast value in any year.

(b) Desired Selling Expenses Level for a Product-- $P(2,L)$

$$A(2,L) = A(2,L)_{t-1} + B(2,L)$$

$$P(2,L) = A(2,L) \times P(1,L) + C(2,L)$$

Where

$P(1,L)$ was the product sales forecast

$A(2,L)$ was the proportion of sales set as the desired level of selling expenses for a product,

$B(2,L)$ was a permanent discrete change in the selling expenses proportion,

$C(2,L)$ was a temporary discrete change in the desired selling expense level for any particular year.

(c) Desired Administration Expenses Level for a Product-- $P(3,L)$

$$A(3,L) = A(3,L)_{t-1} + B(3,L)$$

$$P(3,L) = A(3,L) \times P(1,L) + C(3,L)$$

Where

$P(1,L)$ was the product sales forecast

$A(3,L)$ was the proportion of sales set as the desired level of administration expenses for a product,

$B(3,L)$ was a permanent discrete change in the administration expenses proportion,

$C(3,L)$ was a temporary discrete change in the desired administration expenses level for any particular year.

(d) Weighted Average Selling Price per Pallet of a Product (in dollars)-- $P(4,L)$

$$A(4,L) = A(4,L)_{t-1} + B(4,L)$$

$$P(4,L) = A(4,L) \times P(4,L)_{t-1} + C(4,L)$$

Where

$A(4,L)$ was the product selling price growth rate relative to the previous year,

$B(4,L)$ was a permanent discrete change in the selling price growth rate,

$C(4,L)$ was a permanent discrete change in the product selling price in any year.

(e) Pallets of Product in the Sales Forecast (in units)-- $P(5,L)$

$$P(5,L) = P(1,L) \times 1000/P(4,L)$$

Where

$P(1,L)$ was the product sales forecast (in thousands of dollars),

$P(4,L)$ was the weighted average price per pallet (in dollars).

2. Status Variables as Product Sums

(a) Total Desired Selling Expenses Level--S(1)

$$S(1) = \sum_{L=1}^8 P(2,L)$$

(b) Total Desired Administration Expenses Level--S(2)

$$S(2) = \sum_{L=1}^8 P(3,L)$$

(c) Total Gross Sales Forecast--S(3)

$$S(3) = \sum_{L=1}^8 P(1,L)$$

3. Operating Variables (in calculating sequence)

(a) Number of Salaried Sales Personnel--F(2)

$$F(2) = F(2)_{t-1} + G(2)$$

Where

G(2) was a permanent discrete change in the number of personnel in any year.

(b) Total Sales Salaries--F(3)

Given that

$$D(3) = D(3)_{t-1} + E(3) \text{ and}$$

$$D(2) = (D(2)_{t-1} + E(2)) \times D(3)$$

Where

D(2) was the average sales salary,

E(2) was a permanent discrete change in the average salary,

D(3) was the average sales salary growth rate relative to the prior year's average salary,

E(3) was a permanent discrete change in the average sales salary growth rate.

Then

$$F(3) = D(2) \times F(2) + G(3)$$

Where

F(2) was the number of salaried sales personnel,

G(3) was a temporary discrete change in the total sales salaries in any year.

(c) Total Sales Travel Costs--F(4)

$$D(4) = D(4)_{t-1} + E(4)$$

$$F(4) = D(4) \times F(2) + G(4)$$

Where

F(2) was the number of salaried sales personnel,

D(4) was the average travel cost per salaried sales person,

E(4) was a permanent discrete change in the average travel cost,

G(4) was a temporary discrete change in the total sales travel costs in any year.

(d) Total Sales Commissions--F(5)

$$D(5) = D(5)_{t-1} + E(5)$$

$$F(5) = D(5) \times S(3) + G(5)$$

Where

S(3) was the total gross sales forecast

D(5) was the average commission rate on the total gross sales,

E(5) was a permanent discrete change in the average commission rate,

G(5) was a temporary discrete change in the total sales commissions in any year.

(e) Total Freight-Out Charges--F(6)

$$D(6) = D(6)_{t-1} + E(6)$$

$$F(6) = D(6) \times S(3) + G(6)$$

Where

S(3) was the total gross sales forecast,

D(6) was the average freight-out rate on the total gross sales,

E(6) was a permanent discrete change in the average freight-out rate,

G(6) was a temporary discrete change in the total freight-out charges in any year.

(f) Total Advertising and Promotion Costs--F(7)

$$D(7) = D(7)_{t-1} + E(7)$$

$$F(7) = D(7) \times S(3) + G(7)$$

Where

S(3) was the total gross sales forecast,

D(7) was the average advertising and promotion rate on the total gross sales,

E(7) was a permanent discrete change in the average advertising and promotion rate,

G(7) was a temporary discrete change in the total advertising and promotion costs in any year.

(g) Total Selling Expenses--F(1)

$$F(1) = \sum_{I=3}^7 F(I)$$

4. Internal (or Accumulating) Variables

(a) The Difference Between Total and Desired Selling Expenses--T(1)

$$T(1) = F(1) - S(1)$$

Where

F(1) was the total selling expenses predicted,

S(1) was the total desired selling expenses level.

(b) Percent of Expenses Difference over the Desired Selling Expenses Level--T(2)

$$T(2) = T(1) \times 100/S(1)$$

5. Status Variables Cumulated Toward Balance Sheet Calculations.

(a) Total Company Wages and Salaries (Source for Accrueds Payable at year end)

$$S(13) = S(13) + F(3) + F(5)$$

Where

S(13) designated the total wages and salaries cumulated through previous model components; initialized at zero in the SALES component.

F(3) was the total sales salaries,

F(5) was the total sales commissions.

(b) Total Company Purchases (Source for Accounts Payable at year end)

$$S(14) = S(14) + F(4) + F(6) + F(7)$$

Where

S(14) designated the total purchases cumulated through previous model components; initialized at zero in the SALES component.

F(4) was the total sales travel costs,

F(6) was the total freight-out charges,

F(7) was the total advertising and promotion costs.

Summary of the Functional Relationships

There were basically only three different types of functional relationships used in the SALES component of the model:

1. The simple equation starting at the origin with one dependent variable, a rate (or ratio) parameter, one independent variable and two possible exogenous change parameters where $Y = (b + c)X + d$.

Equations 1 (a), (b), (c) and (d); 3 (b), (c), (d), (3) and (f) all fit in this category.

2. The fixed relationship with one dependent variable, one constant and

two independent variables in the form $Y = X_1 \times C/X_2$. Equations 1 (e) and 4 (b) fit in this category.

3. The mathematical summation of two or more variable values to cumulate a dependent variable value usually in the form $Y = Y(\text{previous}) + X_1 + X_2 + \dots$. Equations 2 (a), (b), (c); 3 (a); 4 (a); 5 (a) and (b) all fit in this category.

A similar summary of functional relationship forms would hold for all other model components except MANUFACTURING and ADMINISTRATION. In these two components a fourth form was added for the simple linear regression equations--having one dependent variable, an intercept parameter, a rate (or ratio or slope) parameter, one independent variable and two possible exogenous change parameters where $Y = a(1 + c) + b(1 + c)X + d$.

The Transformation to Computer Programs

The analytical formulations were transformed into computer programs allowing for a five-year forecast horizon while calculating one year at a time. Several key variable values (product sales forecasts are one example) in one year were based upon their values as calculated in the previous year. Almost all product and operating variables, and some status variables, had initial parameter values developed analytically; values that could subsequently be modified by the entry of exogenous changes for any and all years in any evaluation. This "base" had to be provided first in each component program to initialize the calculations.

Each model component program was also set up to allow the entry of changes one year at a time. The next step in each program, then, was the initialization of changes for each year. This was done through

the AMEND subroutine to set any new values for rate (or ratio) parameters and to set the appropriate value, in any year, for a dependent variable value change parameter. To attain model continuity changes to rate (or ratio) parameters were cumulated in the subroutine so that only the functional relationships used to compute variable values appeared in the computer programs.

For example, the product sales forecast functional relationship (see 1 (a) above) appeared in the computer model as $P(1,L) = A(1,L) \times P(1,L) + C(1,L)$ utilizing the $A(1,L)$ and $C(1,L)$ updated in the AMEND subroutine. The functional relationships for all other variables were programmed in a similar manner for all operating components of the model.

Also, in the computer programs, where the functional forms were identical for any sequential group of equations such relationships were programmed for calculation in loops. In SALES, for example, equations for the variables in 1 (a), (b) and (c) were programmed as $P(I,L) = A(I,L) \times P(1,L) + C(I,L)$ where I ranged from 1 to 3. This procedure was used, wherever possible, for programming efficiency.

Overall the analytical formulations were programmed for the computer model in much the same forms as they were developed. Some transformations were made for computational necessity and others for programming efficiency. However, in all model components, as in SALES, the primary analytical formulations could be traced from the computer programs and be found to be basically simple in nature. The complexity of the model came not from complex analytical formulations but from the large number of interdependent functional relationships needed to

simulate the overall operations of a complex system--in this case a manufacturing firm as seen through the eyes of its executives for strategic planning purposes.

CHAPTER VIII

APPLICATIONS OF THE ORGANIZATION MODEL

This chapter reports on the measurements used to determine the model's performance, special model applications, and the situations chosen for test applications.

The criteria used to determine the benefits of the computerized organization model were outlined in Chapter III. In relation to the criteria this chapter focuses first on the measurements used to gather test records because they were dependent in some ways on the actual applications (as reported below). The measurements are presented in order for each objective criterion cited.

The model applications made are detailed after the discussion of the measurements. The presentations are in order of the researcher's perception of the overall importance of the applications in determining the value of the model, rather than the chronological order in which they were made. Therefore, the development of a four-year forecast for the company is discussed first. The next section outlines the model applications made during two management group meetings. The five test situations used to obtain most of the objective measurements are then presented in the final section of this chapter. The results of the test applications and the model evaluations are reported later in Chapter IX.

The Measurements Used to Determine Model Performance

Some objective measurements were developed for use in determining the model's performance during test applications. The measurements used are detailed below in relation to the specific criteria to which they were applied. The subjective measurements used were relative in nature and, as a result, are embodied in the discussions of the managers' evaluations of the model in Chapter IX.

1. Reduction in the Time for Evaluations

The reduction in time taken for evaluations has been a key factor in computer applications (for example see Ferguson and Jones, 9). The time reduction benefit for this research was based on the difference between the hand evaluation time and the computer evaluation time during the test applications. However, there was a cost associated with attaining this benefit. The commercial rate for usage of the computer facility was \$7.90 per hour (including tax). The potential for saving evaluation time with the model would be a benefit as long as the cost per unit of time saved did not exceed the value of that time to the organization.

Time measurements were taken for each model test application. The Controller first carried out a hand evaluation (aided by an adding machine) and recorded the working time needed for calculations and the preparation of proforma financial statements. He also estimated the amount of time he would need to make an amendment to his evaluation. The Controller then evaluated the same proposal using the computer model (under the guidance of the researcher regarding operating pro-

cedures) and the time was recorded for data input preparation, entering data and running the model, and getting the full print-out of results. In all cases the print-out made with the model included proforma statements not normally prepared by the Controller during hand evaluations but that he considered desirable for assessing each particular proposal. The model time was also recorded for running a revised evaluation of each proposal.

The recorded and estimated times were totalled for all of the tests conducted. Totals were obtained for all initial and alternative evaluations for proposals. The average times for each method were also computed for comparisons. The model's benefit over the five tests was taken as the difference between the total times. The cost for this benefit was calculated from the model usage time multiplied by the commercial rate. The model usage time was determined as the total model time minus the data preparation time. The data preparation time did not add an incremental cost to model evaluations because the teletype terminal was not in operation while that activity was being carried out. The cost per hour of time saved was calculated by dividing the incremental model usage cost by the time saving. The magnitude of the calculated cost per hour of time saving for first evaluations and for alternatives of proposals was taken as an indicator of the extent of this benefit. This was a relative measure in that a lower cost per hour of time saved meant that the realizable benefit was greater.

2. Reduction in Total Elapsed Time

The reduction in total elapsed time was suggested as a criterion

from experiments conducted by Morton in which the total elapsed time collapsed from three weeks to one-half day (32). The intention was to compare the number of working days needed to prepare evaluations by hand and with the model. However, at Kemp Products the planning evaluations were not carried out on a regular, repeated basis as they were in the situation used by Morton. In addition, the Controller conducted hand evaluations for the test applications under conditions where there was extra inducement for him to put other work aside to complete the evaluations quickly. Thus it was not possible to observe the Controller to get a realistic record of the number of days he would normally take to complete a particular type of evaluation.

However, some indication of this benefit was obtained from the preparation of a four-year forecast for the company (reported below). The Controller did not prepare a hand evaluation of that forecast. Instead he was asked to estimate the number of working days that he would have needed to prepare a four-year forecast by hand while carrying out his other duties. The Controller was also asked to estimate the number of working days that he would need to prepare a complete revision of such a forecast for a planned change. A record of the number of days and actual working times was then kept for the initial four-year forecast preparation using the model and for revisions to the forecast. The differences between the Controller's estimates and the recorded model times were taken as the measurements of the reductions in elapsed time that could be realized by utilizing the model.

3. Increase in the Number of Relevant Variables

The number of relevant variables was considered to be the number of variables whose values changed during any proposal evaluation. The difference between the two methods was determined by counting the value changes made by the Controller during his evaluation in each test and the number made by the model. The counts were taken separately on the basis of particular accounting statements because the Controller normally only prepared full statements for income and manufacturing costs during any evaluation. In addition, he usually considered some other variables needed to develop costs for the statements and these were included in the count. The model, in all but two cases, was used to prepare more statements and to provide information on other variables not usually included in the Controller's evaluations. The test-by-test and statement-by-statement comparisons provided the full indication of the extent of the differences between the Controller's and the model's methods. An overall measure was obtained by summing the counts for each test, cumulating the totals across all tests, and then determining the average number of relevant variables considered in the use of each method for the tests.

4. Increase in the Number of Unanticipated Proposal Effects Found

This criterion was stated in terms of the number of infeasibilities and/or unanticipated effects detected in a proposal at the top planning level. In practice the researcher found that it was very difficult to define just what an infeasibility was although Gershefski used that term (13). As a result the measurement of model benefits for this criterion was concentrated on the number of important effects not

previously anticipated. An important effect was defined as any change that a proposed plan would induce in parts of the company's operations other than those directly considered within the scope of the plan as initially set down. For example, in one test a proposed product addition was outlined in terms of the sales forecast, material costs, production rates, equipment, and worker needs. In his evaluation the Controller considered additional effects on inventory space and the overall workforce but did not consider the inventory value, number of extra machines needed for other products, or added plant space needs that the model evaluated.

The measurement of this benefit was taken on the basis of a count of the number of such effects considered by the manager's and the model's evaluations. The count was made by preparing a list of possible important effects and determining whether each was appropriate to a particular evaluation, considered in the evaluation, or not considered. The list was extended as necessary when a particular test indicated further items were appropriate. In the record that was kept an affirmative response indicated that a particular important effect was relevant and was considered in an evaluation. The measure of the increase in the number of previously unanticipated effects found was taken as the difference between the number of affirmative responses recorded for each test for the two evaluation methods. The counts recorded were totalled and averaged across the tests to obtain an overall measure of this benefit.

5. Increase in the Number of Alternatives Considered

At the start of the project the Controller stated that he was

usually constrained by time to evaluating only one alternative for any particular planning proposal. However, he felt that it would be highly desirable if evaluations were made for as many alternatives as the other managers might suggest--anywhere from three to six. The intention then was to measure this benefit of the model on the basis of the number of alternatives evaluated for each proposal using the model as compared to the number of alternatives the Controller would have been compelled to evaluate by hand. In this regard an alternative was to be considered as either a different way to achieve the same end objective, or an assessment of different results that would obtain if conditions were not the same as initially expected.

During the tests, however, it was discovered that the Controller wished to have only one alternative evaluated for each proposal. This occurred because the first three test applications were actually building towards the development of the four-year forecast for the company. As a result the last two tests actually constituted alternative evaluations for the four-year forecast. Once that long-term forecast had been developed the Controller and the other managers were interested in running the model to evaluate several alternative proposals. Thus the measurement taken for this criterion was the difference in the number of four-year forecasts that might have been prepared by hand and the number that were actually evaluated with the model.

The measurement obtained was considered by the researcher to be of more value than the one initially proposed. The key factor in the researcher's assessment was that the evaluations conducted for the first three tests were really short-term in nature (i.e. for one or

two years). Since a major purpose of the model was to provide comprehensive long-term plan evaluations, the ease with which a four-year forecast could be made was of the greatest importance relative to hand evaluation methods. The consideration of a large number of four-year forecast alternatives was the strongest possible support for benefits related to this criterion.

The measurements desired to assess each of the above criterion were obtained during applications of the model to evaluate actual planning proposals for the company. The situations in which the model was applied are described in the next three sections. They are reported in the order of their importance to the acceptance of the model in the real situation (as determined by the researcher) rather than their chronological order of occurrence over time.

The Four-Year Forecast Application

The initial intent was that the major tests of the model would be its application to evaluate five planning proposals in parallel with evaluations made by the company's Controller. These test applications were made as reported below in order to obtain objective measures of the benefits of using the model. However, in December 1970 the opportunity arose for a major application of the model that later proved to be the most important indicator of its benefits and potential value to the company (as determined from the managers' assessments reported later).

At the beginning of December 1970 the Kemp Products Board of Directors asked the managers to develop a four-year forecast for the

company by January 11, 1971. The managers had not previously made a long-term forecast except in terms of sales and profit expectations. By the time the request was made the managers had sufficient confidence in the model to ask that it be used to develop the complete four-year forecast. The first three model test applications (reported below) had been completed by early December 1970 and the managers were satisfied that the evaluations being made by the model were realistic in relation to their expectations. They had been able to make this judgement by comparing the model's predictions with those made by the Controller in his hand evaluations.

As reported by the Controller, the Board of Directors wanted to be sure that the company had a concrete and feasible long-term plan that would assure growth and a continuously successful performance. They were particularly concerned about sales, profitability, expansion and capital needs, overall company size, and so on for the four-year period. Previously the Directors' concern, and that of the managers, had largely been for a detailed forecast of the next year's expectations. Using time consuming hand evaluation methods with limited resources the past treatment could be considered as a legitimate approach in view of the declining accuracy that Vancil has shown to exist as plans extend further into the future (50). Rapid technological change in the plastics moulding industry also had made it difficult to predict operations very far into the future. Thus the managers had been reluctant to develop a complete long-term plan when large amounts of hand calculating time would be needed to revise it. However, the recent failure of the blow moulding operation and the company's poor financial condition in 1970

were strong factors inducing the consideration of longer term plans, regardless of their accuracy with respect to changing conditions. Such plans would provide some guidelines for action.

The foundation for the four-year forecast development was a two-year forecast that was developed in the third model test application (see below). From this base the managers provided additional information in the form of dollar sales increases (since they did not feel there was a particular percentage trend), expected higher wage rate increases, and likely trends increasing costs for all rentals, utilities, and so on. The managers also indicated any policy changes that they felt should be made for such factors as research and development, accounts payable, equipment additions, sales commissions, and advertising and travelling expenses.

The procedure followed was to calculate the parameter changes necessary for particular policy revisions and foreseen trends, enter them into the model and develop a proforma forecast. The President and the Controller reviewed each proforma forecast, as it was developed, to determine whether key variable values fell within the realm of what they considered to be realistically possible. Further changes were made according to their judgement of the predicted results. This procedure actually required only five cycles including a preliminary model run made before predicted changes were first entered. Then two alternative sets of statements were printed out in preparation for a management group meeting to finalize the presentation for the Board of Directors. The first set was for the results predicted for the

company if a new high growth product line was not added. The second set was the predicted results including the new growth product. A total of nine statements was printed for each set. The two sets were used for comparison to determine the importance of revising the company's product lines as an integral part of the four-year plan.

Each set of statements printed for the alternative four-year operations included variable values in columns for the base year (1969-70) and each of the four forecasted years. Samples of the two sets of statements produced by the model are included in Appendices I and J. The statements printed were for:

1. Income,
2. Selling expenses and product sales,
3. Administration expenses,
4. A status variables report,
5. Manufacturing costs,
6. Mould division costs,
7. Balance sheet,
8. Retained earnings, funds flow, and working capital, and
9. A selected report regarding production facilities.

Throughout the four-year forecast development the time was recorded for the review of statements and reconciliation of differences, the preparation of data for entry into the model, the entry of data and running of the model, and the printing of proforma statements. A record was also kept of the number of calendar days needed for the initial forecast development. At the same time the Controller was asked to estimate the number of days that he felt would have been

needed to prepare an equivalent, hand evaluated four-year forecast. After the initial forecast was developed a time record was kept for all alternative proposals evaluated using the model. Two of these alternatives became the fourth and fifth model test applications. Other alternatives were evaluated to consider such eventualities as radical changes in the proposed new product sales, different ways in which future warehousing might be provided, and revised policies for the purchase and resale of moulds to customers. Overall this set of applications provided the most severe tests of the model's flexibility because they required the use of many different parameter changes for forecasts extending almost to the limits set for the model. The maximum capability of the model was for a five-year forecast.

The four-year forecast application became an important input for some of the measured test results. It became the basis for the model applications during two group meetings of Kemp Products' five top managers. The purpose of those meetings was to examine some ramifications that possible changes in plans could have on the four-year performance of the company. The details of these meetings and their results are reported below. The four-year forecast also formed the base for the fourth and fifth model test applications which were conducted after the management group meetings.

The Management Group Sessions

Two management group sessions were held during which the computer model was used to evaluate ideas for the Kemp Products' executives. The purpose of these meetings for the research project was to demonstrate

the model's capabilities to the whole executive group by having their ideas evaluated during the sessions. The managers' purpose was to develop necessary strategic plans.

The first meeting was held to consider the first two alternative four-year forecasts developed in order to finalize a submission for the Board of Directors. The first strategic alternative, which was to continue with the same type of operations as in the past, was rejected by the group. They felt it provided useful information but would not accept a plan where predicted income rose for two years then began falling off again (see Appendix I). The second alternative, which included the addition of the proposed new growth product line for the last three years, was considered to be generally acceptable. But the Chairman of the Board questioned the inventory levels set for the new product. His dealings with the potential customer had indicated that a minimum of two months buffer inventory would have to be held at all times to get and keep the contract. The previously set inventory levels would have to be carried in addition to the buffer. To evaluate the implications of the new inventory policy the required parameter changes were entered into the model for a run and print-out of some key variable values. The management group agreed that the proposal still looked highly favourable and were impressed with the way storage space and financing needs were spelled out. They then requested that a full set of statements be printed out for the Board of Directors and the meeting was adjourned. This set of statements is included in Appendix J.

The second management group meeting was held to consider some of the possible ramifications of the four-year plan that had been

accepted by the Board of Directors. Two proposals were considered on a preliminary basis during this meeting. For each the proposal was first advanced for discussion, then evaluated using the model, and then the results were assessed. Revaluations and full statement print-outs for both proposals were run later as the fourth and fifth model application tests. In the first proposal the Manufacturing Vice-President wondered what effect the installation of a water chiller would have on the four-year forecast. The chiller was being installed and he expected that it would increase the productivity of the injection moulding machines by 5%. The chiller capacity was expected to be sufficient for the number of machines predicted up to 1974. This proposal was evaluated using the model and, although the overall effects were not predicted to be great, the managers were pleased to learn that the chiller could mean that they would need one less moulding press in 1974.

The Controller advanced the second proposal. He wanted to know whether it should be advantageous for the company to buy the plant and property that it occupied and build all future plant and warehouse additions rather than continuing its policy of leasing all major assets. The preliminary model run provided sufficient information to suggest that the company could realize a profit gain by undertaking the purchases. It also provided information for a discussion of financing needs and possible sources. However, the discussions revealed that the evaluation would have to be refined through more parameter changes. Since the managers were prepared to wait for that revaluation the meeting was adjourned. The managers were later asked to assess the

benefits that they obtained from these two meetings.

The Five Model Test Applications

The test applications of the model began as soon as it had been developed and all of the logical programming errors were considered to have been eliminated. The model was applied during three months from November 1970 to February 2, 1971, to obtain a record of its performance. The applications included those for the four-year forecast development and the management group sessions reported above as well as the five test applications outlined in this section. The evaluations conducted were for actual company planning proposals advanced during the model testing period.

The preparation for model tests was basically the same preparation that the Controller, or another manager, would have to make in any situation before he could carry out an evaluation. The preparation consisted of the data gathering needed to provide evaluation information. The type of information needed depended on the particular proposal under consideration. For example, in a situation involving the proposed addition of a new process and product line the Controller would have to have a detailed proposal for his evaluation. This would include the type of machine with its purchase and lease cost, production method and rates, inventory needs, sales forecasted, labour effects, effects on sales force and office staff (if any), research and development expenditures likely, supplies and maintenance needs, and the way in which it was proposed to provide the machines. Once this information had been gathered the Controller could proceed to carry out his evalua-

tion. This was taken as the starting point for all time measurements in comparing the manual and model methods of evaluation.

The only other preparation for the tests was that the Controller was given simple instructions on how the model operated and an index to all of the variables, parameters, and possible parameter changes along with the base values stored on the computer data files. For the variables and parameters the index with the base values provided the reference point for the calculation of parameter changes to enter for any evaluation run with the model.

The index of possible parameter changes was perhaps the most important in use during any model application. Each change had to be entered using a six digit numerical code followed by a change value. The code was needed to distinguish between model components, variable numbers, and the type of change desired. The parameter change index listed the code number and description for each change that could be made to the model. Before running the model the Controller had to determine the changes desired, determine the appropriate code number for each, and list this information on a data sheet. The time required for this activity was recorded as part of each model test run. The five model test applications included: 1) a one-year forecast for a new product proposal; 2) an updating of the 1970-71 forecast and a major equipment sale; 3) the development of a two-year forecast to the end of fiscal 1971-72; 4) an evaluation of a machine and labour productivity increase proposal over four years; and 5) an evaluation of the four-year effects of a proposal to purchase the plant building and future additions.

1. The First Test Situation

The first model test application was made to evaluate a proposed plan for the addition of a new process and product group to the existing lines at Kemp Products Limited. For this evaluation the managers assumed that the 1971-72 fiscal year should be better than the 1970-71 fiscal year. Although the new process and products could not be added until 1971-72 they felt that a good enough evaluation of the proposal would be obtained by overlaying its effects on their 1970-71 forecast. Accordingly the Controller prepared his hand evaluation by modifying his 1970-71 forecast. In preparation for the model test run the researcher entered the changes needed to set up a spurious 1971-72 forecast that was the same as the one that had already been developed for 1970-71. This step was taken so that when the Controller used the model for the proposal evaluation he could make a direct column to column comparison when assessing the effects of the proposal.

The planning proposal evaluated in this application was for the addition of injection-blow moulded containers (the proposed high growth product mentioned above) to the product lines. The containers were to be produced, after major tooling changes, on two of the intermediate sized injection moulding machines that the company already had on lease. The machines were to be used exclusively for injection-blow moulding which meant that the second group of machines was to be exogenously reduced by two to provide machines for the proposed product group. The managers provided information for the sales forecast, product prices, number of units per pallet, maximum inventory levels,

mould and research costs, royalties, material cost per unit, and operators needed to run the machines. In addition they indicated that the new product group would not increase the selling or administrative costs because only one potential sales contract would account for all of the expected revenues.

The above factors were then incorporated in the analyses made by the Controller using hand and model evaluations. Both evaluations indicated that the proposed addition of the new product group should result in a large increase in company profits. However, the model evaluation revealed three very important effects that the managers had not anticipated. The model indicated that funds would be needed for a \$26,000 inventory build up, that at least one new injection moulding machine would be needed, and that the total plant space would have to be expanded for the machine addition. When presented with this information the managers agreed that the predictions were realistic. The managers then suggested an alternative evaluation with an increased sales forecast for some injection moulded products. Again the evaluation indicated that the proposal should be very profitable but it then predicted that the company would have to add two injection moulding machines to replace those devoted to injection-blow moulding. The managers also thought that those results were realistic and that their planning considerations had to be broadened with respect to the proposed addition of injection-blow moulding.

2. The Second Test Situation

The second model test application was really a two step combination evaluation to revise the Kemp Products' predictions for

changes made in fiscal 1970-71. The first part of this test consisted of an application to revise the predicted results for new sales forecast expectations. The managers had lowered their sales expectations late in November 1970 as a result of the sales performance in the first six months of the fiscal year. The test was made after the Controller had built up revised annual sales forecasts from the detail given to him by the Marketing Vice-President and the President. In this application the performance times measured were for the Controller's hand change to the overall forecast, income statement, and manufacturing costs statement; and for the model's revision to all relevant statements including the balance sheet and the selling and administration expense statements.

The second part of this test consisted of an application to revise the 1970-71 predictions for a decision that had been taken by the managers to dispose of some equipment. The situation arose after the shut down of the blow moulding plant and the consolidation of operations in July 1970 (reported in Chapter V). Kemp Products was in a position where it owned sufficient equipment to produce milk jugs at a level much higher than the possible demand in the Canadian market. An offer was received from a large United States dairy to buy two blow moulding machines, a microwave oven, and license rights to the process developed to prevent the milk jugs from shrinking in service. The sale was made because it enabled Kemp Products to realize a significant capital gain and a continuing royalties return for the use of its patented process in the United States where there was a large market for plastic milk jugs. After the sale was completed, and its

effects were known in December 1970, the Controller wanted to revise the company's predicted performance for the year. The revisions were made using the hand evaluation methods and then using the model. As in the first part the times recorded included a model print-out of a full set of financial statements (giving more information than the Controller normally provided in a hand evaluation). The measured results were combined for the two parts of this test.

3. The Third Test Situation

The third model test application was made for the development of a complete forecast for the 1971-72 fiscal year for Kemp Products. In this situation the Controller first made an extensive aggregate evaluation that included predicted changes for sales, income statement, selling and administration expenses, mould and manufacturing costs, and some balance sheet items. He recorded his total time but not the number of days during which he accomplished the evaluation. Then he followed a lengthy procedure with the model to develop the same forecast during four working days. The number of days needed were largely determined by the times at which the Controller and the researcher could both be on hand for the evaluation.

During this application a preliminary model run was first made to project the 1971-72 results that would obtain if there were no changes in conditions as they were represented by the parameters for 1970-71. This provided the base from which the Controller could determine initial parameter changes for the two-year forecast. He then had to convert the sales forecasts made on the basis of major customers into projections for product groups so that growth factors could be

calculated for the model. At the same time other proposed changes to the company operations (resulting from management policy decisions) had to be converted into parameter changes. The Controller entered these changes and ran the model to obtain an adjusted 1971-72 forecast. He reviewed these results in a relation to the other managers' expectations regarding operation methods and conditions (information he had been given to prepare his hand evaluation). This resulted in a revision process during which the Controller consulted with the President regarding previously unanticipated effects predicted by the model, made further amendments to the stated operating conditions, calculated another set of model parameter changes, and then ran the model to get a final forecast for 1971-72. The above procedure was carried out under the guidance of the researcher.

The result of this test application was a set of proforma financial statements that the Controller said he would present to the Board of Directors in preference to the forecast he had prepared by hand evaluation methods. He felt that the predictions were very realistic given the management group's expectations regarding conditions, and that the statements were more comprehensive and complete than those he had prepared. This forecast was not revised to consider alternative conditions but the researcher did make a test modification and model run to determine the time needed for a revision. For comparison purposes the Controller estimated the time he would need to make a revision to his proforma statements.

4. The Fourth Test Situation

The fourth model test application was made after the preparation

of the four-year forecast for Kemp Products. The forecast included the expected effects of many changes including sales increases and major labour wage rate increases up to the end of fiscal 1973-74. However, it had not incorporated the effects that the installation of a water chiller was expected to have on the production rates of the injection moulding machines, although the rent of the chiller had been included as an added cost. (This proposal was given preliminary consideration during the second management group meeting.) The water chiller was being installed to be in operation by the start of the 1971-72 fiscal year. The chiller was intended to provide the moulding machines with cooling water at a lower and more constant temperature than that obtained when water was taken direct from the city's water supply system. The uniform cooling would mean that the moulding cycle times could be reduced. The Manufacturing Vice-President indicated that the improvement would be a 5% increase in the output rate for the injection moulding machines. He explained further that the blow moulding machines already had a chiller connected to them, and that the injection-blow moulding proposal had been prepared assuming the water chiller would be available. Thus only the first five machine groups would be affected by the chiller. In addition, since the injection moulding operators represented somewhat less than 50% of the total direct labour force, the Manufacturing Vice-President felt that the overall plant labour productivity should increase by about 2% with the chiller.

This test application was particularly suited to the model which had been developed with the intention of evaluating such factors

as production volumes and machine requirements. The Controller did not have any previously established method for incorporating machine productivity changes into his forecasts of results. Because of this the task would have been very long and difficult for a hand evaluation. Consequently the Controller did not carry out a hand evaluation of the effects. Instead he determined the effects that he felt the productivity increase would have on the four-year forecast and estimated the time he would have needed to evaluate them. However, completing the evaluation using the model required only the entry of five machine and three labour parameter changes (based on the percentages estimated by the Manufacturing Vice-President) and a new run of the model to produce a complete revision of the four-year forecast. The effects were not predicted to be major in the financial sense but the model's evaluation did indicate longer-range benefits in the form of reduced machine and plant space requirements for 1973-74.

5. The Fifth Test Situation

The fifth model test application was also made after the four-year forecast had been developed and constituted a completely new alternative for Kemp Products operations. The proposal advanced was that the company plan to buy the main building and property on which its operations were situated and to build all future additions needed for plant and warehouse. (This proposal was given preliminary consideration during the second management group meeting.) The main plant and property lease included a purchase option. Under this proposal the company would continue to lease major pieces of equipment and the warehouse, which had previously been the blow moulding plant. The lease

on the warehouse would not expire until May 31, 1974 and it did not include a purchase option. Although many assets would still be leased the plan called for a considerable increase in the level of capital investment in the company.

This test application was also well suited to the computer model. Although the calculations would be straight forward for a hand evaluation, the proposal involved a major reworking of the complete four-year forecast to obtain an overall appraisal. A hand evaluation would have required a large amount of time for the Controller. Since he could only make the time available on an overtime basis, the Controller did not conduct a hand evaluation. Instead he determined the factors that the proposal would affect in the forecast and estimated the time that he would likely have required for a hand evaluation. However, the evaluation of this proposal using the model involved only the entry of two policy changes (for buying future additions), the plant and office areas to be purchased, the period over which the buildings would be depreciated, and property tax changes--a total of nine parameter changes. The model evaluation and print-out of a completely revised set of four-year forecast statements required only forty-three minutes.

The five tests outlined above were used to obtain objective measurements of the model benefits. The results of these measurements are reported in Chapter IX together with the subjective evaluations of the computerized organization model's performance.

CHAPTER IX

EVALUATIONS OF THE ORGANIZATION MODEL

This chapter reports on the results of the model tests, the managers' evaluations of the model, a cost-benefits analysis of planning methods, and planning process changes in the real situation.

The evaluations of the computerized organization model came from two sources--measurements taken during the applications and the company's managers. Because the measured results supplied information for the managers' evaluations, they are reported first in this chapter. The chapter is divided into five results and evaluations sections. The material has been arranged so that results and evaluations from similar sources are grouped together. In order of presentation, the sections report on the results of the five model tests, the four-year forecast performance, the managers' assessments of the model, a cost-benefits analysis and planning process changes that occurred in the company during the project. This is generally the chronological order in which the results and evaluations of the model were obtained.

The Measured Results of the Five Tests

The objective measurements taken during the tests for three of the five assessment criteria all indicated advantages in using the model for evaluations. The two exceptions occurred because the total elapsed time per evaluation and a count of the number of alternatives evaluated

could not be considered relevant. These items were discussed in Chapter VIII in the sections relating to the measurements.

First results obtained indicated that the time needed for an evaluation using the model was less than the Controller's hand evaluation time (see the record shown in the third and sixth rows of Table 1). They show that the model application did not provide a large time gain on the initial proposal evaluation when much preparatory work had to be done. This was particularly true in the development of the two-year forecast (test number three). But when most of the preparation had been done for other evaluations (as in the fourth and fifth tests using the four-year forecast) the model had a very large time advantage. The model's time-saving ability was also great when evaluating an alternative for any particular plan proposed. The overall model time advantage is indicated in the first two rows of Table 2. The ratios of the average evaluation times for the Controller as compared to the model (see Table 2) indicate that the Controller required six to ten times as much time.

When the potential model time savings were evaluated in relation to the incremental costs of gaining the benefit it was found that unit costs were very low (Table 3). The cost increment of potential time savings ranged from 64¢ to 70¢ per hour for the initial and alternative evaluations, respectively. When questioned, the Controller said that any time he saved using the model would be utilized in improving the company's cost control systems--a valuable contribution. Therefore, the comparisons indicated that the model time savings would be highly beneficial for Kemp Products.

TABLE 1.--Measurements recorded during the five model test applications with respect to evaluation times, relevant variables considered, and the number of important effects predicted using the two methods

	Test No. 1		Test No. 2		Test No. 3		Test No. 4		Test No. 5	
	Man- ager	Model	Man- ager	Model	Man- ager	Model	Man- ager	Model	Man- ager	Model
Initial Proposal Evaluations										
1. Model Data Prepare Hours . . . . .	..	1.16	..	0.67	..	4.8	..	0.03	..	0.10
2. Model Usage Hours . . . . .	..	<u>0.44</u>	..	<u>1.16</u>	..	<u>2.4</u>	..	<u>0.55</u>	..	<u>0.62</u>
3. Total Evaluation Hours	2.5	1.60	4.75	1.83	10.0	7.2	28.0	0.58	30.0	0.72
New Alternative Evaluations^a										
4. Model Data Prepare Hours . . . . .	..	0.16	..	0.03	..	0.05	..	0.08	..	0.08
5. Model Usage Hours . . . . .	..	<u>0.17</u>	..	<u>0.17</u>	..	<u>0.66</u>	..	<u>0.60</u>	..	<u>0.60</u>
6. Total Evaluation Hours	2.5	0.33	2.0	0.20	2.5	0.71	9.0	0.68 ^b	12.0	0.68 ^b
Relevant Variables Counts										
7. In Sales Statement . . . . .	..	..	..	..	7	8	.. ^c	..	..	..
8. In Production	2	12	1	11	13	45	3 ^c	5	5 ^c	7
9. In Manufacturing	13	17	6	8	17	19	7	7	2	3
10. In Administration . . . . .	..	..	..	..	8	11	..	..	12	12
11. In Income Statement	5	14	7	11	11	18	8	9	12	14
12. In Balance Sheet	0	16	2	12	3	22	6	12	2	15
13. For Other Variables	0	11	0	3	5	27	2	11	1	4
14. Selection Criteria	<u>1</u>	<u>4</u>	<u>1</u>	<u>4</u>	<u>1</u>	<u>4</u>	<u>1</u>	<u>4</u>	<u>1</u>	<u>4</u>
15. Total Number Considered	21	74	17	49	65	154	27	48	34	55
Important Effects Predicted										
16. Inventory Space Change	Yes	Yes	No	Yes	No	No	..	..	..	..
17. Inventory Value Change	No	Yes	No	Yes	No	Yes	..	..	..	..
18. Number of Machines	No	Yes	Yes	Yes	No	Yes	No	Yes	..	..
19. Plant Space Needs	No	Yes	No	No	No	No	No	Yes	..	..
20. Number of Workers	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	..	..
21. Material Handling	No	No	..	..	No	No	..	..	..	..
22. Warehouse Rentals	Yes	Yes	No	Yes	No	No	..	..	Yes	Yes
23. Municipal Taxes . . . . .	..	..	..	..	Yes	Yes	..	..	Yes	Yes
24. Accounts Payable Level	<u>No</u>	<u>Yes</u>	<u>Yes</u>	<u>Yes</u>	<u>Yes</u>	<u>Yes</u>	<u>No</u>	<u>Yes</u>	<u>Yes</u>	<u>Yes</u>
25. Total Affirmative Count	3	7	3	6	2	5	1	4	3	3
26. Number of Alternatives Evaluated ^d	1	2	1	2	1	2	0 ^e	1	0 ^e	1

^aThese times were estimated only for the manager and were the result of one additional trial run for the model except as indicated in the next note.

^bThis time estimate was established from the average of the times recorded for eight runs of the model to evaluate alternatives for the four-year forecast.

^cDuring these two tests the Controller used the model's four-year forecast as a guide for determining the variables that he would likely have to recalculate in a hand evaluation.

^dThe first three test evaluations made were for proposals that later became part of the four-year forecast. The fourth and fifth test applications recorded were really alternatives proposed to modify the four-year forecast. Therefore the count of alternatives evaluated was not relevant except as applied to the long-term forecast (see Table 4).

^eThe data for the manager was obtained from estimates made by the Controller because he did not have time freely available to carry out the full hand evaluations. He would have had to work many hours of overtime to do the evaluations. The model's evaluations were accepted by all of the managers for these two proposals.

In all tests, the computer model evaluated a larger number of relevant variables than the Controller did in his hand evaluations. The tests record was broken down in relation to major financial statements in rows 7 to 15 of Table 1. The relative counts held, although with smaller differences, even for test applications four and five where the Controller had the four-year forecast as a guide. The results have been summarized on the basis of total and average counts of relevant variables considered across all tests (Table 2, third row). Considering the average number of relevant variables evaluated, the count for the model was 2.3 times as great as for the Controller.

TABLE 2.--Summary results of the measurements recorded during the five model tests

	Total Value		Average Value ^a		Controller Versus Model Ratios ^b
	Control-ler	Model	Control-ler	Model	
Evaluation Hours					
1. Initial Proposals	75.25	11.93	15.05	2.39	6.3 : 1.0
2. New Alternatives	28.00	2.80	5.60	0.56	10.0 : 1.0
Relevant Variables					
3. Total Test Count	164	380	32.8	76.0	1.0 : 2.3
Major Effects Shown					
4. Total Test Count	12.	25.	2.4	5.0	1.0 : 2.1

^aThe total figures here were divided by five to get the average values.

^bDetermined by dividing the lesser of the total controller or model value into its appropriate counterpart in each row.

For the third measure, a total list of nine important factors was used to find previously unanticipated effects. In all test situations except the fifth, the model predicted some important effects not considered by the Controller (Table 1, rows 16 to 25). To summarize these results, the totals of affirmative responses were cumulated across all tests for the Controller and for the model, and averages were determined (Table 2, fourth row). Comparing the average number of important effects predicted, the count for the model was 2.1 times that recorded for the Controller.

TABLE 3.--Comparisons of the total times for the five test applications, the time savings potential of the model, and the incremental costs per hour of time saving based on the model usage times for initial and alternative proposal evaluations

	Total Test Results ^a	
	Initial Proposal Evaluations	New Alternative Evaluations
1. Data Preparation Time for Model (Hrs)	6.76	0.57
2. Model Usage Time (Hours)	<u>5.17</u>	<u>2.23</u>
3. Total Model Evaluation Time (Hours) .	11.93	2.80
4. Controller's Total Time (Hours) . . .	75.25	28.00
5. Potential Model Time Saving (Hours) .	63.32	25.20
6. Model Usage Cost at \$7.90/Hour . . .	\$40.84 ^b	\$17.62 ^b
7. Cost Increment per Hour Saved ^c	\$ 0.64	\$ 0.70

^aThe time record was taken from Table 2.

^bThe product of the model usage time in row two and the commercial charge rate.

^cThese figures were determined by dividing the model usage cost in row six by the potential model time saving in row five.

The measures obtained during the five test applications verified the research expectations. The model did reduce, at a low cost, the time needed for planning evaluations; did increase the number of relevant variables considered; did increase the number of previously unanticipated effects found in the plan evaluation phase.

The two other criteria--total elapsed time and the number of alternatives evaluated--could only be recorded in relation to the development of and revisions to the four-year forecast. The details are reported below.

The Model's Four-Year Forecast Performance

The use of the model to develop the four-year forecast for Kemp Products Limited provided the opportunity to obtain the two remaining objective measures of its advantages. The measures became partly subjective because the Controller did not carry out hand evaluations in parallel with the model. However, his estimates in comparison with the model record provided a relative measurement for total elapsed time and number of alternative evaluations made. The Controller's estimates and the model record have been compared in Table 4.

Time savings benefits realized during the four-year forecast applications were developed by computing the incremental costs related to them (Table 5). As in the previous calculations for the five tests (Table 3), the incremental costs were very low. The added cost for the initial four-year forecast development was found to be 26¢ per hour of time saved. The corresponding figure for forecast revisions

was 48¢ per hour. These costs showed the time-saving benefits of the model to be even greater for the four-year forecast applications than for the five tests. The real value to the company could not be estimated by the managers. However, the Controller felt that, while carrying out his normal duties, he would have needed a total of four months to conduct the same evaluations as those made by the model over a one-month period.

TABLE 4.--Elapsed time saving and increased number of alternatives considered using the model for the four-year forecast applications

	Controller by Hand	Computer Model	Model Saving
1. Time for consultations, revisions, and data preparation (Hrs)	. .	4.22	. .
2. Enter changes, run model, and print proforma statements (Hours)	$\frac{. .}{90^a}$	$\frac{2.75}{6.97}$	$\frac{. .}{83}$
3. Total working time need (Hours) .			
4. Total elapsed time need (Days) . .	18 ^a	3	15
5. Average alternative time (Hours)	10.50 ^a	0.68	9.82
6. Alternative elapsed time (Days) .	3.5 ^a	0.5	3
7. Number of alternatives evaluated to February 2, 1971	2 ^b	6	4
8. Alternatives proposed for immediate future evaluation . . .	$\frac{3^b}{5}$	$\frac{7^c}{13}$	$\frac{4}{8}$
9. Total alternatives count.			

^aEstimates only prepared by the Controller because he did not actually conduct hand evaluations.

^bThese counts are estimates only based on the number of alternatives the Controller felt he would have been required to evaluate fully by hand if the model had not been available.

^cThis prediction was made by the Controller.

TABLE 5.--Comparisons of the four-year forecast development times; the model time savings, and the incremental costs per hour of time savings based on the model usage times for the initial development and alternatives evaluated

	Four-Year Forecast ^a	
	Initial Development Evaluations	Each New Alternative Evaluation ^b
1. Data Preparation Time for Model (Hrs)	4.22	0.08
2. Model Usage Time (Hours)	<u>2.75</u>	<u>0.60</u>
3. Total Model Evaluation Time (Hours). .	6.97	0.68
4. Controller's Estimated Time (Hours). .	90.00	10.50
5. Model Time Saving Realized (Hours). .	83.03	9.82
6. Model Usage Cost at \$7.90/Hour	\$21.73 ^c	\$4.74 ^c
7. Cost Increment per Hour Saved ^d	\$ 0.26	\$0.48

^aThe time record was taken from Table 4.

^bThe time and cost for each new alternative evaluation was based on the average time record as shown in Table 1 for tests four and five.

^cThe product of the model usage time in row two and the commercial charge rate.

^dThese figures were determined by dividing the total costs shown in row six by the model time savings shown in row five.

The model's major calculating advantages were revealed during consideration of six alternative plans for the four forecast years (only two of these were recorded as test applications). The Controller's estimates of the time required for hand evaluations of these new proposals indicated an average of three and one-half working days (Table 1, tests four and five). He would need a further one and one-third

working days to evaluate a proposed revision. He suggested his likely elapsed time would be far greater for such evaluations since he would not be able to set aside all his normal duties. This time-saving had substantial value for him. The Controller was also impressed with the model's capability to make projections for physical facilities needs which he would find extremely difficult or impossible to project by "conventional methods", as he phrased it.

The above results give a "mechanical" indication of the model's performance with the four-year forecast evaluations. The managers reported they were greatly impressed with the ease with which the model was able to produce the forecast in time for the January 11, 1971 deadline.

A very important qualitative judgement of the model's performance was indicated by the confidence with which the executives presented the forecast to the Board of Directors. The presentation was outlined by the Controller (24) who first reported how the predictions were made. He then detailed the plant, warehouse and equipment additions that the model predicted would have to be made during the fiscal years 1971-72 through 1973-74. The President provided the Directors with the plan outline and the set of forecast statements (included in Appendix J) in a manner such that the plan was given almost immediate approval by the Directors (as observed during the meeting). Most of the meeting time was subsequently spent discussing preliminary plans for financing the projected expansions to physical facilities. The managers and Directors said they felt the meeting had been particularly fruitful.

Remaining indicators of the model's performance in developing the four-year forecast are revealed below in the management group's assessments. However, it seems appropriate to report first the reaction of the Chairman of the Board who had remained relatively aloof and uninterested in the model development until presented with alternative four-year forecast evaluations. He then recognized these long-term projections provided him with valuable information to use when approaching potential large-contract customers who were concerned about the company's solvency. The Chairman's confidence and interest in the model's projections was indicated concretely when he asked the researcher to have two further alternatives evaluated on February 2, 1971. He wanted projections of the effects that large changes in the demand for injection-blow moulded products could have on the company. The information was provided that same day. This change in the Chairman's attitude was taken as a further strong indicator that the model had performed very well during the four-year forecast development applications.

The Managers' Evaluations of the Model

The managers' evaluations of the model were obtained through the use of two questionnaires (see Appendix K) and through personal interviews.

The first questionnaire was used to obtain written assessments of the value of management group meetings where the model was used for evaluations.

The second was given to the managers after all model test applications had been completed. Its purpose was to gain written assess-

ments of the model's overall usefulness and information for the costs benefits analysis reported in the next section.

The personal interviews provided the opportunity for an informal appraisal of the project's effects in the Kemp Products organization and the future usefulness of the model to the management.

1. The Managers' Assessment of the Group Meetings

The managers were asked five questions regarding the usefulness of the management group meetings where the model was used. The first related to extra time needed for the meetings. General response was that very little extra time was needed and, further, that it was insignificant compared to the results. The only disclaimer was from the President who felt it should not be necessary for the executives to be present while the model was being run for evaluations. He would rather have this conducted separate from any meetings to ensure the executives' attention on the discussion rather than the action at the computer terminal. However the President, like the other managers, was impressed with the speed of evaluations and feedback of information about key variables.

The second question related to the usefulness of the meetings. The managers felt them to be more useful than other regular management meetings. They felt the immediate feedback provided conclusive information that allowed on-the-spot decisions in more depth. The President, again, felt that model evaluations would be sufficient after a meeting particularly because of the long-term nature of the proposals. In a later interview, the Chairman of the Board suggested an alternative of providing proposal information for model runs during, but remote from, meetings. Since the teletype terminal was noisy while in operation, the

discussions would not have to compete with it but the answers would come back quickly enough to allow decisive action in the meetings.

The third question related to the relevance and accuracy of the model's projections. All managers felt the information provided was as accurate as possible and most of it relevant. The respondents realized that the accuracy was dependent upon the information fed into it as well as the actual structure of the model. Their answers showed they felt the forecasts made were realistic in relation to their judgement and expectations.

The fourth question related to the value of getting statements and information other than that normally provided in their income and manufacturing costs statements. All felt this to be very useful and worthwhile. The Marketing Vice-President stated it was particularly valuable in helping to set new budgets. The President and Chairman of the Board both said the additional information was essential for considering expansion, financing sources and cost-saving programs.

The fifth question related to any new insights or ideas obtained from the model's evaluations. The answers were quite different from each of the executives and did not relate specifically to the model applications during the meetings. Two answers centred on a new understanding of the effects of sales on storage and production facilities. Another insight reported was the relationship of selling and administration expenses to sales and to total overhead costs. The Chairman was impressed by the opportunity the model's evaluations gave him to demonstrate the solid future of the company to potential customers. The general feeling was that the model had given the five executives

a valuable new awareness of total company operations.

In general, then, the managers felt the group meetings during which the model was used for evaluations were very beneficial. However, as suggested by the President's comments and from answers given in response to the second questionnaire, the managers agreed their use of the model could be more beneficial. Later assessments placed a higher value on using the model outside or after the meetings.

2. Assessment of the Printed Statements and Model Use

To assess the printed statements and model use, each manager was asked in the second questionnaire to refer to copies of the four-year forecast statements and answer a series of questions. The managers all rated the accuracy of the statements as 'very good' (second of a choice of six responses with 'excellent' being the highest). Again from a choice of six responses, they rated reading and understanding the statements as 'fairly easy' to 'very easy'. They were unanimous in the view that the information provided by the model could be 'very useful' (the highest rating) in helping them make planning and other decisions. These three assessments were considered of primary importance regarding acceptance and understanding of the model's results.

Then the managers were asked two questions relating to the completeness of the statements. All indicated no items should be eliminated. Three of the five did not feel any items should be added. The two suggesting additional items were actually recommending expansion of the model. The Controller felt a cash flow should be added. The Manufacturing Vice-President felt the model should have the capability to assess and predict transportation needs. The model could handle

transportation but only through specific parameter change inputs. Cash flow predictions were not provided for in any way. However, both said they felt they had benefited greatly from the results provided by the model.

In this first section of the questionnaire the managers were also asked to indicate ways in which the information provided was particularly useful and how the model's evaluations could help with particular decisions. Responses were the same or very similar in the case of each individual--but somewhat different for the five respondents. The answers have been compiled without reference to individuals. The managers felt the information provided was particularly useful for assessing personnel, plant, equipment, warehouse and financing needs on a long-range basis in relation to a specific sales strategy. They were pleased to have enough detailed information to suggest budget needs for factors such as advertising and machine sizes and capacities. Areas mentioned separately for particular decisions or planning situations were the consideration of purchase or lease alternatives, warehousing alternatives, personnel hiring and advertising policies to supplement sales.

In summing up, the President said the awareness of future needs predicted by the model "allowed the executives to focus their attention on the critical areas and to provide the most advantageous method of fulfilling those needs".

Personal interviews also added information indicating benefits from the model's use. The managers generally felt the predictions had made them more aware of many factors related to strategic planning and

the implication of changes in Kemp Products operations. The information gave them something concrete to work with for immediate decisive action and evaluating ideas. There was also a feeling expressed that the executive group would not have been able to determine many of the long-term implications without the model--or that, if they could, it would have taken a much longer time. In other words, the managers felt the computer model had provided almost innumerable benefits by the time the test applications were completed.

3. Relative Planning Value Weights

As part of the second questionnaire asking for an assessment of the relative value of planning to the company, the managers assigned numerical weights to various types of planning methods. They had previously judged the group meetings using the model as being very useful. However, the numerical weights assigned showed they felt much more useful planning could be done if the computer model was used to evaluate proposals outside or after meetings. The weightings were assigned on a 0-100 scale and are summarized in Table 6. There was considerable variation among the individual weights assigned but a good degree of consistency among the relative rankings for the five planning processes suggested.

The weight assessments suggested that having the model evaluations done within the meetings was only slightly better than formal planning meetings where hand-evaluated information was provided. But having the model available for evaluations outside or after formal meetings enabled a planning improvement of approximately 65% (Table 6).

TABLE 6.--Numerical weights assigned to plans developed by each of five planning methods, average numerical weights, and average values relative to formal group meetings

	Numerical Weights Assigned by Managers					Average Number Weight	Average Relative Values ^a
	One	Two	Three	Four	Five		
1. No group planning meetings (this assumes unilateral decisions)	20	10	25	10	0	13	24
2. Informal group meetings with no minutes recorded	30	30	40	50	25	35	65
3. Regular, formal group meetings with agenda and minutes kept	60	50	75	60	75	54	100
4. Formal meetings with model evaluations made <u>inside</u> meetings . . . . .	. .	30	80	80	50	60 ^b	111
5. Formal meetings with model evaluations made <u>outside</u> meetings	75	80	90	100	100	89	165

^aThese values are the average numerical weights expressed as percentages of planning method three to indicate the perceived model benefits for methods four and five.

^bThis average was determined by dividing the total numerical weights for the fourth method by four. All others were divided by five.

Thus having the model available was considered by the managers to provide a substantial increase in the value of the planning method used (i.e. formal group meetings).

A Cost-Benefits Analysis of the Model

Information for a cost-benefits analysis of the model for use by Kemp Products was obtained with the second questionnaire. Two methods were used.

The first was to have the managers estimate the amount of money they would be willing to pay for one four-year plan (assuming it suggested a continuously profitable operation for the company) developed by each of the five planning methods cited in Table 6.

The second was to have them estimate the amount they would be willing to pay to maintain the model and have it available on a continuing basis.

1. Plan Values in Relation to Model Costs

Although each of the managers was able to assign numerical rank weights to the value of the five planning procedures, only the Chairman of the Board, President and Controller estimated the amounts they would be willing to pay for a plan developed by each method. Their estimated average plan values and the model evaluation costs associated with them, based on a once-a-year application, are shown in Table 7. The average plan value where the model was used within the meetings decreased relative to meetings without the model available because of one very low evaluation of that method. As a result, there was no possible incremental benefit from the model application in that case.

TABLE 7.--The managers' estimated purchase values of plans developed by each of five methods, the average estimate values, and the perceived net benefits realized using the model for evaluations on a once-a-year basis (units in dollars)

Planning Method	Manager's Estimated Four-Year Plan Values ^a			Average Plan Value ^b	Model Value Change	Added Model Cost ^c	Net Model Benefit ^d
	One	Two	Three				
1. No group meetings	3000	0	1000	1300	..	..	..
2. Informal meetings	3000	1000	2000	2000	..	..	..
3. Formal meetings	4000	3000	3000	3300	..	..	..
4. Formal--model in	..	1000	5000	3000	-300	2586	-2886
5. Formal--model out	6000	6000	6000	6000	+2700	2586	+114

^aOnly three of the five top managers felt they could attach dollar values to plans.

^bThe average plan values were determined by dividing the sum of the managers' estimates by the appropriate number of respondents for each method.

^cThe model cost was taken as the extreme that would occur if it was kept continuously available but was used only once each year to develop a four-year forecast. The cost estimate included a fixed charge of \$2507 (as calculated below) and the variable cost of the initial forecast development plus twelve alternative evaluations at \$79 (as calculated below).

^dThe net model benefit was determined from the model value change minus the added model cost.

The model costs used in Table 7 included the fixed costs associated with maintaining the model continuously available for use because they represent costs that would not otherwise be incurred by the company. The fixed costs included the teletype terminal rental, computer storage costs and model usage costs for updating. Model updating (computer program revisions and base data changes) could require up to 50 hours of terminal connected usage during the year. Using commercial rental rates the fixed costs were:

Teletype rental	-- 12 months at \$116	= \$1392
Computer storage	-- 12 months at \$ 60	= 720
Model updating	-- 50 hours at \$ 7.90	= <u>395</u>
Total fixed model costs		\$2507

The model variable costs for the four-year forecast plan development were computed from the times recorded for that type of application during the project. The initial four-year forecast development required 2.75 hours of teletype connected time and 4.22 hours of data preparation (Table 4). The variable costs for the initial four-year forecast development was \$21.73 (Table 5). Assuming a total of 12 alternatives (Table 4) would have to be run at a cost of \$4.74 each (Table 5) to establish a finalized plan, the variable cost would increase by \$56.88 to a total of \$78.61.

The cost-benefits comparisons in Table 7 indicated that, at the above evaluation costs, the model applied to develop a four-year forecast only once during a year would yield a positive benefit. Thus if the model was to be used more than once each year the benefits could only increase in relation to the costs. The data gathered for the predicted model use on a continuous basis indicated the model would likely be used twice a month or 24 times a year. Therefore, the

benefits from using the model for strategic planning evaluations would actually be much greater than that shown in Table 7.

2. The Value of Model Availability Relative to Costs

All managers provided estimates of the amount they would be willing to pay to have the model available for future use. These ranged from \$100 to \$500 per month with an average of \$301, or \$3612 per year (Table 8).

The average estimated annual dollar payments contained one very low and one very high estimate but the median was approximately equal to the mean value. The average estimate was therefore compared with the total annual costs based on the fixed charges and predicted usage to indicate the relative benefit (Table 8). It was found the total usage costs would be \$652 less than the average amount the managers had estimated they would be willing to pay.

In summary, the benefits the managers felt would accrue from planning evaluations were found to be larger than the costs they would have to pay to obtain them. The total fixed and variable annual costs of the model were less than the benefits value of one four-year plan development. The monthly costs of the model were also less than the average amount the managers would be willing to pay.

Planning Process Changes During the Project

The research project was carried out at Kemp Products Limited from April 1970 through February 1971. During that time several important changes occurred in the company's planning processes. In April 1970 only informal planning meetings were being held, not all of the

TABLE 8.--Estimates of the payments the managers would be willing to make to keep the model available (for their expectations of usage), and the total model costs

	Annual Dollar Rate	Annual Usage Frequency
Payment and Usage Estimates by Manager Number		
1. --One	3,600	24
2. --Two	6,000	24
3. --Three	3,600	24
4. --Four	3,600	48
5. --Five	1,260	2
6. Totals of Payment and Usage	18,060	122
7. Average Payment and Usage	3,612	24.4
8. Annual Fixed Model Costs	2,507	..
9. Variable Cost for Average Usage ^a	<u>453</u>	..
10. Total Annual Model Costs	2,960	..
11. Expected Payment less Costs	652	..

^aDetermined from the average model usage time of 0.60 hours for a four-year forecast alternative (Table 1) and the expected usage. The managers had suggested that approximately four alternatives would be evaluated during each model application. Thus the total number of model runs predicted for each year was 97.6 which would result in a total model usage time of 58.56 hours at a cost of \$7.90 per hour.

five managers were involved in each session and the President and Controller were the only two fully aware of financial results. During May 1970 the managers were all getting financial reports and full, although informal, executive group meetings were being held. In October 1970 the executive meetings were made formal with agenda and minutes and were being held on a regular basis twice each month to discuss new ideas, developments and planning evaluations.

Throughout the same period a greater emphasis was being placed on the need for and importance of strategic planning for the company's operations. A coincidental primary consideration was being given to cutting operating costs and developing product innovations. Examples were the shut-down of the separate blow moulding plant and the development of injection-blow moulded food containers. Two further changes were closely connected to the change in meetings. These were improvements in the communication of ideas among the executives and increasing awareness of the effects that any one planning proposal could have on the whole company.

The reasons for these developments were discussed during interviews with the managers who all expressed strong belief they were highly beneficial and that further improvements could and would be made. They cited a number of causes.

First, the previous Controller had not been competent and had developed unreliable financial reports; as a result he had been released. A new Controller was hired in December 1969 who by April 1970 had the financial records straightened out, was able to give reliable reports and was pushing for changes in the operations to

improve performance.

Second, the President felt that all executives should know about and have a voice in major decisions affecting the company because Kemp Products was having financial difficulties and desperately needed rejuvenation. In the past, with unreliable financial data and some uncertainty about the mood of the executives, the company had operated with the President and Chairman making the major decisions. In an attempt to resolve some of these difficulties, the Vice-Presidents of Manufacturing and Marketing were invited to become shareholders and two outsiders became shareholders and members of the Board. For the first time, in May 1970, Kemp Products enjoyed the experience of having group meetings for overall planning and decision-making activities.

In addition to citing the above factors as reason for more co-ordinated planning, the President suggested the research project had acted as a catalyst by forcing an introspective examination of the company.

Finally, the past history of fluctuating success and failure and the need for decisive action helped bring about formal meetings. Informal meetings had resulted in much discussion but no clear record of what was to be done. Agenda were introduced to guide the executives' preparations for meetings and to direct the discussion to key points. Minutes were introduced so that decisions would be recorded with all members aware of responsibilities assigned. As the President summarized it, the formal meetings enabled the development of concrete plans and actions.

When the field application research began in April 1970, the company

appeared to the researcher to be managed by a group of individuals primarily concerned with the performance of their functional responsibilities. They knew the company was in trouble but were not sure they could agree on ways to reverse the poor performance trend.

Within six months--by October 1970--the executives were united in a co-ordinated management group primarily concerned with the total company performance and the contributions of their individual functions. Besides enabling concrete decisions and actions, the planning process changes had resulted in a communication of ideas among the executive group that was "infinitely better than before", in the view of the Marketing Vice-President. All executives agreed on this point and felt that intragroup communications would become even better in the future.

None of the managers felt the complex model or project per se had been the cause of specific changes. However, they did agree the project had been an influencing factor because of the need to examine the company's operations to provide information for the computer model. Then, when the model was developed it provided information the executives had felt was not available to them, such as predictions of plant and warehouse space and equipment and financing needs in relation to sales, product changes and growth trends. Because it made projections of major project needs, the "model reduced the number of surprises and changed the approach from the piecemeal method of the past", the Chairman of the Board said.

The researcher felt the model evaluations had given the managers much more assurance about and awareness of the implications of any proposal such as the addition of injection-blow products. The

executives agreed the model had given a new impetus with respect to strategic planning because it offered immediate evaluations of their ideas. But the Controller suggested the benefits went even further. He felt the model and project had boosted executive morale by helping to determine how company plans should be carried out to ensure future success.

In summary, the planning process at Kemp Products had been altered greatly in relation to conditions that had existed or had been developing prior to April 1970. The research project acted as a catalyst giving further impetus to the changes. In addition, the computer model provided evaluating capabilities that the managers had not previously had available.

CHAPTER X

MODEL ACCEPTANCE BY OTHER ORGANIZATIONS

This chapter describes contacts with organizations other than Kemp Products, the natures of these organizations, and their assessments of the model and project results in terms of the characteristics they felt would foster or mitigate success in applications of the modelling approach.

The Importance of Acceptance by Others

The research undertaken during this project was predicated, to a great extent, on the assumption that the structure of many organizations and their planning evaluation procedures were basically similar in nature. If this assumption was valid the conceptual modelling approach taken, and the resulting type of organization model developed, should have considerable potential.

Only one company was involved, however, in the field development, application and measurements of the organization model used. The results (reported in Chapter IX) indicated a highly successful application and provided evidence that the conceptual approach was beneficial. But at least two questions remained unanswered: Were there some unique characteristics that fostered the success in the chosen situation? Would the same modelling approach have been as likely to succeed in other organizations? Answers to these questions could provide direction for future research efforts.

The conclusion drawn was that some useful answers could be obtained by having the model and project results assessed by executives in other organizations. Likely candidates had been contacted previously --the six smaller firms that declined participation in the project during March 1970.

Assessments from those companies could be particularly important. In March 1970 the researcher had concluded that the organization modelling approach could be equally successful in any of those firms. Judgments of the modelling approach and the successful project by executives who had previously declined involvement could support or reject the researcher's prior opinion.. Any conclusions drawn would be subjective. However, such assessments, when related to the characteristics of the other organizations, might identify situations for potentially successful modelling applications. They should also provide directional indicators for answers to the questions posed above.

The Natures of the Other Organizations

The seven small companies contacted during March 1970 all varied in size in relation to the number of workers employed (London Chamber of Commerce, 27) but had the functional type of executive organization characteristic of Thain's Stage II company definition (49). One of these firms was Kemp Products Limited. Another ceased to exist early in 1971 when it became an integral part of one major division of a large international firm. Thus five other small organizations, structurally similar to Kemp Products, remained as preferred candidates to assess the model and project results.

As stated above, these five companies had all declined involvement at the start of the main research project. Executives in four of the firms had not been interviewed during March 1970. Their reasons for not considering involvement were given in written responses to the researcher's original proposal letter (Appendix A). These companies and their executives will be designated as ACO, BCO, CCO and DCO in the following discussions. ACO and BCO indicated that they did not think their organizations were suitable for the project and that they would not be able to commit the time needed. CCO cited previous costly experiences with student research projects and DCO indicated that they would not wish to divulge the type of information needed (based on prior approaches from University researchers). Only one of the five, to be called ECO, had expressed a willingness to consider involvement. However, ECO had been eliminated as a project candidate when ECO's president and the researcher mutually agreed that the type of model proposed would be more sophisticated than the one needed for strategic planning in the particular situation.

The follow-up survey for assessments of the main research project was also used to gather more information about the nature of these companies. Three of them--ACO, BCO and CCO--were found to be very similar to Kemp Products in nature. They manufactured products mainly on a custom contract basis for producers of consumer durable goods. These firms also produced a few proprietary items for sale from stock. DCO manufactured inexpensive consumer products that were widely distributed for sale--some products were made to contract order but the majority were for sale from stock. The fifth company, ECO, was a producer

of a service that was sold largely on a contract basis.

These five companies all varied in size as measured by sales, assets and numbers of employees (see the summary in Exhibit I). However, they all had management structures of the functionally divided type similar to that of Kemp Products. The five firms all indicated they were using long-range planning but ACO and DCO did not consider themselves as having formal strategic planning procedures--the claims of the others were not challenged by the researcher. In addition the executives of these companies claimed that their operations were financial successful.

Model Assessments by the Other Organizations

The presidents of the five organizations were all contacted by letter, sent one copy each of the researcher's article describing the project (Nobbs, 37), and interviewed to obtain their assessments of the organization model and its use. All agreed that a model of the type described could be very useful in particular kinds of organizations, but not necessarily theirs. BCO and DCO were prepared to consider immediate involvement in a duplicate research project, though, and ACO could foresee conditions under which it could make beneficial use of such a model. In addition, CCO felt the approach could be used for a proposed subsidiary expansion in a new market (to be referred to as CSO). CCO and ECO felt they could not use such a model for their Southwestern Ontario operations because of their characteristics.

In essence the overall assessment (summarized in Exhibit II) was that a situation with several characteristics similar to those of Kemp Products would be ideal for a model application. The key characteristics

EXHIBIT I

The Natures of the Other Organizations (in the Fall of 1971) in Comparison to Kemp Products in the Spring of 1970

Company	Management Structure	Type of Ownership	Work Force Size	Sales \$ Million	Assets \$ Million	Financial Success	Planning Horizon	Formal Planning	Nature of Product and Sales
Kemp	Functional Departments	Private	90-110	2	1.2	No	1 year	No	Custom manufactured for other producers
ACC	Functional Departments	Private	150-170	5-6	2-2.5	Yes	1 (detail) 4 (vague)	No	Custom manufactured for other producers
BCO	Functional Departments	Private	150-160	5-6	2-2.5	Yes	10 years	Yes	Custom manufactured for other producers
CCO	Functional Departments	Private	350-400	5-6	3-5	Yes	5 years	Yes	Custom manufactured for other producers
DCO	Functional Departments	Private	125-150	5-6	2-2.5	Yes	1 year (3 proposed)	No	Manufactured consumer goods widely distributed
ECO	Functional Departments	Private	90-100	3-4	4-4.5	Yes	5 (detail) 9 (vague)	Yes	Service sold on a contract basis

EXHIBIT II

Summary of Characteristics Assessed as
Fostering Organization Modelling Success
or Failure and Their Existence in the
Companies Surveyed^a

	Kemp	ACO	BCO	CCO	CSO	DCO	ECO
Characteristics for Success:							
1. Limited number of product lines	X	X	..	..	..	X	X
2. Relatively stable products	X	X	X	..	..	X	X
3. Fluid market environment with growth and change opportunities	X	X	X	..	X	X	..
4. Felt need for long-range forecasts and strategic planning	X	X	X	X	X	X	X
5. Need for frequent plan evaluations	X	X	X	..	X	X	..
6. Support economical computer applications ideas	X	X	X	X	X	X	X
7. Willing to participate in an organization model application (1971) ^b	X	X	X	..	X	X	..
Characteristics Against Success:							
1. Relatively stable market	..	..	X	X	X	..	X
2. High market share with few expansion possibilities	..	..	..	X	..	..	X
3. Closely predictable sales volumes	..	..	..	X	..	..	X
4. Existing long-range forecasts needing revaluation once a year	..	..	..	X	..	..	X

^a An X indicates existence of the characteristic and .. indicates non-existence.

^b Also includes companies that could foresee conditions under which they would be willing to participate (i.e. ACO and CSO).

Note that CCO's president felt that the success characteristics existing in CSO would outweigh the two missing ones and the existence of a stable, easily defined market.

mentioned in the assessments were a limited number of product lines, relatively stable types of products, a competitive market with opportunities for change and growth, a felt need for or the existence of long-range forecasts and strategic planning procedures, and a need for relatively frequent evaluations of planning proposals in view of changing conditions. All five of the other organization's presidents perceived computer approaches as being useful as long as the results justified the costs in relation to company size. If that condition was perceived to hold then the other essential ingredient for a successful application --willing executive co-operation and participation--would exist.

Not all of the companies surveyed had the characteristics described above. However, for those that did have them one question remained, what was the real reason they had not wished to participate in the research in 1970? In addition to the responses cited previously, one answer appeared to emerge from the interviews. ACO, BCO and DCO did not perceive any urgent need for revamping and revitalizing their organizations or planning processes (the other one, CSO, had not existed in 1970). On the other hand, in early 1970 Kemp Products had been in a poor financial position (see Chapter V) and was willing to consider any proposal that might help the company become successful again.

The characteristics cited by GCO and ECO as mitigating potential model success reinforced their reasons for not agreeing to participate in the research in 1970. The key characteristics acting against success were stated as a relatively stable market, a high market share with few expansion possibilities, closely predictable sales volumes, existing long-range forecasts (five years or more) and no felt need for

re-evaluation more than once a year. The researcher's opinion was that the perceived lack of need for frequent strategic planning evaluations was the most important mitigating factor. This opinion was most strongly supported by the assessment given by CCO's president with respect to CSO. CSO was the same type of manufacturing operation as CCO with similar products, but it was expanding in a new market area (in Europe) and was perceived as being in a position to benefit from frequent planning evaluations.

Summary

In summary, the presidents of the five companies not involved in the organization model development all felt the approach taken should be successful and beneficial for a small sized firm in a competitive market with many opportunities for change. From a total of six potential applications situations, four were considered by the presidents (and the researcher) to be well suited to duplicate model developments. CSO had not existed in 1970. The other three--ACO, BCO and DCO--could appreciate the potential after the fact of a successful application. The researcher had the impression that the main reason they had not wished to participate in 1970 was that, unlike Kemp Products, they had not perceived any urgent need for planning evaluation assistance.

In the two remaining situations the assessment was that the type of organization model proposed would not be successful because the cost would not be justified by its use. CCO and ECO considered their markets to be relatively stable and predictable, offering few opportunities for expansion. Thus, they considered yearly hand-calculated evaluations to be sufficient for long-range planning. The researcher

considered that this attitude would, indeed, preclude success in spite of the benefits the Kemp Products' executives felt they realized from the more comprehensive treatment of activity interdependencies embodied in the model. CCO and ECO might have had fully comprehensive planning evaluation procedures, though, in which case the above cited model benefit could not be realized.

The assessment results did not agree with the researcher's prior expectations in March 1970 for all of the other organizations. However, reflection upon the results indicated they should not have been unexpected. The small firm with few perceived opportunities for change should be able to keep pace with its "world" while experiencing few planning and evaluation problems. On the other hand, a small firm with many perceived opportunities upon which it might capitalize could be continually frustrated by the problems of keeping up to the pace of change. This latter type of organization, like Kemp Products, should be able to realize many benefits from a tool that promised to reduce the time needed for strategic planning evaluations.

CHAPTER XI

CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the contributions made by the research, implications of organization models for managerial decision making and recommendations for future research needed to establish the full potential of the techniques.

The Research Purposes and Contributions

The first purpose of the research project was to obtain objective evidence of the values of a computerized organization model in one small company. This was established as the initial purpose because recent literature (Gershefski, 12; 13; and Schrieber, 39) reported an increasing use of organization models but no measurements of the real benefits obtained. The project was designed to develop a computerized organization model of a real situation, make test applications and measure the model's benefits relative to existing methods of evaluating strategic planning proposals in the company.

A further purpose was to gather, from other organizations, information that might assist the formulation of similar projects in the future. This was established as the second purpose because of the success of the field research application. Six small companies had refused to become involved in the research when contacted initially in March 1970. These organizations were similar in size to the one selected for the project. The conclusion taken was that they could make a

significant contribution by assessing the results in relation to potential applicability of the model to their operations. These assessments were expected to provide indications of conditions under which the modelling approach might be applied successfully in other small organizations.

Contributions from the research project were greater than expected at its inception. As reported in Chapters IX and X, the stated purposes were more than fulfilled. The contributions are summarized in the subsections below.

1. Evidence of the Model Value

Objective measurements of five changes indicated the computerized organization model was a valuable addition to the planning process in one small company. The measurements were obtained through test applications in which model performance was compared to previously used hand methods of evaluating strategic planning proposals. The measured changes were:

- (a) An average reduction of 84% in the time taken for an initial evaluation of a proposal, and an average reduction of 90% in the time taken to evaluate a proposal revision (Table 2). The time savings were all obtained at an incremental cost of less than 70¢ per hour (Table 3).
- (b) A reduction of 30 working days (to 5.5 from 35.5) in the elapsed time needed to develop one four-year forecast planning proposal and to evaluate five alternatives for it (extracted from Table 4).

- (c) An average increase by 2.3 times in the number of relevant variables considered in strategic planning evaluations (Table 2).
- (d) An average increase by 2.1 times in the number of important effects discovered to be related to proposed plans before they might be chosen for implementation (Table 2).
- (e) An average increase by 2.6 times in the number of alternatives considered to develop plans dealing with particular proposals in relation to a four-year forecast (extracted from Table 4).

The measured results supported the assessments of other organization model builders (see Gershefski, 13; and Schrieber, 39) and indicated the techniques could be valuable in a small organization. The results also complemented the work of others such as Miller (30) and Morton (32) by demonstrating the attainment of more comprehensive evaluations through the use of a computer model.

2. Indications of the Model's Economic Worth

A cost-benefits analysis indicated the model was economical to use in one small organization where prior computer applications had not been made. The managers estimated that one four-year plan developed using the model was worth \$2,700 more than one developed using hand evaluation methods. This benefit was greater than the incremental cost of keeping the model continuously available to use only once each year to develop a four-year plan (Table 7). At the same time the average amount the managers estimated they would be willing to pay annually to keep the model available for regular evaluations was greater than the total annual cost for their usage predictions (Table 8).

The combination of the above two cost-benefits evaluations indicated that the organization model was perceived as having considerable economic worth for the company. These results coincided with reported values of computer models per se as expressed in many experiments such as those conducted by Ferguson and Jones (9), Miller (30) and Morton (32).

3. Model Development Procedures

Chapters VI and VIII contain the details of the procedures for the successful development and application of an organization model in a real situation. The development approach included the selection of the nature of the model, the choice of the major model components needed for the situation and the determination of important functional relationships from historical data and management descriptions. As pointed out, the structure of the model itself was dependent upon the company's financial statements, manufacturing operating relationships and computer constraints.

Another important consideration in the model development was the model user and his needs for planning evaluations. The result was the creation of a model change component, the inclusion of change parameters in the functional relationships and the creation of a multi-mode report generator component. These elements gave the model considerable flexibility as demonstrated through evaluations of several different types of strategic planning proposals.

Every attempt was made to provide all pertinent detail of the model development. Most reports such as those of Gershefski (11),

Jones et al (21) and Naylor et al (34) provide broad outlines only. Much trial-and-error research is often needed to duplicate such reported procedures. The detailed report was intended to reveal many pitfalls in modelling real situations.

4. Evidence of the Importance of a Common Product Unit

The development of a common product unit proved to be the key to obtaining some critical estimates with the model. The common product unit together with conversion parameters made it possible to establish production and storage volume needs in relation to the sales forecast. This enabled the prediction of space, equipment and capital financing needs for long-term projections. The managers' assessments (Chapter IX) indicated the information provided would have been very difficult to obtain by "conventional" methods, gave them a much clearer picture of future requirements and was highly beneficial in discussions with other organizations.

Previous work with production scheduling models, such as that done by Holt et al (19), had high-lighted the importance of a common product unit. Also, optimizing models proposed by operations researchers have relied on the existence of common product units. The results of this project reinforced the importance of such a unit for model development work generally.

5. Procedures to Develop a Common Product Unit

Chapter VI contains the details of procedures used to develop the common product unit. This endeavour was successful in a situation where the company executives maintained there was too much diversity to

obtain such a unit. Essentially the procedures involved a sifting of operations descriptions until one common element was found. In this case that was the company's method of storing and transporting products on pallets of similar volumes. With the "pallet" as a base unit, it was then found that weighted averages could be used to develop the necessary conversion parameters for calculating throughput volumes and facilities needs.

6. Evidence of the Project's Influence on the Situation

There were indications (Chapter IX) that the development of the organization model in a poorly structured planning situation had some significant influence. The model and project was reported by the executives to have been a catalyst in the modification of the planning process in a direction they considered beneficial. The executives were united into a planning group more concerned with total company performance than individual functions. Because the model encompassed all operations the communication of ideas became "infinitely better than before," in the view of the Marketing Vice-President. Much of this effect probably occurred because the managers had to take a close, introspective look at their company's operations in order to decide what they wanted the model to do. Gershefski found similar effects (13).

The model provided predictions of manufacturing facilities and financing needs in relation to sales forecasts, product changes and growth trends. This information had not been available previously. These projections meant "the model reduced the number of surprises and changed the approach from the piece-meal method of the past," reported the Chairman of the Board.

The influence was a large benefit in the view of the President because the awareness of future needs "allowed the executives to focus their attention on critical areas and to provide the most advantageous methods of fulfilling these needs." The final factor cited by the Controller was, "The model boosted executive morale by helping to determine how company plans should be carried out to ensure future success."

7. Characteristics For and Against Successful Applications

The survey of other small companies (Chapter X) provided indications that the existence of some particular company characteristics should foster successful applications. The key characteristics mentioned were a limited number of product lines, relatively stable types of products, a competitive market with opportunities for change and growth, and a felt need for (or existence of) long-range forecasts, strategic planning procedures and relatively frequent evaluations of planning proposals. To these could be added an executive perception that computer approaches may be useful, and an executive willingness to co-operate and participate.

The survey also suggested there were some characteristics that would likely mitigate success in other applications. The key characteristics mentioned were a relatively stable market, a high market share with few expansion possibilities, closely predictable sales volumes, existing long-range forecasts and no felt need for planning evaluations more than once a year. The strongest mitigating characteristic was likely the perceived lack of a need for frequent strategic planning evaluations in the small companies that already had established planning

procedures.

8. Reasons Why Companies Declined Participation

The survey of other organizations also sought reasons why they had declined participation in the original field research project. Some had provided written reasons in March and April 1970. Two had indicated they did not think their companies were suitable for the project and that they would not be able to commit the time needed. Two cited previous experience with student research projects--one indicating the results had been costly and the other indicating a reluctance to divulge the type of information needed. One further company that had expressed a willingness to co-operate was eliminated by mutual agreement of the researcher and the firm's president. The conclusion drawn was that the type of model intended was more sophisticated than the one needed for strategic planning in the particular situation.

The original, written company refusals had been accepted at face value. The later survey revealed one further reason of significant importance. The four companies that had sent the written refusals all indicated, when presented with the project results, that they could foresee beneficial applications in their organizations. However, none of them could perceive any urgent need for revamping and revitalizing their organizations or planning processes. On the other hand, in early 1970 the company chosen for the project had been in a poor financial position and was willing to consider any proposal that might help the company become successful again. For this type of experimental research, then, finding a candidate organization could depend upon the discovery of one with a felt need for change coincident with the research objective.

9. Indicated Values of a "Proven" Project

The survey obtained some indications of the values of a "proven" project. Executives in the other organizations all agreed that the type of model developed could be very useful in particular kinds of organizations, but not necessarily theirs. Two companies reported they were prepared to consider immediate involvement in a duplicate research project, though, and two more could foresee conditions under which they could make beneficial use of such a model.

The five companies surveyed actually represented six potential model applications situations. Thus, two-thirds of the situations that the researcher was originally refused access to were presented as potentially willing participants after expected benefits had been demonstrated through a successful research project. In other words, researchers seeking to reinforce the evidence for a particular technique in similar situations could have less difficulty in contacting potential candidates than researchers attempting to prove the value of particular techniques in new types of situations.

Implications for Management Decision Making

The model development reported had considerable influence on the planning process itself in the particular company chosen. This influence, however, could not be generalized as likely to occur with every similar model application. As Gershefski's survey indicated (13) most companies could be expected to undertake or participate in a computerized organization model development only after formal strategic planning procedures existed. Then the model would not have strong implications for the planning process per se.

There were indications too that the model development had little influence upon the way planning decisions were made ultimately. Resistance to any potential influence was most strongly expressed by the President who did not favour any direct involvement in making evaluations with the model. In the company chosen the President and the Chairman of the Board preferred to generate planning proposals, have them evaluated by others and then make decisions based on those evaluations. Both of these executives reported, however, that the model provided them with more comprehensive evaluations on which to base their decisions (as cited in Chapter IX). This, then, was one major implication for the particular type of model in a small organization--the likelihood that decisions would be better because of more comprehensive evaluations. The same type of result was reported by Gershefski (11).

The greatest direct impact of the model was on the manager who was functioning as the planning evaluator. He reported confidence in the results produced by the model and was, therefore, willing to use them. This acceptance of the model results meant the Controller could take advantage of the calculating speed of the computer to reduce his evaluation load. The Controller thereby gained time for other tasks opening the way for more benefits to the organization. If capitalized upon, the implication would be that the model made it possible for a more effective allocation of the manager's time in decision making tasks. This was similar to the effect that Morton observed in his research (32).

The most important implication of the organization model for management decision making related to the perspective it generated. In

the actual situation, the model enabled all of the managers to see more of the effects that their proposals would have on the total organization than they could previously. Any manager could develop a proposal and have it evaluated to indicate likely total effects. Thus, for example, the Manufacturing Vice-President could propose the use of a water chiller, specify likely effects on plant productivity and obtain a report that enabled him to see the overall effects on facilities needs and profits. In this way all of the managers were provided with a broader view of their functions in relation to the organization performance. The broader view could generate potentially better management decisions from greater knowledge about likely consequences.

The organization model also had implications for decisions relating to activity budgeting and control. Hekimian defined many of the overhead items in a company's operations as "managed" expenses (18). These represented activities that could be budgeted by management direction in relation to the overall operation--for instance, the level of advertising, number of salesmen, clerical staff and many administration expenses. In the research situation the Controller used the model to help develop budget ranges for such expense variables in conjunction with the long-term forecasts. This provided information that he could use later for control purposes. The model also facilitated the same type of budget and control approach in relation to physical facilities such as plant and warehouse space, manufacturing equipment and work force needs. Gershefski (11) and others (see Schrieber, 39) have reported similar implications for management decision making as a result of their model developments.

The organization model, then, was seen as having several important implications for management decision making. These arose from the increased speed of computer calculations and, most importantly, from more comprehensive evaluations of planning proposals than could normally be achieved through hand evaluation methods. The extent and full impact of the implications of using organization models can only be established by the accumulation of future research results.

Recommendations for Future Research

The potential for research with organization models is seen as being almost without limit. There appear to be three major areas in which research efforts could be concentrated. These are:

1. Modifications to organization model evaluation capabilities and reporting devices.
2. Expansion of model comprehensiveness and modifications to the development approach.
3. Improvements in the manager-model interface and implementation methods.

The first area centres largely on the technical aspects of organization modelling. Research could be undertaken here to increase calculating speeds by restructuring functional relationship forms to improve computing efficiency. Further undertakings could concentrate on the addition of a model search capability, for example. This could transform the organization model (as presented by this research) into a tool that could be used to seek solutions to problems as well as to predict likely planning proposal outcomes. Then the model could be used

to find answers to questions such as, "By how much should the company increase prices and/or productivity to offset the costs of a wage increase?", or "What price should the company quote for a major contract to get the normally desired return?" Still another thrust of the technically oriented research could be related to the use of other communication devices in conjunction with the model. Morton (32), Jones (21) and Miller (30) have reported that graphical display devices can provide many benefits. Further research could determine whether a graphical display device would be advantageous for applications in similar situations with the type of model developed.

The second area for future research centres largely on the modelling techniques themselves. The greatest need is for improvements to the model development approach--the transformation of information from the real situation into a representative model. This type of research activity could accumulate much valuable information about methods for finding functional relationships in particular kinds of organizations, methods for developing common product units, and so on. The results of such research should be the elimination of much of the trial-and-error activity that was embodied in the model development phase of this project.

The third area for future research centres largely on manager acceptance of organization models. Boulden and Buffa found that the easier it was for a manager to interact with a model the more likely it was that he would accept and use it (4). Research undertaken in this area might determine how similar types of organization models (with

great flexibility for evaluation) could be applied in small organizations without the need for extensive indices and guides for their use (such as those contained in Appendices G and H). The interface mechanism, as developed for this project, was used by only one manager. Another approach of research in the interface area could be to determine how many managers should be able to use the organization model. The number might be related to the size of the organization. Research here would likely demonstrate that as the number of users of any one model increases the manager-model interaction mechanism has to be more flexible and easier to use. Future research might delineate the interface needs for different types of organizations and situations.

This project has been concerned with the development, application and effects of one type of computerized organization model in one relatively small company. The research determined that the potential benefits of such models could be large. Much more research should be undertaken in relation to the technical aspects of organization modeling, model development techniques and the manager-model interface. Only future research could establish the full potential of organization models as tools to aid managers in strategic planning endeavours in all types of organizations.

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APPENDIX A

INTRODUCTORY LETTER AND RESEARCH
OUTLINE SENT TO PROSPECTIVE COMPANIES

School of Business Administration
The University of Western Ontario

Dear Mr. _____:

I am a doctoral candidate in the area of production/operations management at the School of Business Administration. I have completed the course work for my program and am now commencing research for my thesis under the direction of Professors J.R.M. Gordon, R.R. Britney, A.A. Grindlay and B.E. Hicks. My field of particular interest is in decision making and planning activities in organizations, and in ways that computers can be used to help managers carry out these activities.

One way in which I think managers, especially those responsible for long-range planning in a company, can be assisted greatly is through the development and use of a computerized organization (or company) model. Such a model can be developed for and used by a company even if its managers have not had any contact with computers and the company does not own a computer. The kind of model I am talking about could be developed at low cost for a relatively small company and could yield large benefits. Accordingly I intend to carry out a research project that will determine and measure the benefits of developing and using such a model in a real situation. The enclosed outline of my proposed research project indicates its purpose, reasons for it, the procedure I intend following, the concept of a computerized organization model and its scope, and the benefits that should accrue from the use of such a model.

I am writing to you in the event that you may be willing to meet with me to discuss the possibility of allowing the research to be conducted in your firm. The nature of the research, and the information required, is such that the approval and co-operation of yourself and at least your upper management group will be needed before it could be carried out successfully. I expect that your company would benefit directly from any model development, the results of which you would be free to use as you desire. The thesis would have to be made available to the public but this does not mean that confidential company details would have to be revealed. All company information that might be made available for the research would be kept strictly confidential unless specifically released as public knowledge.

I would like very much to know whether you feel you would like to discuss this proposal with me. I can be reached at 433-8762 during the day.

Yours truly

Richard A. Nobbs, BSc, MBA

Proposal Outline Enclosed with Letter

A COMPUTERIZED ORGANIZATION MODEL: ITS DEVELOPMENT AND THE
MEASUREMENT OF ITS BENEFITS IN A STRATEGIC PLANNING SITUATION

A Research Project Proposed by:

Richard A. Nobbs, B.Sc., M.B.A.
Doctoral Candidate in Business Administration
University of Western Ontario

PURPOSE:

The purpose of the proposed research is to determine the benefits of replacing machine-aided "hand" computation methods, used to evaluate strategic planning alternatives in a specific organization, with a computerized model that represents the essential features, functions and results of the organization and its operation.

REASONS FOR THE RESEARCH:

The conjecture has been advanced that the structure of the strategic planning process is basically similar in many different organizations. If this is so, then it should follow that the structure of an important activity in the strategic planning process in different organizations should also be similar.

This research will take a first step towards objectively validating those conjectures by applying existing planning and modeling theory to concentrate on the structure of the analyses conducted to evaluate strategic planning alternatives in a specific situation.

Several computerized company models exist in business organizations now and are used mainly for evaluating strategic planning alternatives. However, their benefits have not been measured--the users contend that the models are valuable.

This research is being proposed, specifically, in an effort to obtain objective measures of the advantages of applying a computerized model to evaluate alternative proposals in a strategic planning situation.

It is anticipated that many general features will be incorporated in the computerized organization model to be developed and that its structure will be generally applicable to many situations. These conjectures will have to be tested in future studies but it is anticipated that this research will prove to be the first stage in the development of a widely applicable theory of organization models.

THE PROCEDURE TO BE FOLLOWED:

The first step in the research will be to find a suitable organization that is using formalized strategic (or long-range) planning procedures and is willing and able to co-operate closely with the researcher throughout the project. The structure, functions and planning evaluation procedures used in the selected organization will then be examined and analysed to develop a computerized model of the organization as seen by its strategic planners. Once the model has been developed it will be applied to evaluate alternatives proposed as possible solutions to strategic problems for which plans are being developed. The model's performance will be compared with that of the organization's planning staff using its previously existing evaluation methods to determine the model's advantages.

THE CONCEPT OF A COMPUTERIZED ORGANIZATION MODEL:

A computerized organization model is one that is developed from a top management viewpoint so that all areas of the organization are considered although some may be viewed in relatively little detail. It is a computer program, based on relatively simple mathematical equations, which simulates the physical operations, interactions and resulting financial activities of the organization. Such a model will include major blocks of activity for each major operating component or function of the organization together with the inputs and outputs needed to represent the essence of the manner in which the total organization operates. The purpose of an organization model is to provide the strategic planner with an analysis and prediction of results that are likely to obtain in the future if certain actions are taken and certain environmental conditions exist. The planner can then compare the results predicted with the organization's objectives to determine the likely advisability of undertaking the suggested actions.

A computerized organization model is seen as a tool that top management can employ to evaluate strategic planning alternatives in the following manner. When developing a strategic plan to cope with any particular situation (e.g. the feasibility of diversifying, developing new products, expanding markets, etc.) the planner would use the model to evaluate proposed alternative strategies. He could do so by superimposing the major features of an alternative, market and economic characteristics, etc. upon the existing organization model and operating the adjusted model in a simulation mode to determine what the probable effects would be over an extended period of time, if the alternative was actually to be chosen for implementation--in relation to the performance measures and objectives of the organization. By using this procedure the strategic planner could evaluate several alternative strategies in a relatively short period of time in order to determine which ones would likely be best (within the organization's constraints) and thus should be selected for future implementation.

THE SCOPE OF THE MODEL:

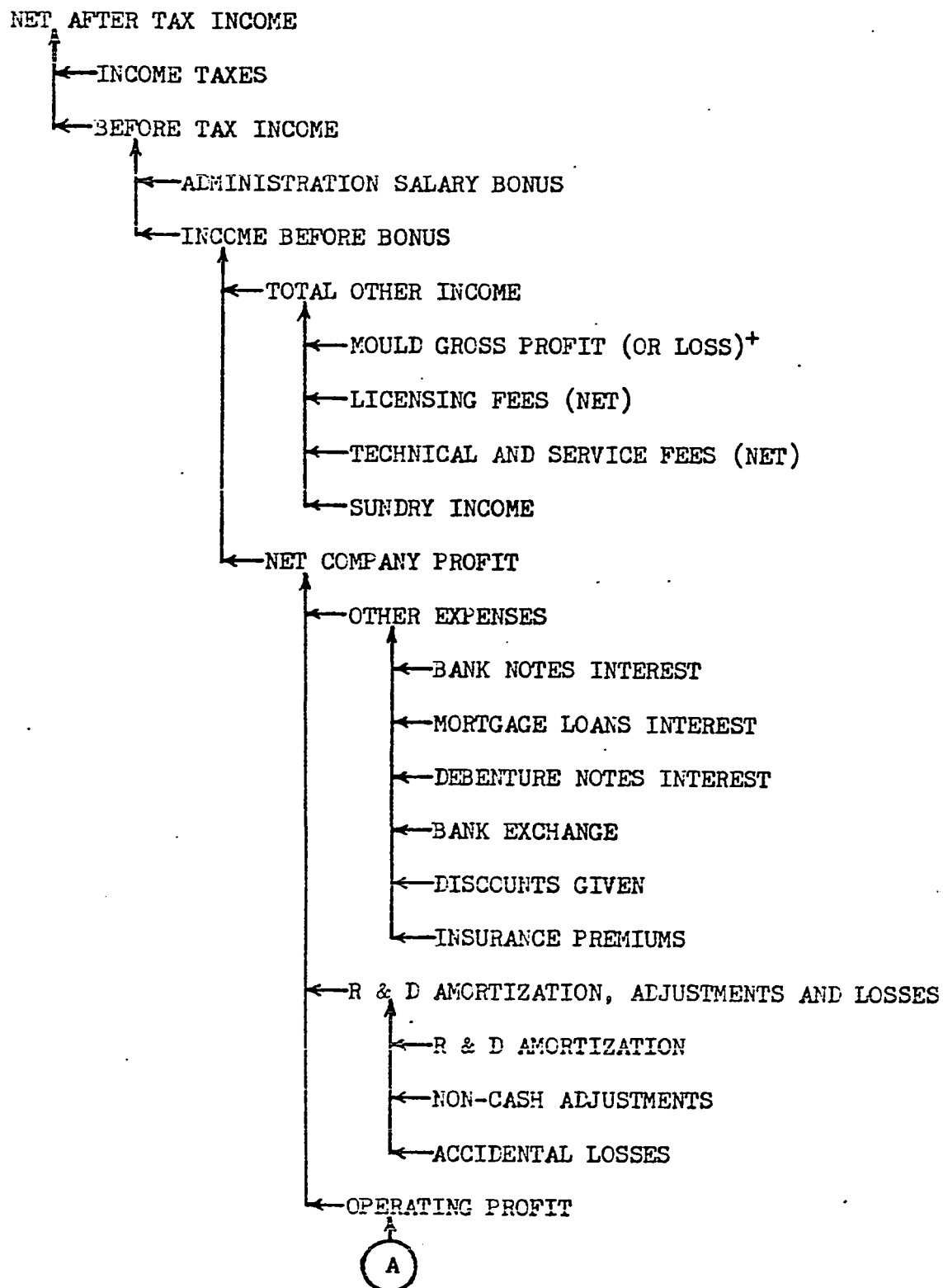
The scope of the organization model to be developed will be very broad. In the form intended for this research the model likely will only consider the major functions of the organization and all of them in relatively little detail using highly aggregated information. It is proposed that the model will be developed using aggregated information about past and present performance of the organization to determine the important functional relationships. Thus the initial form of the model is seen as operating only with aggregate forecasts of performance relevant to marketing, production/operations, finance, control, and personnel and aggregate predictions of environmental and economic conditions. It will be concerned with incremental changes to the total operations of the organization that would result from the proposed undertaking of specific activities. In the case of the possible addition of another product, for example, the results would be reported in relation to such things as the effect on total capacity, effects on marketing activities, added work force required, anticipated contribution to total profits, effects on cash flows, and so on.

ANTICIPATED BENEFITS OF THE ORGANIZATION MODEL:

It is anticipated that the use of the computerized organization model will improve the process of evaluating strategic planning alternatives by reducing the time and costs of evaluations, increasing the number of relevant variables considered, increasing the number of infeasibilities found and eliminated at the strategic level, and increasing the number of alternatives considered to develop plans to deal with particular strategic problems.

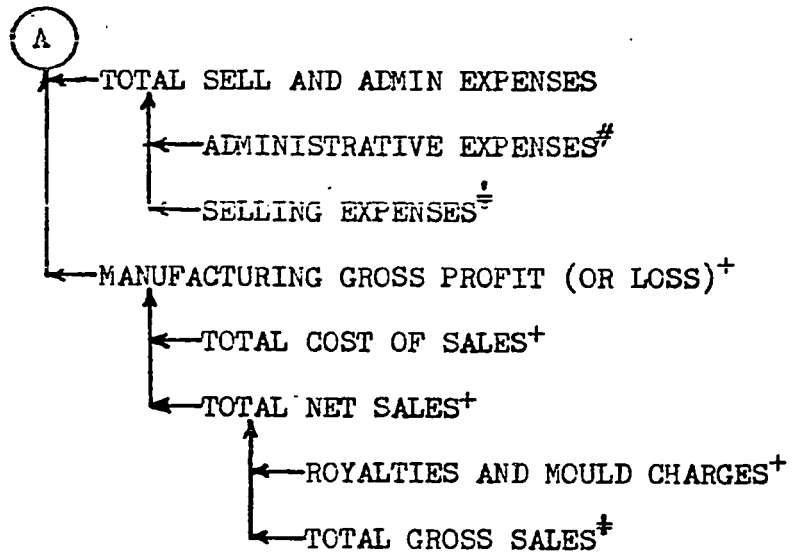
APPENDIX B

SCHEMATICS OF THE MAJOR
ITEMS IN THE COMPANY'S
FINANCIAL STATEMENTS

INCOME STATEMENT ITEMS

(Income Statement Items continued on next page)

Income Statement Items (cont'd)

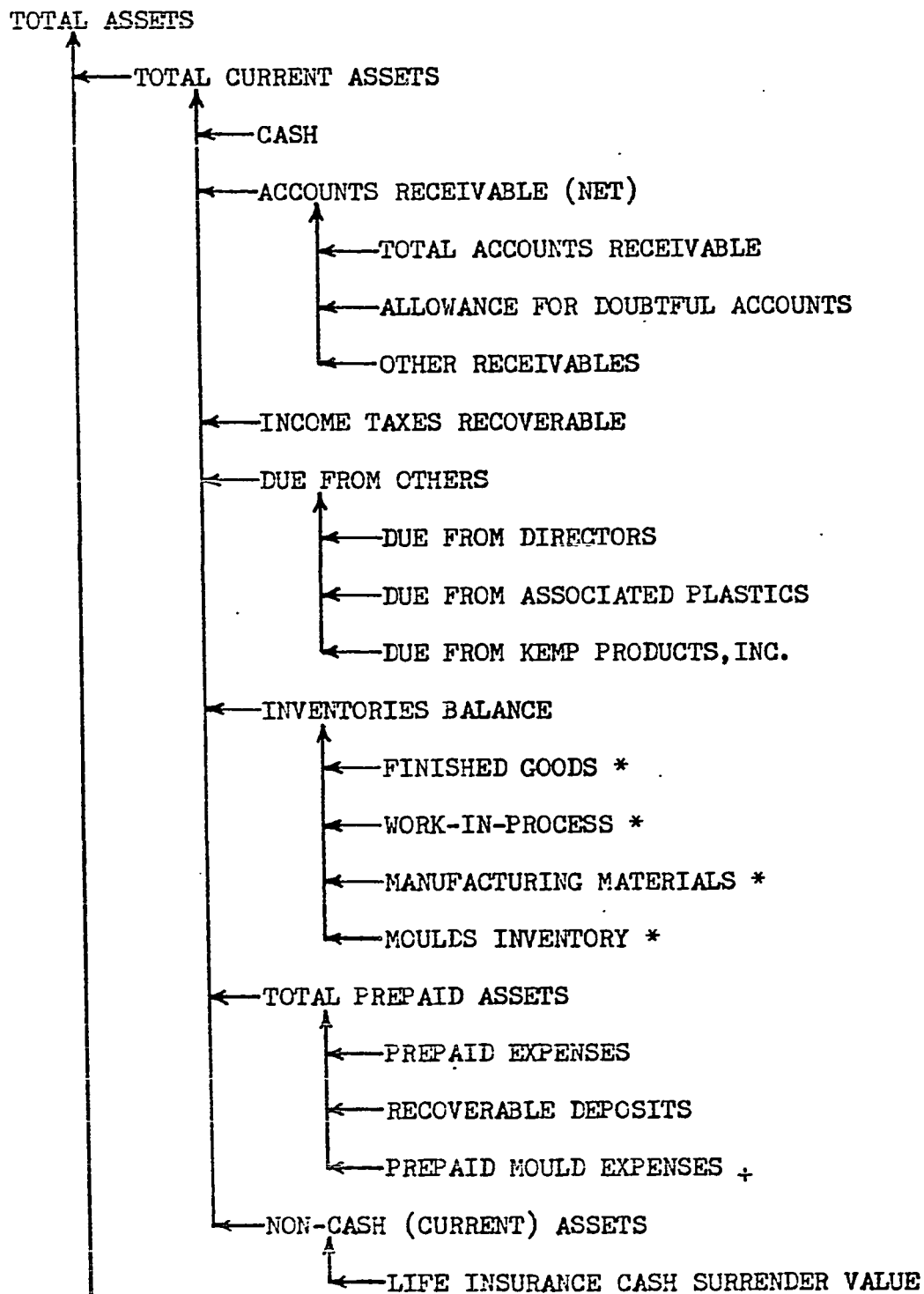


+ These values were taken from the costs statements in the manufacturing component of the model.

‡ These values were taken from the sales component of the model.

This value was determined in the administrative component of the model.

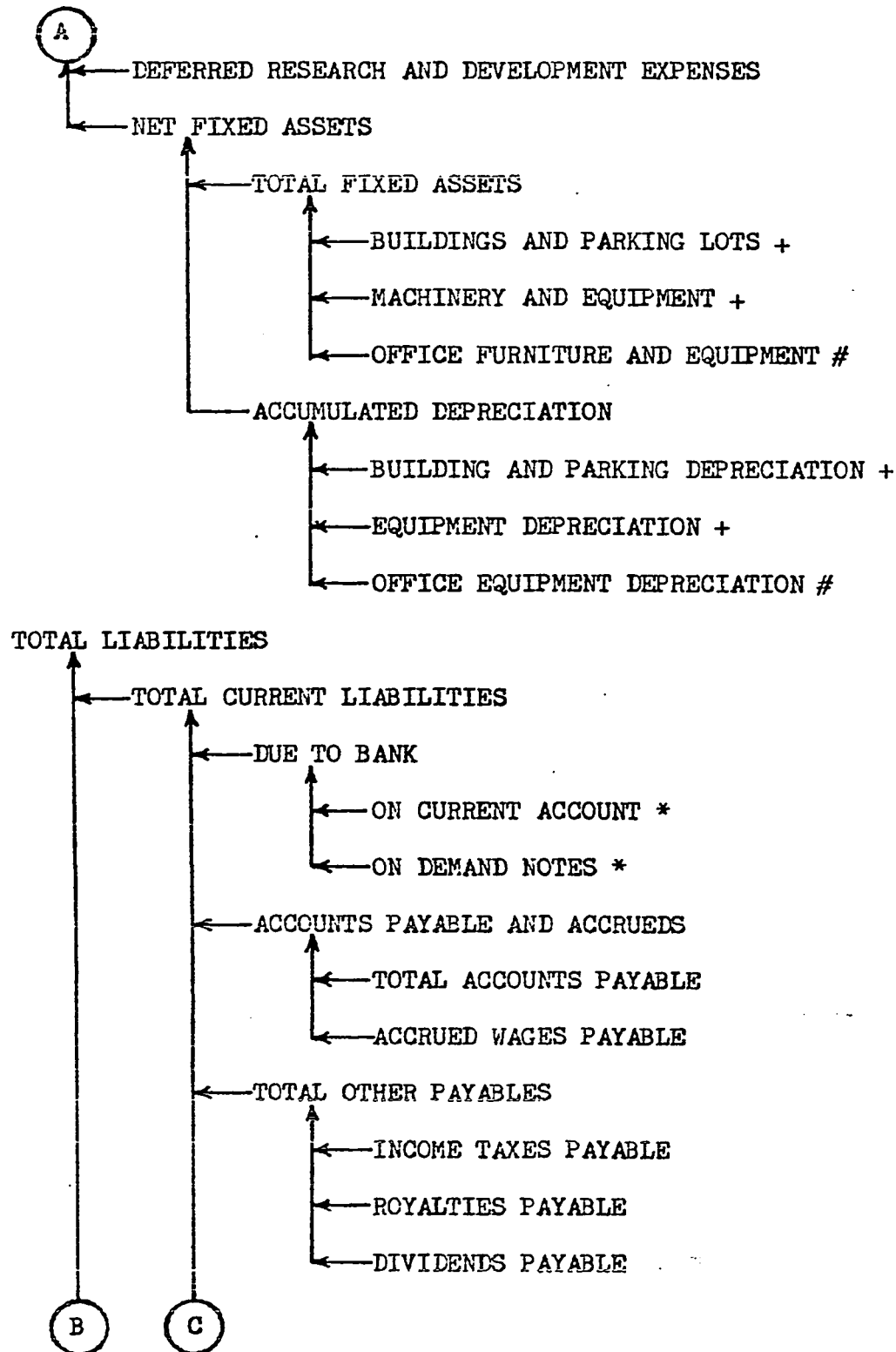
Note: The income statement items were determined in the financial component of the model except as noted above.

BALANCE SHEET ITEMS

A

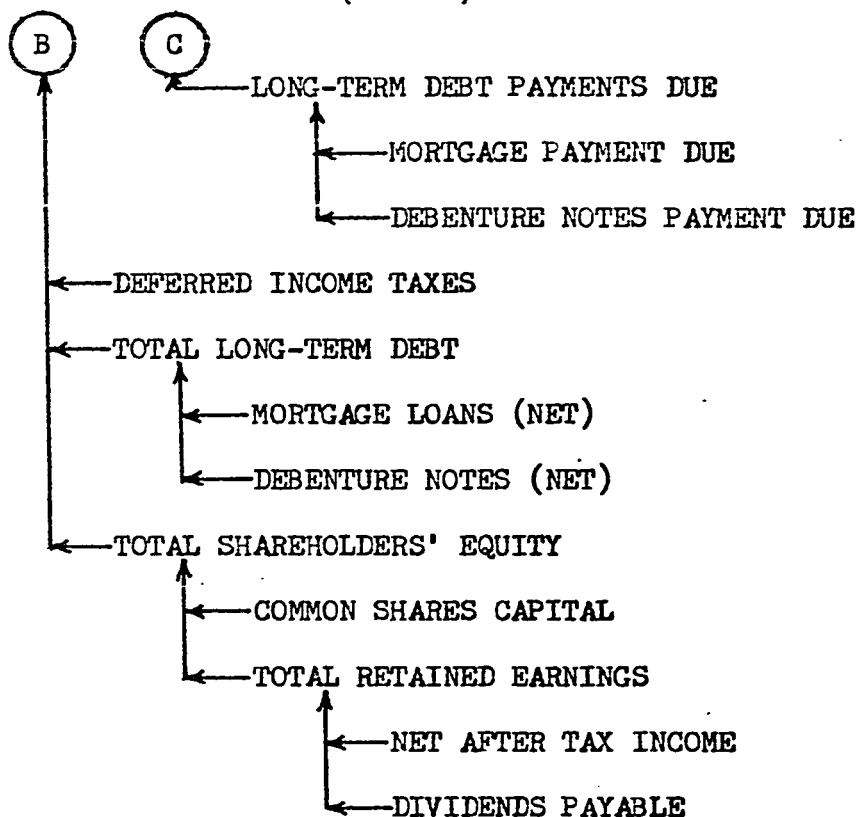
(Balance Sheet Items continued on next page)

Balance Sheet Items (cont'd)



(Balance Sheet Items continued on next page)

Balance Sheet Items (cont'd)



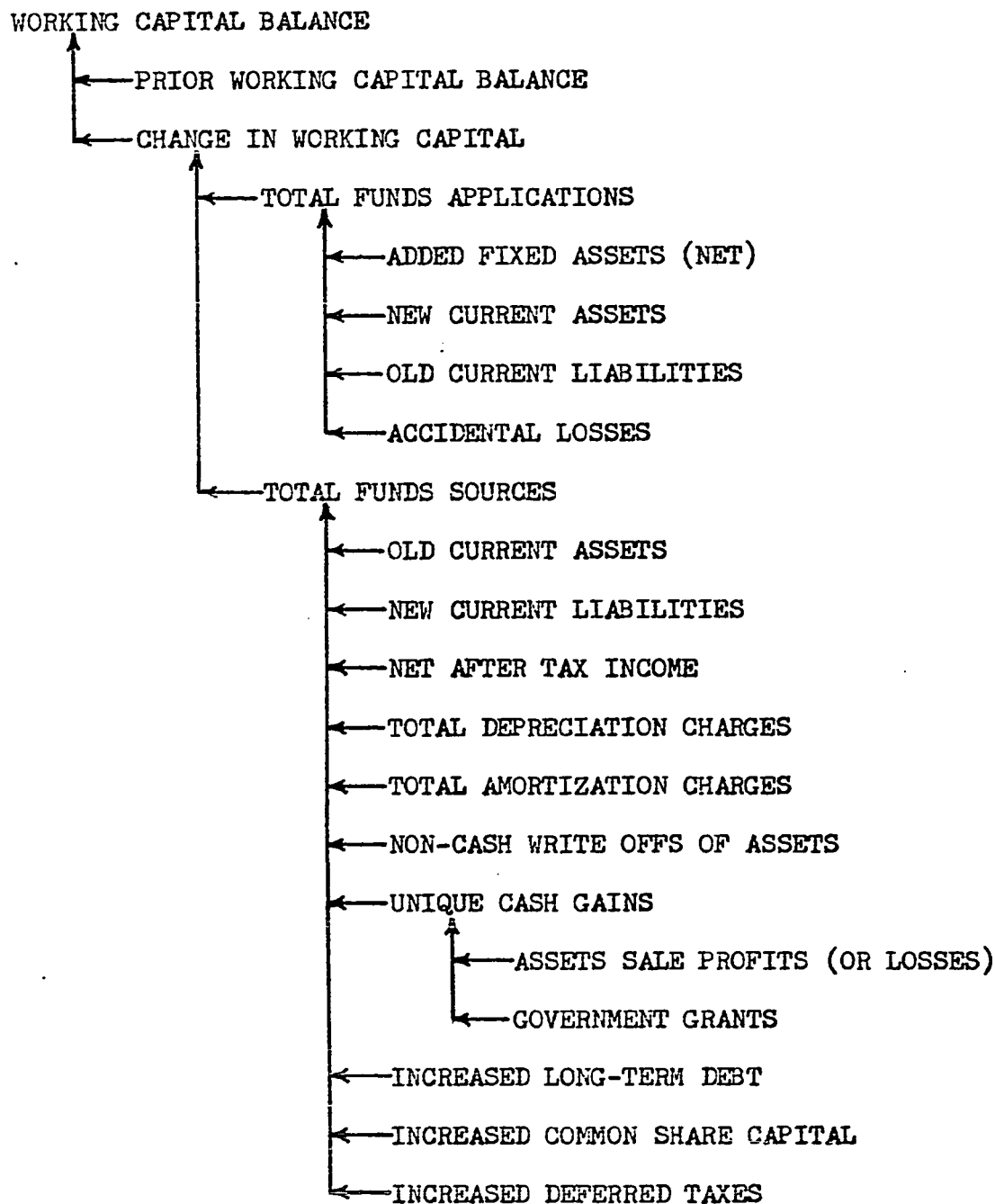
* These items were not included as separate variables in the organization model.

+ The values of these items were determined in the manufacturing component.

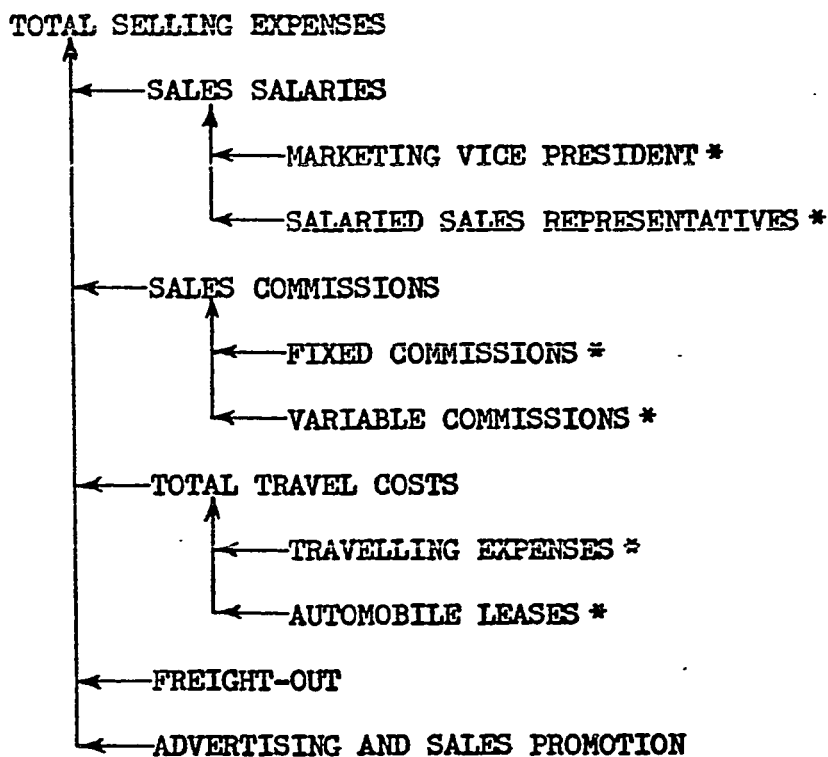
The values of these items were determined in the administration component.

Note: The balance sheet items were determined in the financial component of the model except as noted above.

WORKING CAPITAL AND FUNDS FLOW ITEMS

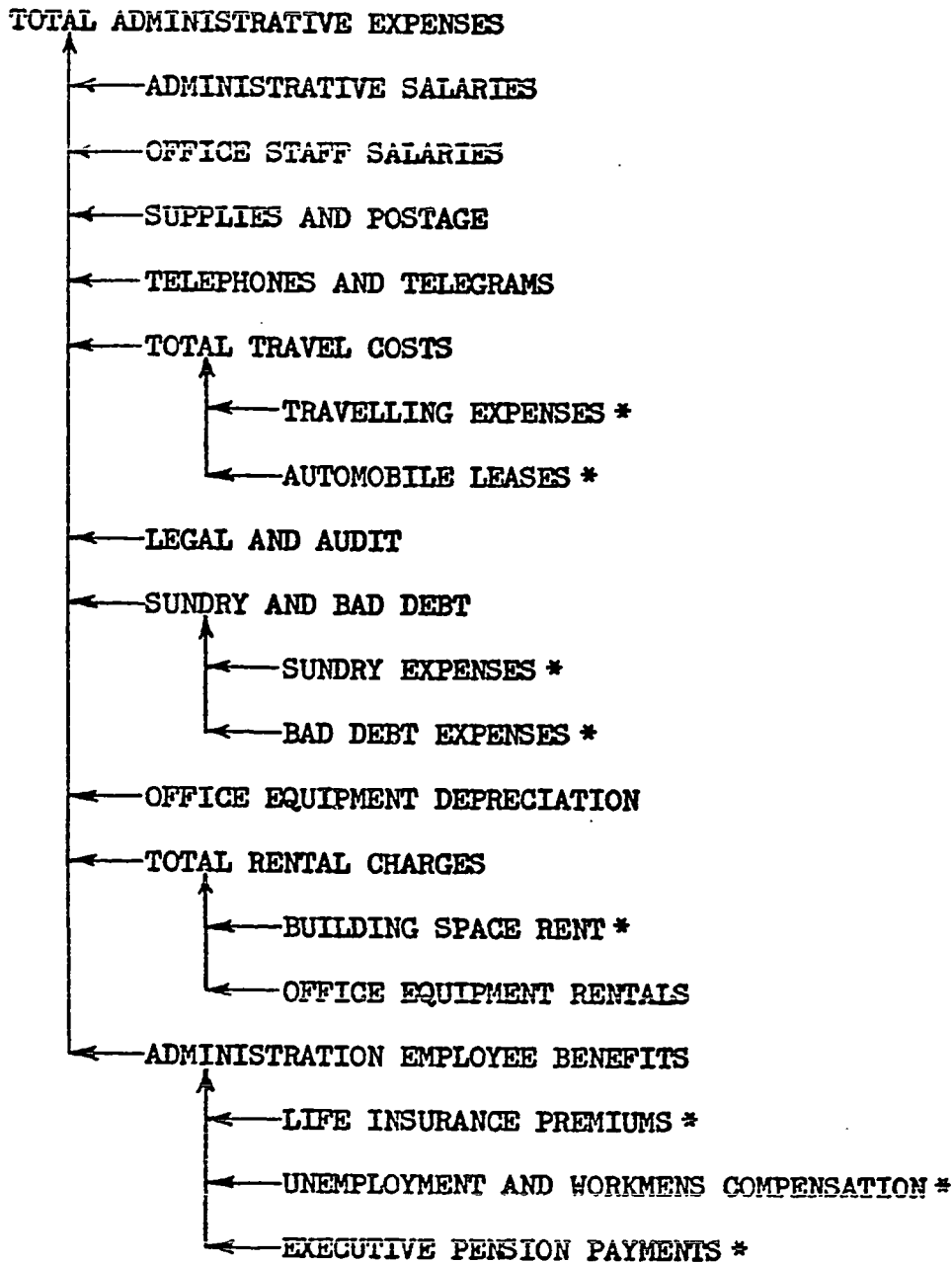


Note: Some of the working capital and funds flow items were incorporated in the financial component of the organization model, however, many of them were not programmed for a funds sources and uses calculation because the Controller did not feel that the development of a funds flow statement was important--he maintained a set of monthly cash flow statements.

SELLING EXPENSES ITEMS

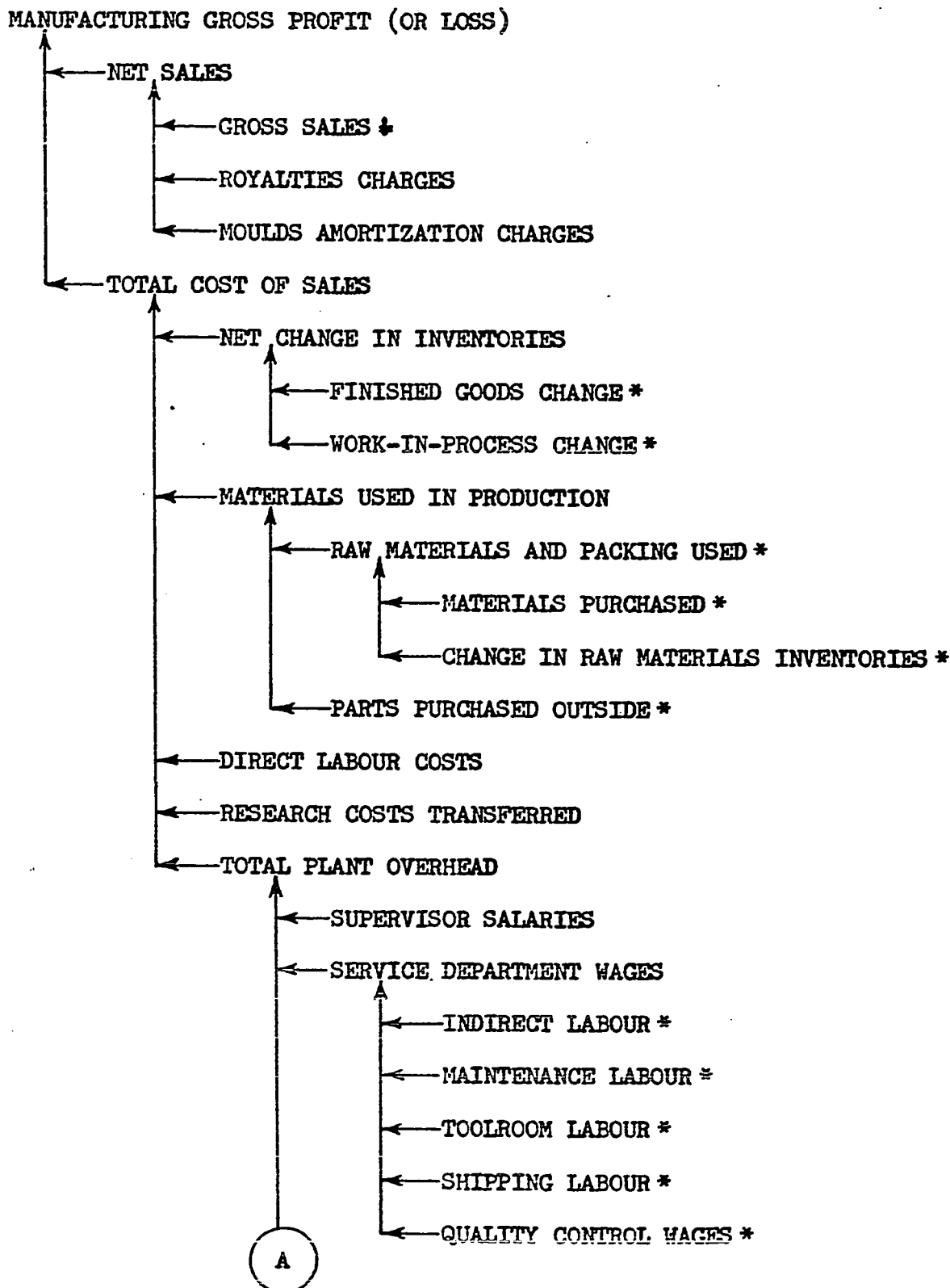
* These items were not included as separate variables in the organization model.

Note: The selling expense items were determined in the sales component of the model. The sales component also determined product forecasts, prices, volumes, and desired expense levels.

ADMINISTRATIVE EXPENSES ITEMS

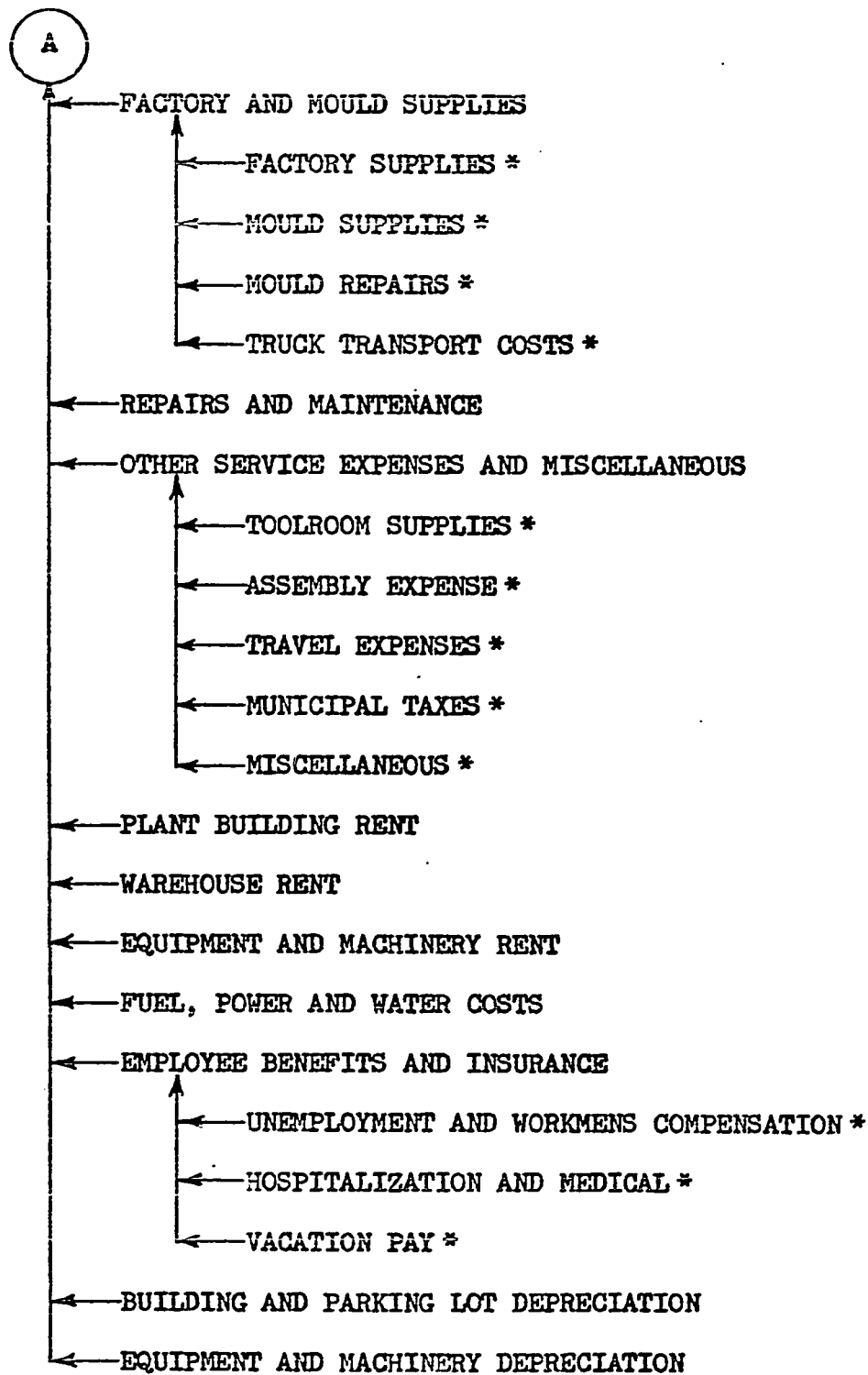
* These items were not included as separate variables in the organization model.

Note: The administration expenses items were determined in the administration component of the model along with any office assets balances.

MANUFACTURING COSTS ITEMS

(Manufacturing Costs Items continued on next page)

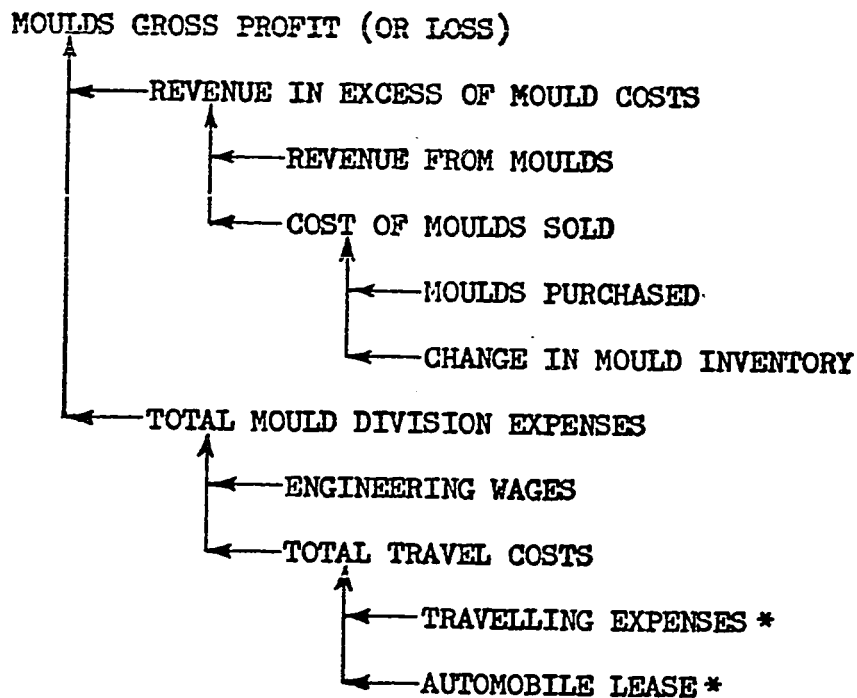
Manufacturing Costs Items (cont'd)



* These items were not included as separate variables in the model.

≠ This item was determined in the sales component of the model.

Note: The manufacturing costs items were determined in the manufacturing component of the model along with any assets balances.

MOULD DIVISION COSTS ITEMS

* These items were not included as separate variables in the organization model.

Note: The mould division costs items were determined in the manufacturing component of the model.

APPENDIX C

REGRESSION ANALYSIS RESULTS

BASED ON FIVE YEARS OF

HISTORICAL DATA

I. REGRESSION ANALYSIS FOR MATERIAL COSTS
IN RELATION TO GROSS PRODUCTION VALUE FOR
1965-1969

M E A N S

INDEPENDENT VARIABLE 1 = 1530.2
 DEPENDENT VARIABLE = 539.8

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE 1 = 602.074
 DEPENDENT VARIABLE = 238.115

C O R R E L A T I O N M A T R I X

1		.9992
.9992	1	

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STD ERROR OF Y
2	0 (CONSTANT)	-64.8738			
	1	.39516	.0094	42.0383	

11.3164

INDEX OF DETERMINATION = .998646

Note: $t_{.95}$ for 3 degrees of freedom = 3.182, therefore the result was highly significant at $t = 42.0382$.

II. REGRESSION ANALYSIS FOR MANUFACTURING EMPLOYEE BENEFITS
IN RELATION TO TOTAL MANUFACTURING WAGES FOR 1965-1969

M E A N S

INDEPENDENT VARIABLE 1 = 271.2
DEPENDENT VARIABLE = 26.8

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE 1 = 105.49
DEPENDENT VARIABLE = 10.8259

C O R R E L A T I O N M A T R I X

1 .997
.997 1

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STD ERROR OF Y
2	0 (CONSTANT)	-.946476			
	1	.10231	.00462	22.145	
					.974657

INDEX OF DETERMINATION = .995136

Note: $t_{.95}$ for 3 degrees of freedom = 3.182, therefore the result was highly significant at $t = 22.145$.

III. REGRESSION ANALYSIS FOR ADMINISTRATION EMPLOYEE BENEFITS
IN RELATION TO TOTAL ADMINISTRATION WAGES FOR 1965-1969

M E A N S

INDEPENDENT VARIABLE 1 = 65.6
DEPENDENT VARIABLE = 5

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE 1 = 22.6009
DEPENDENT VARIABLE = 2.9155

C O R R E L A T I O N M A T R I X

1 .9599
.9599 1

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STD ERROR OF Y
2	0 (CONSTANT)	-3.12325			
	1	.12383	.02088	5.93056	
					.943783

INDEX OF DETERMINATION = .937126

Note: $t_{.95}$ for 3 degrees of freedom = 3.182, therefore the result was significant at $t = 5.93056$.

IV. REGRESSION ANALYSIS FOR DIRECT LABOUR COSTS
IN RELATION TO GROSS PRODUCTION VALUE FOR 1965-1969

M E A N S

INDEPENDENT VARIABLE 1 = 1530.2
 DEPENDENT VARIABLE = 182.8

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE 1 = 602.074
 DEPENDENT VARIABLE = 77.6576

C O R R E L A T I O N M A T R I X

1 .9732
 .9732 1

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STD ERROR OF Y
2	0 (CONSTANT)	-9.27069			
	1	.12552	.01714	7.32322	
					20.6392

INDEX OF DETERMINATION = .95762

Note: $t_{.05}$ for 3 degrees of freedom = 3.182, therefore the result was significant at $t = 7.32322$.

V. REGRESSION ANALYSIS FOR NET SALES VALUE
IN RELATION TO GROSS SALES FOR 1965-1969

M E A N S

INDEPENDENT VARIABLE	1	=	1496.4
DEPENDENT VARIABLE		=	1398.6

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE	1	=	584.104
DEPENDENT VARIABLE		=	577.821

C O R R E L A T I O N M A T R I X

1	.9992
.9992	1

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STD ERROR OF Y
2	0 (CONSTANT)	-80.5312			
	1	.98846	.02267	43.6021	
					26.478

INDEX OF DETERMINATION = .998741

Note: $t_{.05}$ for 3 degrees of freedom = 3.182, therefore the result was highly significant at $t = 43.6021$.

APPENDIX D

COMPARISONS OF ACTUAL RESULTS AND
REGRESSION EQUATION ESTIMATES

TABLE 9.--Actual versus estimated values for 1965-1969 using the five year regression equations (units in thousands of dollars)

Material Costs from Gross Production Value				
Year	Actual Value	Estimate Value	Difference	Percentage Difference
1965	241	235	- 6	-2.48963
1966	335	339	4	1.19403
1967	679	677	- 2	- .294551
1968	792	781	-11	-1.38889
1969	652	667	15	2.30061
Mean Absolute Differences			7.6	1.53354
Manufacturing Employee Benefits from Total Manufacturing Wages				
1965	13	12	- 1	-7.69231
1966	19	20	1	5.26316
1967	28	29	1	3.57143
1968	35	35	0	0
1969	39	38	- 1	-2.5641
Mean Absolute Differences			.8	3.8182
Administration Employee Benefits from Total Administration Wages				
1965	2	2	0	0
1966	3	3	0	0
1967	4	5	1	25
1968	9	9	0	0
1969	7	6	- 1	-14.2857
Mean Absolute Differences			.4	7.85714

TABLE 9 (Cont'd)

Year	Actual Value	Estimate Value	Difference	Percentage Difference
Direct Labour Costs from Gross Production Value				
1965	84	86	2	2.38095
1966	121	119	- 2	-1.65289
1967	201	226	25	12.4378
1968	260	259	- 1	- .384615
1969	248	223	-25	-10.0806
Mean Absolute Differences			11	5.38738
Net Sales Value from Gross Sales				
1965	669	663	- 6	- .896861
1966	895	910	15	1.67598
1967	1708	1718	10	.58548
1968	1977	1995	18	.91047
1969	1744	1707	-37	-2.12156
Mean Absolute Differences			17.2	1.23807

TABLE 10.--Actual versus estimated values for 1965-1970 using the five-year regression equations (units in thousands of dollars)

Material Costs from Gross Production Value				
Year	Actual Value	Estimate Value	Difference	Percentage Difference
1965	241	235	- 6	- 2.48963
1966	335	339	4	1.19403
1967	679	677	- 2	- .294551
1968	792	781	-11	- 1.38889
1969	652	667	15	2.30061
1970	626	685	59	9.42492
Mean Absolute Differences			16.1667	2.84877
Manufacturing Employee Benefits from Total Manufacturing Wages				
1965	13	12	- 1	- 7.69231
1966	19	20	1	5.26316
1967	28	29	1	3.57143
1968	35	35	0	0
1969	39	38	- 1	- 2.5641
1970	55	49	- 6	-10.9091
Mean Absolute Differences			1.66667	5.00002
Administration Employee Benefits from Total Administration Wages				
1965	2	2	0	0
1966	3	3	0	0
1967	4	5	1	25
1968	9	9	0	0
1969	7	6	- 1	-14.2857
1970	9	13	4	44.4444
Mean Absolute Differences			1	13.955

TABLE 10 (Cont'd)

Year	Actual Value	Estimate Value	Difference	Percentage Difference
Direct Labour Costs from Gross Production Value				
1965	84	86	2	2.38095
1966	121	119	- 2	- 1.65289
1967	201	226	25	12.4378
1968	260	259	- 1	- .384615
1969	248	223	-25	-10.0806
1970	337	229	-108	-32.0475
Mean Absolute Differences			27.1667	9.83073
Net Sales Value from Gross Sales				
1965	669	663	- 6	- .896861
1966	895	910	15	1.67598
1967	1708	1718	10	.58548
1968	1977	1995	18	.91047
1969	1744	1707	-37	- 2.12156
1970	1777	1798	21	1.18177
Mean Absolute Differences			17.8333	1.22869

TABLE 11.--Actual versus estimated values for 1965-1970 using the six-year regression equations (units in thousands of dollars)

Material Costs from Gross Production Value				
Year	Actual Value	Estimate Value	Difference	Percentage Difference
1965	241	235	- 6	- 2.48963
1966	335	336	1	.298507
1967	679	664	-15	- 2.20913
1968	792	765	-27	- 3.40909
1969	652	654	2	.306748
1970	626	671	45	7.1885
Mean Absolute Differences			16.	2.65027
Manufacturing Employee Benefits from Total Manufacturing Wages				
1965	13	11	- 2	-15.3846
1966	19	19	0	0
1967	28	30	2	7.14286
1968	35	37	2	5.71429
1969	39	40	1	2.5641
1970	55	52	- 3	- 5.45455
Mean Absolute Differences			1.66667	6.0434
Administration Employee Benefits from Total Administration Wages				
1965	2	2	0	0
1966	3	3	0	0
1967	4	5	1	25
1968	9	7	- 2	-22.2222
1969	7	6	- 1	-14.2857
1970	9	10	1	11.1111
Mean Absolute Differences			.833333	12.1032

TABLE 11 (Cont'd)

Year	Actual Value	Estimate Value	Difference	Percentage Difference
Direct Labour Costs from Gross Production Value				
1965	84	86	2	2.38095
1966	121	125	4	3.30579
1967	201	251	50	24.8756
1968	260	289	29	11.1538
1969	248	247	- 1	- .403226
1970	337	253	-84	-24.9258
Mean Absolute Differences			28.3333	11.1742
Net Sales Value from Gross Sales				
1965	669	663	- 6	- .896861
1966	895	909	14	1.56425
1967	1708	1714	6	.351288
1968	1977	1989	12	.60698
1969	1744	1702	-42	- 2.40826
1970	1777	1793	16	.900394
Mean Absolute Differences			16	1.12134

TABLE 12.--Comparisons of mean absolute percentage differences for the sets of regression equation estimates

Equation ^a Number	(a) Five-Year Mapd	(b) Six-Year Mapd	(b) - (a) Difference
1	1.534%	2.650%	1.116%
2	3.818	6.043	2.225
3	7.857	12.103	4.246
4	5.387	11.174	5.787
5	1.238	1.121	-0.117

TABLE 13.--Comparisons of 1970 values estimated from the regression equation sets (units in thousands of dollars)

Equation ^a Number	(a) Five-Year 1970	(b) Six-Year 1970	(b) - (a) Difference	Percentage Differ/(a)
1	685	671	-14	-2.05%
2	49	52	3	6.12
3	13	10	-3	-23.10
4	229	253	24	10.50
5	1798	1793	-5	-0.28

^aThe equation number refers to the equation descriptions in the order in which they appear on page 132 in Chapter VI.

TABLE 14.--Actual versus estimated values for 1970 using the modified regression coefficients (units in thousands of dollars)

Material Costs from Gross Production Value ^a				
Year	Actual Value	Estimate Value	Difference	Percentage Difference
1970	626	630	4	.638978
Manufacturing Employee Benefits from Total Manufacturing Wages ^b				
1970	55	54	-1	-1.81818
Administration Employee Benefits from Total Administration Wages ^c				
1970	9	9	0	0

^aModified Coefficients: Intercept = -59.629
Slope = 0.3638

^bModified Coefficients: Intercept = -1.051
Slope = 0.11356

^cModified Coefficients: Intercept = -2.142
Slope = 0.08485

APPENDIX E

REGRESSION ANALYSIS RESULTS
BASED ON SIX YEARS OF
HISTORICAL DATA

I. REGRESSION ANALYSIS FOR MATERIAL COSTS
IN RELATION TO GROSS PRODUCTION VALUE FOR 1965-1970

M E A N S

INDEPENDENT VARIABLE	1	=	1591.33
DEPENDENT VARIABLE		=	554.167

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE	1	=	558.944
DEPENDENT VARIABLE		=	215.864

C O R R E L A T I O N M A T R I X

1	.9934
.9934	1

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STD ERROR OF Y
2	0 (CONSTANT)	-56.3643			
	1	.38366	.0221	17.3602	
					27.6269

INDEX OF DETERMINATION = .989079

Note: $t_{.95}$ for 4 degrees of freedom = 2.776, therefore the result was highly significant at $t = 17.3602$.

II. REGRESSION ANALYSIS FOR MANUFACTURING EMPLOYEE BENEFITS
IN RELATION TO TOTAL MANUFACTURING WAGES FOR 1965-1970

M E A N S

INDEPENDENT VARIABLE 1 = 307.5
DEPENDENT VARIABLE = 31.5

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE 1 = 129.648
DEPENDENT VARIABLE = 15.0433

C O R R E L A T I O N M A T R I X

1	.9919
.9919	1

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STD ERROR OF Y
2	0 (CONSTANT)	-3.89017			
	1	.11509	.00738	15.5949	
					2.1389

INDEX OF DETERMINATION = .986523

Note: $t_{.95}$ for 4 degrees of freedom = 2.776, therefore the result was highly significant at $t = 15.5949$.

III. REGRESSION ANALYSIS FOR ADMINISTRATION EMPLOYEE BENEFITS
IN RELATION TO TOTAL ADMINISTRATION WAGES FOR 1965-1970

M E A N S

INDEPENDENT VARIABLE 1 = 76.1667
DEPENDENT VARIABLE = 5.6667

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE 1 = 32.8415
DEPENDENT VARIABLE = 3.0768

C O R R E L A T I O N M A T R I X

1 .919
.919 1

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STD ERROR OF Y
2	0 (CONSTANT)	-.891283			
	1	.0861	.01846	4.66414	
					1.35585

INDEX OF DETERMINATION = .87054

Note: $t_{.95}$ for 4 degrees of freedom = 2.776, therefore the result was significant at $t = 4.66414$.

IV. REGRESSION ANALYSIS FOR DIRECT LABOUR COSTS
IN RELATION TO GROSS PRODUCTION VALUE FOR 1965-1970

M E A N S

INDEPENDENT VARIABLE 1 = 1591.33
DEPENDENT VARIABLE = 208.5

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE 1 = 558.944
DEPENDENT VARIABLE = 93.7417

C O R R E L A T I O N M A T R I X

1	.8746
.8746	1

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STANDARD ERROR OF Y
2	0 (CONSTANT)	-24.9167			
	1	.14668	.04065	3.60836	
					50.8106

INDEX OF DETERMINATION = .804138

Note: $t_{.95}$ for 4 degrees of freedom = 2.776, therefore the result was significant at $t = 3.60836$.

V. REGRESSION ANALYSIS FOR NET SALES VALUE
IN RELATION TO GROSS SALES FOR 1965-1970

M E A N S

INDEPENDENT VARIABLE 1 = 1563.67
DEPENDENT VARIABLE = 1461.67

S T A N D A R D D E V I A T I O N S

INDEPENDENT VARIABLE 1 = 547.806
DEPENDENT VARIABLE = 539.413

C O R R E L A T I O N M A T R I X

1 .9992
.9992 1

R E G R E S S I O N A N A L Y S I S

ITERATION NO.	VARIABLE	REGRESSION COEFFICIENT	STANDARD DEVIATION	T-RATIO	STD ERROR OF Y
2	0 (CONSTANT)	-76.7625			
	1	.98386	.02011	48.9239	
					24.6374

INDEX OF DETERMINATION = .998613

Note: $t_{.95}$ for 4 degrees of freedom = 2.776, therefore the result was highly significant at $t = 48.9239$.

APPENDIX F

ANALYSIS RESULTS FOR DETERMINING
THE COMMON PRODUCT UNIT AND PARAMETERS

TABLE 15.--The means and variability results of the preliminary analysis for hours per pallet

	Machine Type				
	One	Two	Three	Four	Five
Arithmetic Mean..	212.6	24.4	46.1	9.12	4.69
Variance	192384.0	851.3	4384.3	48.22	33.03
Standard Deviation	438.616	29.2	66.2	6.94	5.75

TABLE 16.--Results of the preliminary analysis for the weighted average hours per pallet based on total pallets

	Machine Type				
	One	Two	Three	Four	Five
Forecast Production Hrs .	6367.0	15632.0	9414.0	4676.0	2033.0
Forecast Total Pallets . .	242.5	1527.8	248.9	473.4	716.7
Weighted Avg Hours/Pallet	26.3	10.2	37.8	9.9	2.8
Estimated Production Hrs	6367.0	15632.0	9414.0	4676.0	2033.0

TABLE 17.--Results of the preliminary analysis for the weighted average hours per pallet based on total hours

	Machine Type				
	One	Two	Three	Four	Five
Forecast Production Hrs	6367.0	15632.0	9414.0	4676.0	2033.0
Forecast Total Pallets .	242.5	1527.8	248.9	473.4	716.7
Weighted Avg Hours/Pallet	272.7	17.5	91.3	18.0	10.5
Estimated Production Hrs	66129.0	26719.0	22725.0	8499.0	7522.0
Estimate Difference . . .	+59762.0	+11087.0	+13311.0	+3823.0	+5489.0

TABLE 18.--Results of the detailed analysis for the weighted average hours per pallet, selling price per pallet, and inventory sales value per pallet.

	Machine Type					
	One	Two	Three	Four	Five	Six
Forecast Production Hours . . .	6290.00	13081.00	14032.00	4430.00	3053.00	3794.00
Forecast Total Pallets . . .	240.27	1295.00	564.06	463.92	994.43	1052.30
Weighted Avg Hours/Pallet . . .	26.18	10.10	24.88	9.55	3.07	3.61
Production Sales Value (\$) . . .	133937.00	485716.00	357828.00	221333.00	251351.00	221887.00
Weighted Avg Sales \$/Pallet . . .	557.44	375.07	634.38	477.10	252.76	210.87
Year-end Inventory Pallets . . .	8.97	105.63	94.87	52.76	34.32	307.20
Year-end Inventory Value (\$)	6498.70	41548.00	53535.00	25576.00	10428.00	71850.00
W Avg Inventory \$/Pallet . . .	724.55	393.33	564.29	484.73	303.79	233.89
Estimated Production Hours . . .	6290.00	13081.00	14032.00	4430.00	3053.00	3794.00
Estimated Sales Value . . .	133937.00	485716.00	357827.00 ^a	221333.00	251351.00	221887.00
Estimated Inventory Value 1 . . .	6499.00	41548.00	53535.00	25576.00	10428.00	71850.00
Estimated Inventory Value 2 . . .	5000.00	39619.00	60183.00	25173.00	8676.00	64779.00
Inventory Difference (1-2) . . .	+1499.00	+1929.00	-6648.00	+403.00	+1752.00	+7071.00
Percentage Difference (%) . . .	23.10	4.64	-12.40	1.58	16.80	9.84

^aThe only difference found between the actual and estimated production sales values was likely due to rounding effects. No differences were found between actual and estimated production hours.

Note: Inventory Value 1 was based on the actual inventory distribution.
 Inventory Value 2 was based on the forecasted production distribution.
 Only the inventory value differences for machine types two and four were small enough to indicate no significant differences in the inventory and production distributions of products.

APPENDIX G

ORGANIZATION

MODEL USERS' GUIDE

ORGANIZATION MODEL OPERATING INSTRUCTIONS

1. Determine Operating Conditions

- (a) Years to forecast
- (b) Lease or buy equipment, plant, warehouse?
- (c) Take option to enter changes during run? (Usually, "NO")

2. Determine the factors you think should be changed.

Consider in terms of Sales (Forecasts and/or expenses), Production (Inventory, rates, equipment and building costs, labour productivity, etc.), Manufacturing Costs (material costs, wage and salary rates, overhead items, research and development, mould costs, etc.), Administration (personnel, salaries, supplies costs, rents, etc.) and Financial (other income and expenses, adjustments, payables and receivables rates, financing sources, etc.).

Look up likely changes in the Index--by model component and item description. Calculate new parameter values and changes with respect to those recorded in the Index. Prepare a list, for each forecast year, of change code numbers and parameter change values.

3. Operate model using the following sequence

- (a) GET - MODCHG
RUN
(Enter changes as requested by the program)
(Scratch when done)
- (b) GET - SALES
APP - AMEND
RUN (SCRATCH when done)
- (c) GET - PRODN
APP - AMEND
RUN (SCRATCH when done)
- (d) GET - MANFG
APP - AMEND
RUN (SCRATCH when done)
- (e) GET - ADMIN
APP - AMEND
RUN (SCRATCH when done)
- (f) GET - INCOM
APP - AMEND
RUN (SCRATCH when done)

4. Obtain desired results print-out
 GET - REPORT
 RUN

The program will ask you to specify:

COMPONENT CODE NO.?
 REPORT MODE NO.?
 NUMBER OF STATEMENTS or NUMBER OF VARIABLES?
 STATEMENT or VARIABLE INDEX NUMBERS?

It will then print the information you have asked for. Note that this program will have to be Run each time you want to get more information or information from a different model component.

- (a) The Component Codes are:

1 SALES	3 MANFG	5 INCOM
2 PRODN	4 ADMIN	

- (b) The Report Modes are:

1. Selective (for individual variable values - You can ask for up to 20 variables at once).
2. Statement (for particular standard statements).
3. Complete (to list all variable values for any component).

- (c) The STATEMENTS you can ask for are:

<u>COMPONENT</u>	<u>STATEMENT NO.</u>	<u>DESCRIPTION</u>
Sales	1	Selling Expenses
Prodn	2	Production Conditions
Manfg	3	Manufacturing Costs
"	4	Mould Division Costs
Admin	5	Administration Expenses
Incom	6	Income Statement
"	7	Balance Sheet
"	8	Retained Earnings, Funds, Work Cap
**	9	Status Variables

** The Status Variables statement can be requested in conjunction with statements from any of the model components.

- (d) In the SELECTIVE mode you can ask for the results for up to 20 variables in one component at a time. You have to specify the number of variables and then enter their index numbers. The variable index numbers are those listed in the INDEX and not enclosed in brackets.

5. Compare results with expectations and look for apparent inconsistencies. At this time you will likely find that more changes should be made to improve the predictions for factors not considered in the initial evaluation preparations.
6. Repeat steps 2 to 5 until a forecast is developed that incorporates all of the changes that you can reasonably anticipate.

MODEL CHANGE COMPONENT

Program Name: MODCHG

Purpose:

To set up a data file of change parameter values that will be used in the running of the Kemp Organization Model to evaluate proposed plans. Use of MODCHG to load the CHANGE file will enable the user to enter changes only once and avoid the time consuming practice of making all changes during each run of the model. The user will be able to make the minimum number of parameter change entries needed by keyboard to alter the model from run to run.

Operation:

This program will have to be run to load the CHANGE file and/or update it before each model run. The file must contain a record of changes or a set of indicators that signify that no model changes are to be made during any run. However, once a change record has been set up, the model user will only have to update the CHANGE file between runs.

Procedure:

Load and run as follows:
GET - MODCHG
RUN

In a conversational mode the program will then ask the user to enter the appropriate change values from the keyboard. It will signify how many changes can be made--both to old values, and as new values--in any forecast year and make checks to ensure that the CHANGE file capacity is not exceeded. The CHANGE file is set up to accept a maximum of 63 parameter change values for any forecasting year (this is approximately 1/6 of the total potential model changes in any year).

Preparation:

The user should first prepare a list of the index numbers and change parameter values that he wishes to enter for each year. The years used run from 1 to 5 for the forecasting horizon--currently the first is the year ending May 31, 1971. The list of changes should conform to the series of questions that will be asked by the computer to set up and maintain the CHANGE file.

The Questions and Answers are:

1. Ques: "Change in Years, Lease Status or Change Option"?

Ans.: Yes or No

(If "No" the program advances to Question #5 to ask for the parameter changes you want to make. If "Yes" proceed to next question.)

2. Ques: "How many years will you forecast"?

Ans.: 1 to 5 (i.e. The number of years that you want the model to evaluate beyond the base year.)

3. Ques: "Will you lease Equipt. Bldg. and/or Whse"? (3 answers needed)

Ans.: Yes--if to lease equipment; No--if to buy all new equipt.

Ans.: Yes--if to lease plant additions; No--if to buy additions.

Ans.: Yes--if to lease whse. additions; No--if to buy additions.

4. Ques: "Will you enter extra changes during model run"?

Ans.: Yes or No.

A "Yes" answer will command the computer to stop and ask you for further changes to parameters at the start of each forecast year in each of the five main calculating components.

The usual answers should be "No". This signifies that you will enter changes only through the CHANGE file and will not interrupt any of the calculations. It results in a faster evaluation by the model.

NOTE: The answer to the first question will usually be "No" when making changes to evaluate different alternatives for a particular proposal. The subsequent instructions are needed only if you wish to change the length of the forecast horizon, to change from buying to leasing various assets (or vice versa) or to change the manner in which you will enter parameter changes.

5. Ques: "New Record, Modify or Keep Old"?

Ans.: "New" if you wish to wipe out the existing CHANGE file record and enter a complete new list of changes.

"Modify" if you wish to add, delete, or alter the values of any parameter changes on the file.

(For both of these responses, the program proceeds to Question #6 to ask for changes.)

"Keep" if you wish to retain the CHANGE file in its current state for the next model run.

(If "Keep" the program terminates.)

The next series questions will be repeated for each year that you wish to have the model forecast.

6. Ques: "New Changes for Year 1"?

Ans.: Yes or No. (If No--the computer will proceed to ask for changes for Year 2, 3, 4, etc. If "Yes" the computer goes to Question #7.)

The computer lets you know how many old changes exist for the year and how many more can be made (a maximum of 63 changes can be stored for any given year).

7. Ques: "How many changes now"?

Ans.: 1 to 63 (i.e. the number of changes you wish to type in).

Then the computer will instruct you to "Enter index no. and new value for each" and print a question mark for you to type in the first change. The computer will continue to respond with a question mark (after each change you type in) for each of the number of changes you said you would make.

For Example: ? 11013.3, .02 (you type in the numbers and return)
? 32270.4, 20
and so on until all are entered for that year.

Questions #6 and #7 are then repeated until answers have been given for all of the years that you want the model to forecast. The program terminates automatically.

CHANGE PARAMETER INDEX CODES

In the above example two numbers were entered for each change. The first was a 6-digit change parameter index code and the second was the desired change. The code was established as follows (and is obtained from the Index to Kemp Organization Model Variables, Parameters and Change Codes):

1. First Digit--used to indicate the model component.
 - 1 = Sales component
 - 2 = Production component
 - 3 = Manufacturing costs component
 - 4 = Administration component
 - 5 = Financial (Income) component
2. Second Digit--used to indicate the type of variable in the particular component.
 - 1 = A product variable (used in Sales and Production).
 - 2 = An operating variable
 - 3 = An internal or cumulating variable
 - 4 = A Status variable (can be modified by any model component.)

3. Third and Fourth Digits--used to indicate the variable number within any particular model component. These numbers can range from 01 to 99 but the maximum number of any one type of variable is 49 in the Financial component.
4. Fifth Digit--used to indicate the machine or product type for a product variable.
1 to 8 = machine type for a Sales or Production product variable.
0 = used as the fifth digit for all other variable types.
5. Sixth Digit (Preceded by a decimal)--used to indicate the type of change to be made.
.3 = A percentage or discrete change to a growth or rate factor.
.4 = A discrete or unique lump sum change to a variable value.

Thus for the two examples shown the codes specify:

(11013.3) 1 = Sales component
 1 = Product variable
 01 = First sales product variable (Sales Forecast)
 3 = Third machine group (machines #9 and 11)
 .3 = Discrete change to the sales growth factor.

Since the change suggested was .02, this would call for an increase in the sales growth rate from the base of 1.101 (or 10.1%) to 1.121 (or 12.1%) for the particular year.

(32270.4) 3 = Manufacturing component
 2 = Operating variable
 27 = twenty-seventh variable (Material costs)
 0 = Required because not a product variable.
 .4 = A discrete change in material costs.

Since the change suggested was 20 this would call for a \$20,000 increase in total material costs above that estimated by the model as a proportion of the gross sales and inventory change value.

CHANGE FILE STRUCTURE

The CHANGE file is made up of 20 records (of 64 words each reserved as follows:

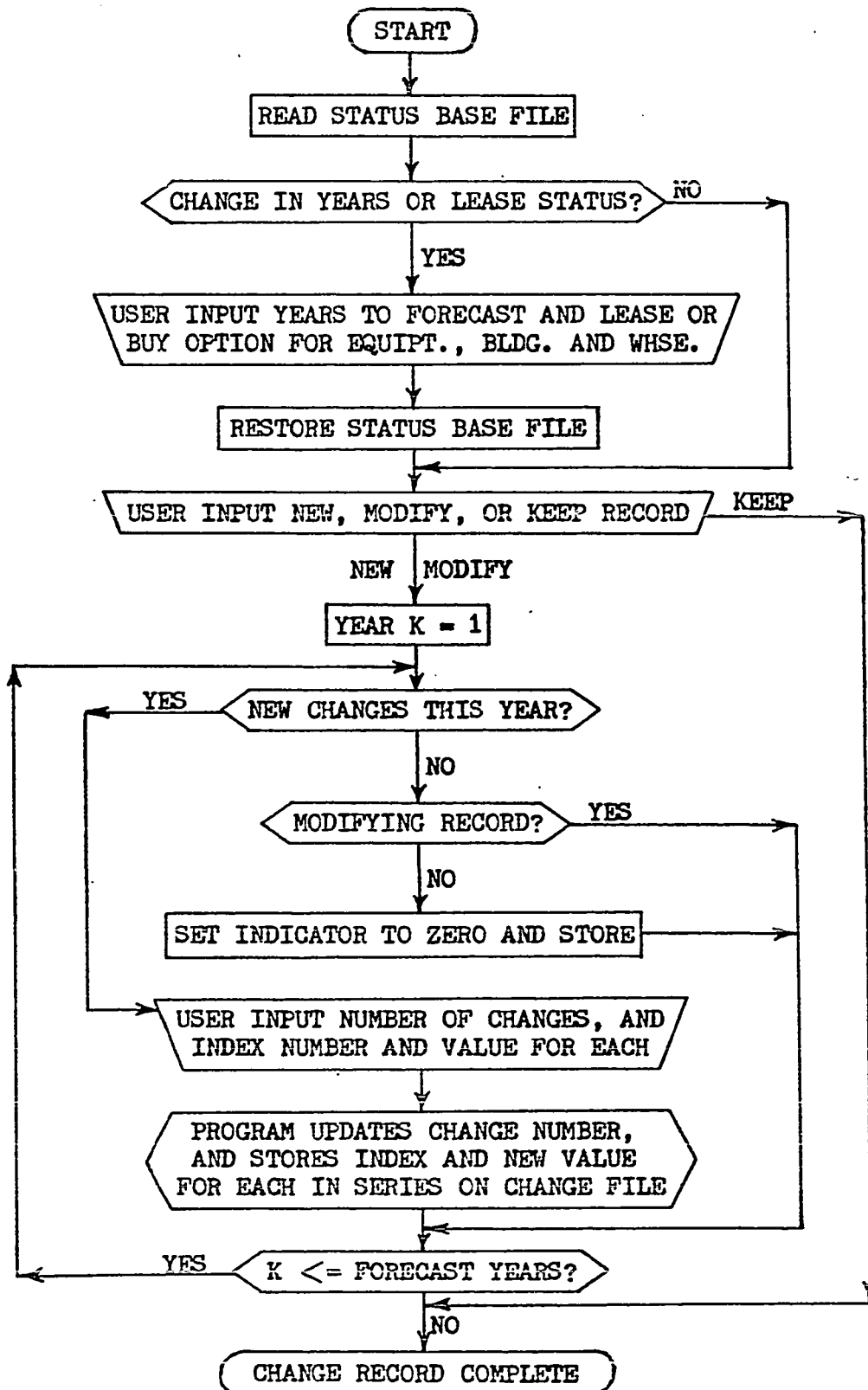
RECORDS		
1 to 4	-	For Year 1
5 to 8	-	For Year 2
9 to 12	-	For Year 3
13 to 16	-	For Year 4
17 to 20	-	For Year 5

The first entry for each year is a count of the number of changes stored. This is followed by a sequential list of index numbers and change values.

Four records are enough to store 128 numbers: less 1 for the counter leaves 127. Thus 63 changes (126 numbers) can be stored for each forecast year.

MODIFICATIONS

MODEL CHANGE COMPONENT FLOW DIAGRAM



MODEL CHANGE COMPONENT COMPUTER PROGRAM

```

10 FILES CHANGE,PARAM
15 DIM A$(3),D$(6),Z(5),N(12),L$(12)
20 DIM I(63),Y(63),S(15),U(15)
25 MAT READ #2,1;N(12)
30 READ #2;L$
35 MAT READ #2;S(15),U(15)
40 PRINT "CHANGE IN YEARS, LEASE STATUS OR CHANGE OPTION ";
45 INPUT AS
50 IF A$(1,2)="NO" THEN 115
55 PRINT "HOW MANY YEARS WILL YOU FORECAST ";
60 INPUT N(1)
65 PRINT "WILL YOU LEASE EQUIPT, BLDG AND/OR WHSE"
70 INPUT L$(1,3)
75 INPUT L$(4,6)
80 INPUT L$(7,9)
85 PRINT "WILL YOU ENTER EXTRA CHANGES DURING MODEL RUN ";
90 INPUT L$(10,12)
95 REM RELOAD STATUS BASE PARAMETERS
100 MAT PRINT #2,1;N
105 PRINT #2;L$
110 MAT PRINT #2;S,U
115 PRINT
175 PRINT "NEW RECORD, MODIFY OR KEEP OLD ";
190 INPUT DS
195 IF D$(1,4)="KEEP" THEN 530
200 FOR K=1 TO N(1)
205 LET J=(K-1)*4+1
210 PRINT
215 PRINT "NEW CHANGES FOR YEAR";K;
220 INPUT AS
225 IF AS="YES" THEN 260
230 IF D$(1,3)="MOD" THEN 515
235 REM SET FOR NO CHANGES THIS YEAR
240 LET Z(K)=0
245 PRINT #1,J;Z(K)
250 GOTO 515
255 REM UPDATE THE CHANGE PARAMETER FILE
260 IF D$(1,3)="MOD" THEN 275
265 LET Z(K)=0
270 GOTO 300
275 READ #1,J;Z(K)
280 IF Z(K)=0 THEN 300
285 FOR J3=1 TO Z(K)
290 READ #1;I(J3),Y(J3)
295 NEXT J3
300 PRINT

```


Model Change Component (cont'd)

```

305 PRINT "YOU HAVE A RECORD OF";Z[K];"OLD ";
310 PRINT "CHANGES AND CAN ADD UP TO";63-Z[K];"NEW ONES"
315 PRINT
320 PRINT "HOW MANY CHANGES WILL YOU ENTER NOW ";
325 INPUT I1
330 IF I1#0 THEN 355
335 PRINT "DID YOU INTEND TO ENTER ZERO CHANGES ";
340 INPUT A$
345 IF A$="YES" THEN 515
350 GOTO 315
355 PRINT
360 PRINT "ENTER INDEX NO. AND NEW VALUE FOR EACH"
365 FOR I2=1 TO I1
370 INPUT I3,C1
375 IF Z[K]#0 THEN 400
380 REM ENTERING FIRST NEW CHANGE
385 GOSUB 735
390 GOTO 485
395 REM CHECK FOR REPLACING OLD CHANGE
400 FOR J1=1 TO Z[K]
405 IF I[J1]#I3 THEN 465
410 REM CHECK FOR DELETING OLD CHANGE
415 IF C1#0 THEN 455
420 FOR J2=J1+1 TO Z[K]
425 LET I[J2-1]=I[J2]
430 LET Y[J2-1]=Y[J2]
435 NEXT J2
440 LET Z[K]=Z[K]-1
445 GOTO 485
450 REM REPLACE OLD CHANGE VALUE
455 LET Y[J1]=C1
460 GOTO 485
465 NEXT J1
470 REM ADD CHANGE TO PREVIOUS RECORD
475 GOSUB 560
480 GOTO 14 OF 400,485
485 NEXT I2
490 REM STORE CHANGE RECORD
495 PRINT #1,J;Z[K]
500 FOR J3=1 TO Z[K]
505 PRINT #1;I[J3],Y[J3]
510 NEXT J3
515 PRINT
520 PRINT "CHANGE RECORD SET FOR YEAR";K
525 NEXT K
530 PRINT
535 PRINT "THE RECORD OF CHANGE PARAMETER VALU";
540 PRINT "ES HAS NOW BEEN SET UP FOR A NEW RUN"
545 PRINT "OF THE KEMP PRODUCTS COMPANY MODEL"
550 STOP

```

Model Change Component (cont'd)

```
555 REM CHECK FOR CHANGE LIMIT
560 IF Z[K]=63 THEN 630
565 IF Z[K]=62 THEN 585
570 GOSUB 735
575 LET I4=2
580 RETURN
585 PRINT
590 PRINT "WARNING***ONLY THE LAST CHANGE YOU ";
595 PRINT "ENTERED WILL BE ACCEPTED AS A NEW CHANGE"
600 PRINT "***ALL FUTURE CHANGES FOR YEAR";K;"CAN";
605 PRINT " ONLY BE REPLACEMENTS OF OLD CHANGE"
610 PRINT "PARAMETER VALUES"
615 GOSUB 735
620 LET I4=2
625 RETURN
630 PRINT
635 PRINT "YOU ARE TRYING TO ADD A 64TH CHANGE IN ";
640 PRINT "YEAR";K;".. IT WILL NOT BE ACCEPTED"
645 PRINT "UNLESS YOU CHANGE THE INDEX NO. TO REPL";
650 PRINT "ACE A PREVIOUS CHANGE"
655 PRINT
660 PRINT "WILL YOU REENTER THE CHANGE WITH AN ";
665 PRINT "EXISTING CHANGE INDEX NO. ";
670 INPUT AS
675 IF AS#"YES" THEN 705
680 PRINT
685 PRINT "ENTER NEW INDEX NO. AND CHANGE VALUE";
690 INPUT I3,C1
695 LET I4=1
700 RETURN
705 PRINT
710 PRINT "THE CHANGE YOU ATTEMPTED TO ENTER HAS ";
715 PRINT "BEEN DELETED--PLEASE CONTINUE"
720 LET I4=2
725 RETURN
730 REM ADD A NEW CHANGE TO THE RECORD
735 LET Z[K]=Z[K]+1
740 LET I[Z[K]]=I3
745 LET Y[Z[K]]=C1
750 RETURN
755 END
```

SALES COMPONENT

Program Name: SALES

Purpose:

This program is used with the AMEND subroutine to update the sales forecasts (and other product group values) and to calculate the selling expenses items for each year evaluated by the model.

Operation:

When run this program first initializes the Status variables accumulators. Only the INCOM component does not affect the status variables. Therefore, all components must be run in the SALES, PRODN, MANFG, ADMIN and INCOM sequence when any new value is to be calculated in any of the first four components. Otherwise the results printed out will not be correct.

The key input for this program is new sales forecast information (a dollar lump sum or percent growth change for any or all products). However, changes can be used to affect the calculation of any values in the component (see the Index).

Variable Contents:

This program has 5 product variables (the P(I,L)'s for up to eight products), 7 operating variables (F(I)'s) and 2 internal variables (T(I)'s). It also affects status variables (S(I)'s) #1, 2, 3, 13 and 14.

Procedure: Load and run as follows:

GET - SALES
APP - AMEND
RUN

Storage of Results:

The computed values are stored on the RESULTS file in 2 records per year starting with record #6. That is, the values are stored in records no. 6 through 15.

Sales Variables ListingProduct Variables

P(1,L)	Product Sales Forecast
P(2,L)	Desired Product Selling Expenses Level
P(3,L)	Desired Product Admin. Expenses Level
P(4,L)	Product Selling Price per Pallet
P(5,L)	Product Sales Pallets

Operating Variables

F(1)	Total Selling Expenses
F(2)	Number of Salaried Sales Personnel
F(3)	Total Sales Salaries
F(4)	Sales Auto Leases and Travel Expenses
F(5)	Total Sales Commissions
F(6)	Freight-Out Charged
F(7)	Advertising and Promotion Expenses

Internal Variables

T(1)	Total Expenses Difference from Desired Level
T(2)	Percentage Difference from Desired.

Status Variables Affected

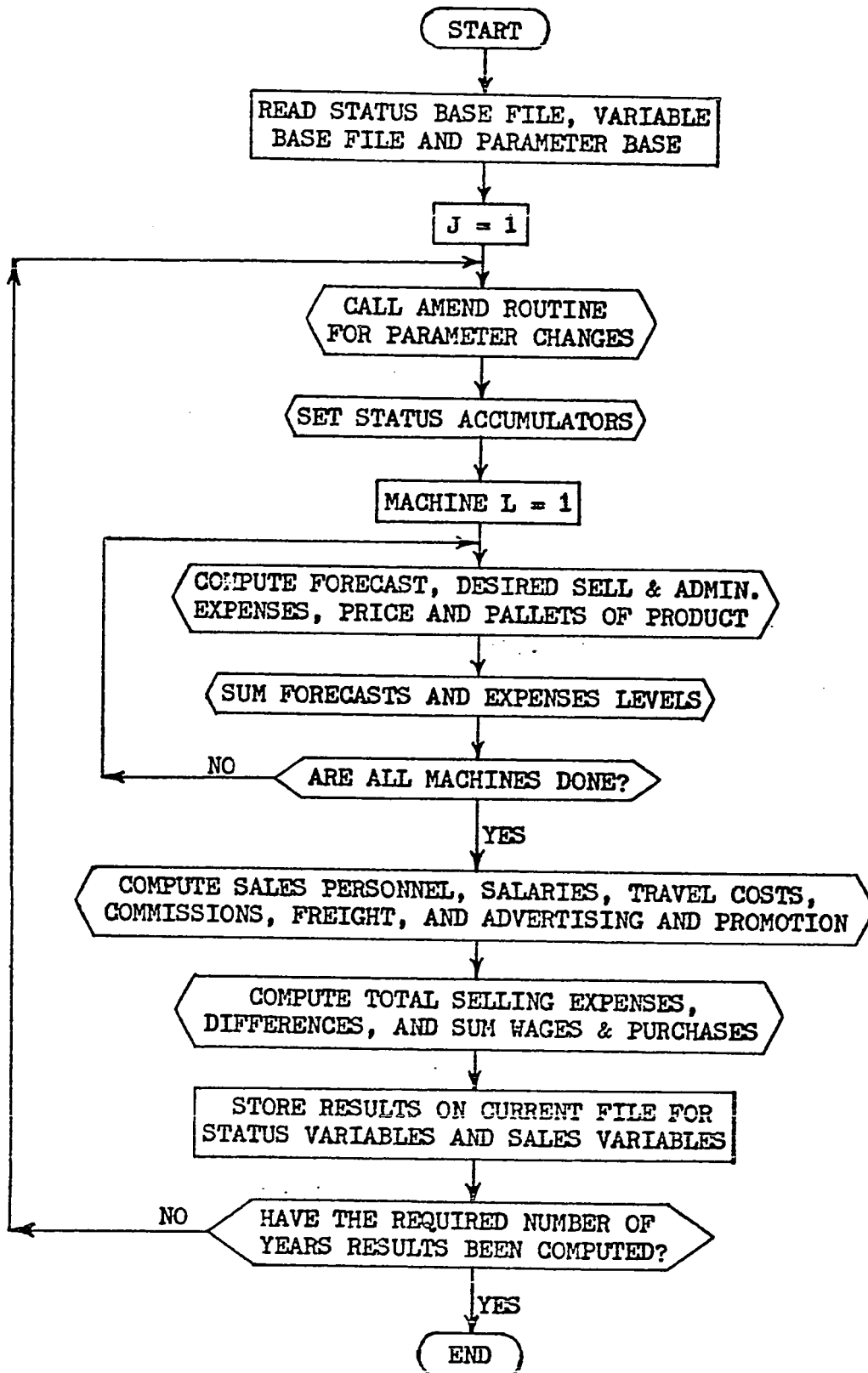
S(1)	Total Desired Selling Expenses
S(2)	Total Desired Admin. Expenses
S(3)	Total Gross Sales Forecast
S(13)	Total Wages and Salaries
S(14)	Total Source of Payables

Product Groups Are: (Indicates types in May 1971)

1	=	Machines #1, 6
2	=	Machines #5, 7, 12, 13, 14
3	=	Machines #9, 11
4	=	Machines #8
5	=	Machine #10
6	=	Blow Moulding
7	=	Injection - Blow Moulding
8	=	(Not used)

MODIFICATIONS

SALES COMPONENT FLOW DIAGRAM



SALES COMPONENT COMPUTER PROGRAM

```

10  FILES PARAM,CHANGE,RESULT
15  DIM P[5,8],A[5,8],C[5,8]
20  DIM F[7],D[7],G[7]
25  DIM S[15],U[15],W[15]
30  DIM Z[5],AS[3],N[12],LS[12]
35  DIM T[2]
40  MAT READ #1,I;N[12]
45  READ #1;LS
50  MAT READ #1;S[15],U[15]
55  REM TO READ INITIAL VALUES & CHANGE INDICATOR
60  READ #1,N[3]
65  MAT READ #1;P[5,8],F[7],T[2]
70  MAT READ #1;A[5,8],D[7]
75  LET K=10000
80  REM TO COMMENCE YEARLY COMPUTATIONS
85  FOR J=1 TO N[1]
90  REM TO INITIALIZE CHANGE PARAMETERS
95  MAT C=ZER
100 MAT G=ZER
105 MAT W=ZER
110 GOSUB 3000
115 REM TO SET ACCUMULATORS
120 LET S[1]=S[2]=S[3]=S[13]=S[14]=0
125 REM COMPUTE BY MACHINE TYPE
130 FOR L=1 TO 8
135 IF P[1,L]=0 AND C[1,L]=0 THEN 195
140 REM COMPUTE FORECAST, AND SELL & ADMIN EXP. DESIRED
145 FOR I=1 TO 3
150 LET P[I,L]=INT(A[1,L]*P[1,L]+C[1,L]+.5)
155 NEXT I
160 REM PRICE AND PALLETS FORECAST
165 LET P[4,L]=A[4,L]*P[4,L]+C[4,L]
170 LET P[5,L]=P[1,L]*1000/P[4,L]
175 REM TO ACCUM SUMS--SALES, SELL, ADMIN
180 LET S[3]=S[3]+P[1,L]
185 LET S[1]=S[1]+P[2,L]
190 LET S[2]=S[2]+P[3,L]
195 NEXT L
200 REM SALES SALARIES AND TRAVEL COSTS
205 LET F[2]=F[2]+G[2]
207 LET D[2]=D[2]*D[3]
210 LET F[3]=INT(D[2]*F[2]+G[3]+.5)
215 LET F[4]=INT(D[4]*F[2]+G[4]+.5)
220 REM COMMISSIONS, FREIGHT, & ADVERTISING
225 FOR I=5 TO 7
230 LET F[I]=INT(D[I]*S[3]+G[I]+.5)
235 NEXT I

```

Sales Component (cont'd)

```
240 REM CUMULATE SELL EXPENSES
245 LET F[1]=0
250 FOR I=3 TO 7
255 LET F[1]=F[1]+F[I]
260 NEXT I
265 REM EXPENSE DIFF AND %D FROM DESIRED
270 LET T[1]=F[1]-S[1]
275 LET T[2]=T[1]*100/S[1]
280 REM CUMULATE WAGES AND PAYABLES
285 LET S[13]=S[13]+F[3]+F[5]
290 LET S[14]=S[14]+F[4]+F[6]+F[7]
295 REM TO STORE RESULTS
300 READ #3,N[4]+(J-1)*2
305 MAT PRINT #3;P,F,T
310 MAT PRINT #3,N[2]+J-1;S
315 REM END OF SALES YEAR
320 NEXT J
325 STOP
710 REM THIS IS A DUMMY
830 REM ANOTHER DUMMY
```

PRODUCTION COMPONENT

Program Name: PRODN

Purpose:

This program is used with the AMEND subroutine to evaluate the physical facilities needed to meet any given set of sales forecasts. It also evaluates the costs of any equipment, plant or warehouse facilities to be purchased for predicted growth (or rental charges if the facilities are to be leased).

Operation:

When run this program first calculates any inventory change, using stated inventory policies, for each product. The change combined with sales volume determines the production volume in pallets. Production hours for each product group are then determined from the volume and a weighted average hours per pallet.

Given the production hours the number of each type of machine needed is calculated. The machines in each category are based on a desired loading of 4500 hours per year with a permitted maximum of 5000 hours. When the maximum load is exceeded in any group the program allows for load shifting--between groups #2 and #3 and groups #4 and #5 in the injection machines only. The model determines that machines should be added only to cover any over load that cannot be shifted with the provision that the maximum load for any group can be exceeded by 500 hours or less for the year without adding a machine. (That is, if one group--say blow moulding--has 3 machines and a load of 15500 hours no machines will be added, but if the load was 15510 hours the number of machines would be increased to 4.). The program determines the number of machines to add to keep the loading as close to 5000 hours per machine as possible. However, it does calculate the desired number of machines based on a 4500 hour loading so the managers can decide whether they wish to add more machines.

Once the number of machines is known for each group the program computes the necessary plant space. The program works with a desired and minimum (crowded conditions) space based on square foot factors for each machine type--the total space includes machines, aiseways, assembly, raw materials and supplies storage, work-in-process storage, tool storage and repair, quality control area, canteen and washrooms. It calls for an increase to the desired plant space level when the minimum space needed exceeds the available space.

Similarly, warehouse space is calculated. It is based on the number of pallets of inventory needed for each product group and the storage space per pallet (which is set for the maximum inventory level and actual pallet plus aisle space). The total warehouse space is comprised of the storage needs plus a fixed square foot allotment for office, shipping and receiving. An

increase is called for when the space needed exceeds the space available. When the machine and space needs are known the program calculates the costs associated with them (including installation costs for new machines).

The program then evaluates the work force needs. It has been set up to compute labour productivities by machine groups. Productivities are computed as the number of pallets per year for all workers associated with any machine type (machine operators and assembly workers). Productivities are initialized at a 1970 base rate and are all modified by one overall productivity growth factor. However, the computed figure for any machine group can be modified by entering a discrete change for labour productivity. (for example, if a 5% productivity increase applied to 6 machine groups but not to the 7th, productivity for the 7th group could be corrected by entering a discrete change that would decrease the number of pallets per worker by the appropriate amount). The program cumulates the total number of workers for the plant. It cannot provide a record of the number of workers needed for any particular product group. The computed work force size is used in the MANFG component to calculate the direct labour costs.

Variable Contents:

This program has 13 product variables (the P(I,L)'s for up to eight products), 9 operating variables (F(I)'s) and 6 internal variables (T(I)'s). It also affects status variables (S(I)'s) #4, 5, 6, 7, 8, 9, 10, 11 and 12.

Procedure:

Load and run as follows:

```
GET - PRODN
APP - AMEND
RUN
```

Storage of Results:

The computed values are stored on the RESULTS file in 4 records per year starting in record #16. That is, the values are stored in records no. 16 through 35.

Product Groups Are: (Indicates types in May 1971)

- 1 = Machines #1, 6
- 2 = Machines #5, 7, 12, 13, 14
- 3 = Machines #9, 11
- 4 = Machines #8
- 5 = Machines #10
- 6 = Blow Moulding
- 7 = Injection Moulding
- 8 = (Not used)

Production Variables ListingProduct Variables

P(1,L)	Pallets for Inventory
P(2,L)	Dollars (and Pallets) of Inventory Change
P(3,L)	Number of Pallets to Produce
P(4,L)	Production Hours
P(5,L)	Number of Machines Leased
P(6,L)	Lease Record Number
P(7,L)	Number of Machines Off Lease in Year
P(8,L)	Number of Machines Available
P(9,L)	Minimum Number of Machines Needed
P(10,L)	Desired Number of Machines
P(11,L)	Hours Transferred from Machine Group
P(12,L)	Desired Machine Group Plant Space
P(13,L)	Desired Product Warehouse Space (Net)

Operating Variables

F(1)	Minimum Plant Space Needed
F(2)	Total Plant Space Available
F(3)	Rented Plant Space
F(4)	Minimum Warehouse Space Needed
F(5)	Total Warehouse Space Available
F(6)	Rented Warehouse Space
F(7)	Total Annual Hours Available
F(8)	Maximum Production Hours per Machine
F(9)	Desired Production Hours

Internal Variables

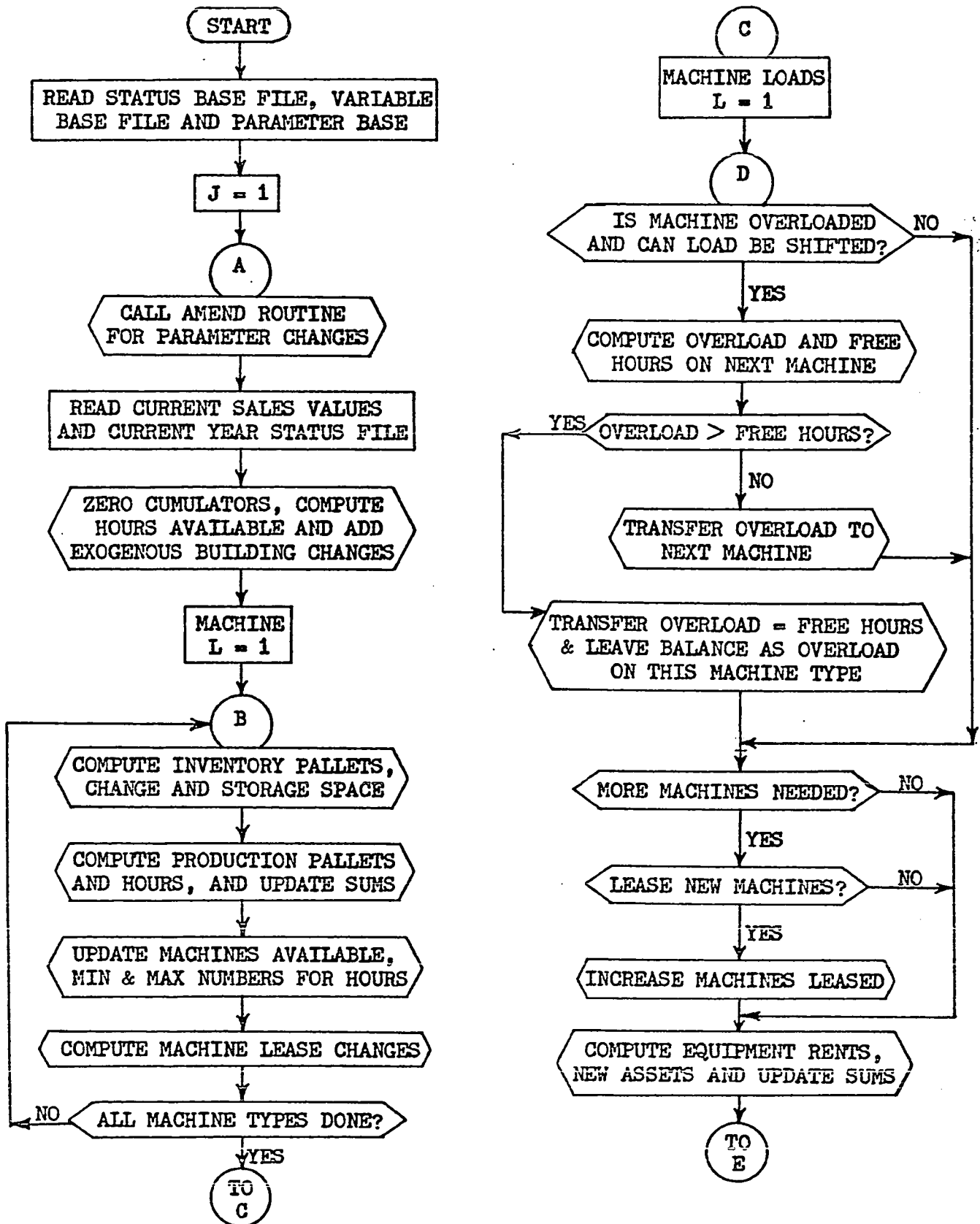
T(1)	Total Inventory Pallets
T(2)	Total Production Pallets
T(3)	Total Desired Plant Space
T(4)	Total Desired Warehouse Space (Net)
T(5)	New Plant Space in Year
T(6)	New Warehouse Space in Year

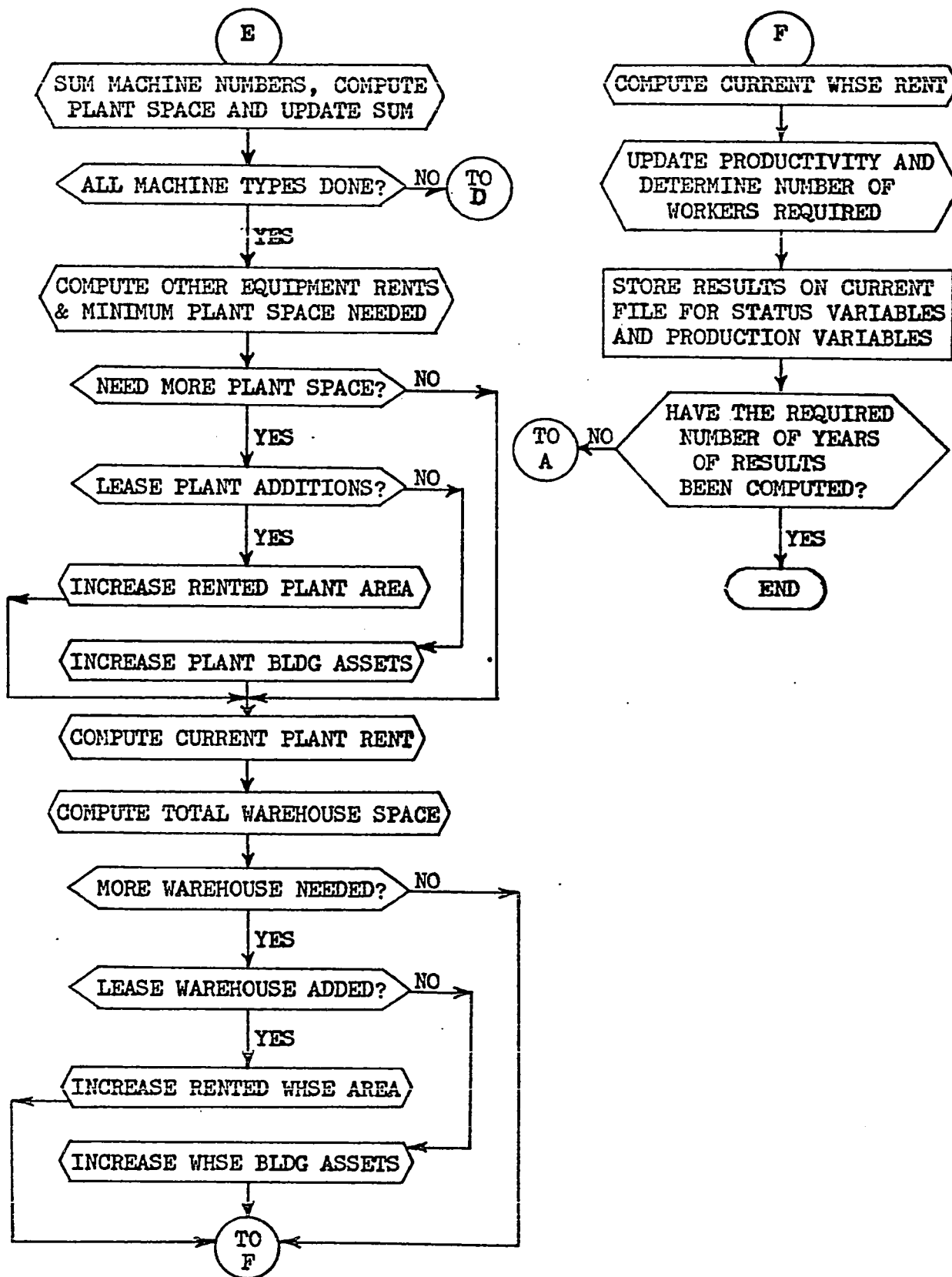
Status Variables Affected

S(4)	Total Gross Inventory Change Value
S(5)	Total Number of Workers
S(6)	Total Plant Rent
S(7)	Total Warehouse Rent
S(8)	Total Equipment Leases
S(9)	Total Number of Machines
S(10)	Building and Parking Lot Assets
S(11)	Warehouse Building Assets
S(12)	Equipment and Machine Assets

MODIFICATIONS

PRODUCTION COMPONENT FLOW CHART





PRODUCTION COMPONENT COMPUTER PROGRAM

```
10  FILES PARAM,CHANGE,RESULT
15  DIM P[13,8],A[13,8],C[13,8]
20  DIM F[9],D[9],G[9]
25  DIM S[15],U[15],W[15]
30  DIM Z[5],A$[3],N[12],L$[12]
32  DIM T[6],Q[5,8],X[3]
35  MAT READ #1,1;N[12]
37  READ #1;L$
40  MAT READ #1;S[15],U[15]
75  REM TO READ INITIAL VALUES & CHANGE INDICATOR
77  READ #1,N[5]
80  MAT READ #1;P[13,8],F[9],T[6]
85  MAT READ #1;A[13,8],D[9]
90  LET K=20000
95  REM TO COMMENCE YEARLY COMPUTATIONS
100 FOR J=1 TO N[1]
105 REM TO INITIALIZE CHANGE PARAMETERS
115 MAT C=ZER
125 MAT G=ZER
135 MAT W=ZER
140 GOSUB 3000
145 FOR I=1 TO 3
150 LET X[I]=S[I+9]
155 NEXT I
325 REM LOAD SALES AND STATUS INFO
327 READ #3,N[4]+(J-1)*2
330 MAT READ #3;Q[5,8]
345 MAT READ #3,N[2]+J-1;S
347 FOR I=1 TO 3
349 LET S[I+9]=X[I]
351 NEXT I
355 REM TO SET CUMULATORS TO ZERO
360 MAT T=ZER
365 LET S[4]=S[8]=S[9]=0
370 REM TO ADD EXOGENOUS WHSE & PLANT SPACE CHANGES
375 LET F[5]=F[5]+G[5]
380 LET F[2]=F[2]+G[2]
425 REM TO SET PRODN HOURS--AVAIL, MAX, DESIRED
430 LET F[7]=F[7]+G[7]
435 FOR I=8 TO 9
440 LET F[I]=INT(D[I]*F[7]+G[I]+.5)
445 NEXT I
450 REM COMPUTE BY MACHINE TYPE
455 FOR L=1 TO 8
480 REM CHECK FOR UNUSED MACHINE
485 IF Q[5,L]=0 THEN 655
```

Production Component (cont'd)

```

490 REM PALLETS FOR INV. & INV. CHG.
495 LET P1=P[1,L]
500 LET P[1,L]=A[1,L]*Q[5,L]+C[1,L]
505 LET T[1]=T[1]+P[1,L]
510 LET P[2,L]=P[1,L]-P1
515 REM DESIRED WAREHOUSE SPACE (NET)
520 LET P[13,L]=A[13,L]*P[1,L]+C[13,L]
525 LET T[4]=T[4]+P[13,L]
530 REM TOTAL PALLETS & HOURS OF PRODN
535 LET P[3,L]=P[2,L]+Q[5,L]
540 LET T[2]=T[2]+P[3,L]
545 LET P[4,L]=INT(A[4,L]*P[3,L]+C[4,L]+.5)
550 REM GROSS VALUE OF INV. CHG.
555 LET P[2,L]=INT(P[2,L]*Q[4,L]/1000+.5)
560 LET S[4]=S[4]+P[2,L]
562 REM EXOG CHG IN M/C LEASED
563 LET P[5,L]=P[5,L]+C[2,L]
565 REM NO. OF M/C AVAIL & NEEDED
570 LET P[8,L]=P[8,L]+C[8,L]
575 LET P[9,L]=P[4,L]/F[8]
580 LET P[10,L]=P[4,L]/F[9]
585 REM TO COMPUTE M/C OFF LEASE THIS YEAR
590 LET P2=P[7,L]=0
592 LET P[6,L]=P[6,L]+C[6,L]
595 IF P[6,L]=0 THEN 655
600 FOR I=1 TO P[5,L]
605 LET P2=P2+10*(P[5,L]-I)
610 NEXT I
615 REM NEW LEASE RECORD
620 LET P[6,L]=P[6,L]-P2
625 LET P3=10*(P[5,L]-1)
630 IF P[6,L] >= P3 THEN 655
635 LET P[5,L]=P[5,L]-1
640 LET P[7,L]=P[7,L]+1
645 IF P[5,L]=0 THEN 655
650 GOTO 625
655 NEXT L
660 REM TO CHECK M/C LOADS & SHIFTS
665 FOR L=1 TO 8
670 LET P[11,L]=0
675 IF Q[5,L]=0 THEN 950
680 IF L >= 6 THEN 820
685 REM TO CHECK FOR M/C OVERLOAD
690 IF P[8,L] >= P[9,L] THEN 820
695 GOTO L OF 820,705,730,705,730
700 REM CHECK FOR SHIFT TO HIGHER M/C
705 LET P3=P[8,L+1]*F[8]-P[4,L+1]
710 REM THIS IS A DUMMY
715 IF P3 <= 0 THEN 820
720 GOTO 745

```

Production Component (cont'd)

```

725  REM CHECK FOR SHIFT TO LOWER M/C & HOURS FREE
730  LET P3=P[8,L-1]*F[8]-P[4,L-1]
735  IF P3 <= 0 THEN 820
740  REM DET. AMT. OF DESIRED SHIFT
745  LET P4=P[4,L]-P[8,L]*F[8]
750  IF P4>P3 THEN 780
755  REM TRANSFER ALL HOURS
760  LET P[11,L]=P4
765  LET P[9,L]=P[8,L]
770  GOTO 820
775  REM TRANSFER LESS THAN MAX HOURS
780  LET P4=P4-P3
785  LET P[9,L]=P[8,L]+INT(P4/F[8]+.979)
790  LET P4=P[4,L]-P[9,L]*F[8]
795  LET P[10,L]=P[9,L]
800  REM CHECK FOR NIL TRANSFER
805  IF P4 <= 0 THEN 820
810  LET P[11,L]=P4
815  REM CHECK FOR ADDED M/C
820  LET P5=0
825  LET P[10,L]=INT(P[9,L]+.8999)
830  IF P[8,L] >= P[10,L] THEN 890
835  IF P[8,L] >= P[9,L] THEN 890
840  REM NO. OF M/C TO ADD
845  LET P5=P[10,L]-P[8,L]
850  LET P[8,L]=P[10,L]
852  IF P5=0 THEN 890
855  IF L$[1,3]#"YES" THEN 890
860  REM TO CHANGE LEASE RECORD & NO. LEASED
865  FOR I=1 TO P5
870  LET P[6,L]=P[6,L]*10+5
875  NEXT I
880  LET P[5,L]=P[5,L]+P5
885  REM TO COMPUTE RENT FOR MACHINES
890  LET S[8]=S[8]+A[5,L]*P[5,L]+C[5,L]
895  REM TO UPDATE EQUIPT ASSETS
900  LET S[12]=S[12]+A[7,L]*P[7,L]+C[7,L]
905  LET S[12]=S[12]+A[9,L]*P5+C[9,L]
910  IF L$[1,3]="YES" THEN 935
915  REM TO ADD NEW M/C VALUES
920  LET S[12]=S[12]+A[10,L]*P5+C[10,L]
930  REM TO SUM MACHINES & PLANT SPACE
935  LET S[9]=S[9]+P[8,L]
940  LET P[12,L]=A[12,L]*P[8,L]+C[12,L]
945  LET T[3]=T[3]+P[12,L]
950  NEXT L
952  LET S[12]=INT(S[12]+W[12]+.5)
955  REM TO ADD RENT OF OTHER EQUIPT.
960  LET S[8]=S[8]+U[8]
965  LET S[8]=INT(S[8]+.5)

```

Production Component (cont'd)

```

970  REM TO COMPUTE PLANT SPACE NEEDS
975  LET F[1]=D[1]*T[3]+G[1]
980  LET T[5]=T[5]+G[2]
985  IF F[2] >= F[1] THEN 1005
990  REM COMPUTE NEW PLANT SPACE
995  LET T[5]=T[5]+T[3]-F[2]
1000 LET F[2]=F[2]+T[5]-G[2]
1005 IF LS[4,6]#"YES" THEN 1035
1010 REM RENTED PLANT AREA & NEW BLDG ASSETS
1015 LET F[3]=F[3]+T[5]
1020 LET S[10]=S[10]+W[10]
1025 GOTO 1055
1030 REM INCREASE BLDG ASSETS
1035 LET S[10]=S[10]+INT(U[10]*T[5]+W[10]+.5)
1040 REM TOTAL PLANT RENT & ASSETS CHANGE
1045 LET F[3]=F[3]-G[3]
1050 LET S[10]=S[10]+INT(D[3]*G[3]+.5)
1055 LET S[6]=INT(U[6]*F[3]+W[6]+.5)
1060 REM TO COMPUTE WAREHOUSE SPACE NEEDS
1065 LET F[4]=T[4]+D[4]
1070 LET T[6]=T[6]+G[5]
1075 IF F[5] >= F[4] THEN 1095
1080 REM COMPUTE NEW WHSE SPACE
1085 LET T[6]=T[6]+F[4]-F[5]
1090 LET F[5]=F[5]+T[6]-G[5]
1095 IF LS[7,9]#"YES" THEN 1125
1100 REM RENTED WHSE AREA & NEW WHSE ASSETS
1105 LET F[6]=F[6]+T[6]
1110 LET S[11]=S[11]+W[11]
1115 GOTO 1145
1120 REM TO INCREASE WHSE BLDG ASSETS
1125 LET S[11]=S[11]+INT(U[11]*T[6]+W[11]+.5)
1130 REM TOTAL WHSE RENT & ASSET CHG
1135 LET F[6]=F[6]-G[6]
1140 LET S[11]=S[11]+INT(D[6]*G[6]+.5)
1145 LET S[7]=INT(U[7]*F[6]+W[7]+.5)
1150 REM TO COMPUTE NO. OF WORKERS
1152 LET S[5]=0
1153 FOR L=1 TO 8
1155 LET A[3,L]=A[3,L]+A[2,1]+C[3,L]
1157 LET S[5]=S[5]+P[3,L]/A[3,L]
1158 NEXT L
1160 REM TO STORE RESULTS
1170 READ #3,N[6]+(J-1)*4
1175 MAT PRINT #3;P,F,T
1180 MAT PRINT #3,N[2]+J-1;S
1185 REM END OF PRODN YEAR
1190 NEXT J
1195 STOP

```


MANUFACTURING COMPONENT

Program Name: MANFG

Purpose:

This program is used with the AMEND subroutine to calculate all items for the manufacturing costs and the mould division costs statements. It includes all costs of sales (except Freight-Out) and calculates gross margins assuming sales equal to forecast.

Operation:

When run this program first updates the supervisory and service personnel numbers in accordance with changes that have been entered. It then calculates average salary and wage rates at stated growth rates. These average rates are used to determine total supervisor salaries, service wages and direct labour costs in accordance with the number of people in each category.

The program takes gross sales as given, computes royalties and mould charges, and determines the appropriate net sales value. It also updates prepaid mould expenses. The program uses gross sales plus the gross value of the inventory change as the gross production value to be used in computing other costs. The net value of the inventory change is determined by reducing the gross value by a percentage (currently 25%) for the desired gross margin. The raw materials costs, factory and mould supplies, and repairs and maintenance are evaluated next as proportions of the gross production value.

The program then updates other service and miscellaneous costs and rents (if any) for building, equipment and warehouse. It computes a utilities cost based on the total number of machines, and then employee benefits as a proportion of total wages and salaries. It completes the manufacturing cost items by evaluating depreciation charges, total overhead costs, research and development costs transferred, total cost of sales and manufacturing gross profits. This part of the program also determines the plant, warehouse and equipment net assets balances and updates the status variable values.

The program then updates mould purchases and mould inventory change, and computes mould revenues as being 111% of the resulting mould costs. It updates engineering wages, travel costs and total expenses and determines the resulting mould division gross profits. The program then updates the sums for total wages and source of payables for each forecast year.

Variable Contents:

This program has 40 operating variables (F(I)'s), 4 internal variables (T(I)'s), and uses or modifies 13 status variables (S(I)'s)--all except status variables #1 and 2.

Procedure:

Load and run as follows:

GET - MANFG
APP - AMEND
RUN

Storage of Results:

The computed values are stored on the RESULTS file in 2 records per year starting in record #36. That is, the values are stored in records no. 36 through 45.

Manufacturing Variables Listing

F(3)	Total Gross Sales
F(4)	Royalties Charges
F(5)	Mould Charges
F(6)	Net Sales
F(7)	Total Cost of Sales
F(8)	Manufacturing Gross Profit
F(9)	Net Inventory Change Value (Manufacturing)
F(10)	Total Plant Overhead
F(11)	Research and Development Costs Transferred
F(12)	Building and Parking Assets (Net)
F(13)	Equipment and Machine Assets (Net)
F(14)	Building and Parking Depreciation
F(15)	Equipment Depreciation
F(16)	Total Supervisor Salaries
F(17)	Total Service Wages
F(18)	Factory and Mould Supplies Cost
F(19)	Plant and Equipment Repairs and Maintenance
F(20)	Other Service and Miscellaneous Costs
F(21)	Plant Building Rent
F(22)	Warehouse Rent
F(23)	Equipment and Machines Rent
F(24)	Fuel, Power and Water Utilities
F(25)	Manufacturing Employee Benefits
F(26)	Engineering Consulting
F(27)	Total Materials Costs
F(28)	Direct Labour Costs
F(29)	Number of Supervisors
F(30)	Number of Service Personnel
F(31)	Average Supervisor Salary
F(32)	Average Service Wage (Annual)
F(33)	Average Worker Wage (Annual)

Mould Division Operating Variables

F(1)	Mould Division Gross Profit
F(2)	Mould Inventory Change

F(34)	Total Mould Revenue
F(35)	Moulds Purchased
F(36)	Total Cost of Moulds
F(37)	Net Mould Revenue
F(38)	Engineering Wages
F(39)	Engineering Auto and Travel Expenses
F(40)	Total Engineering Expenses

Internal Variables

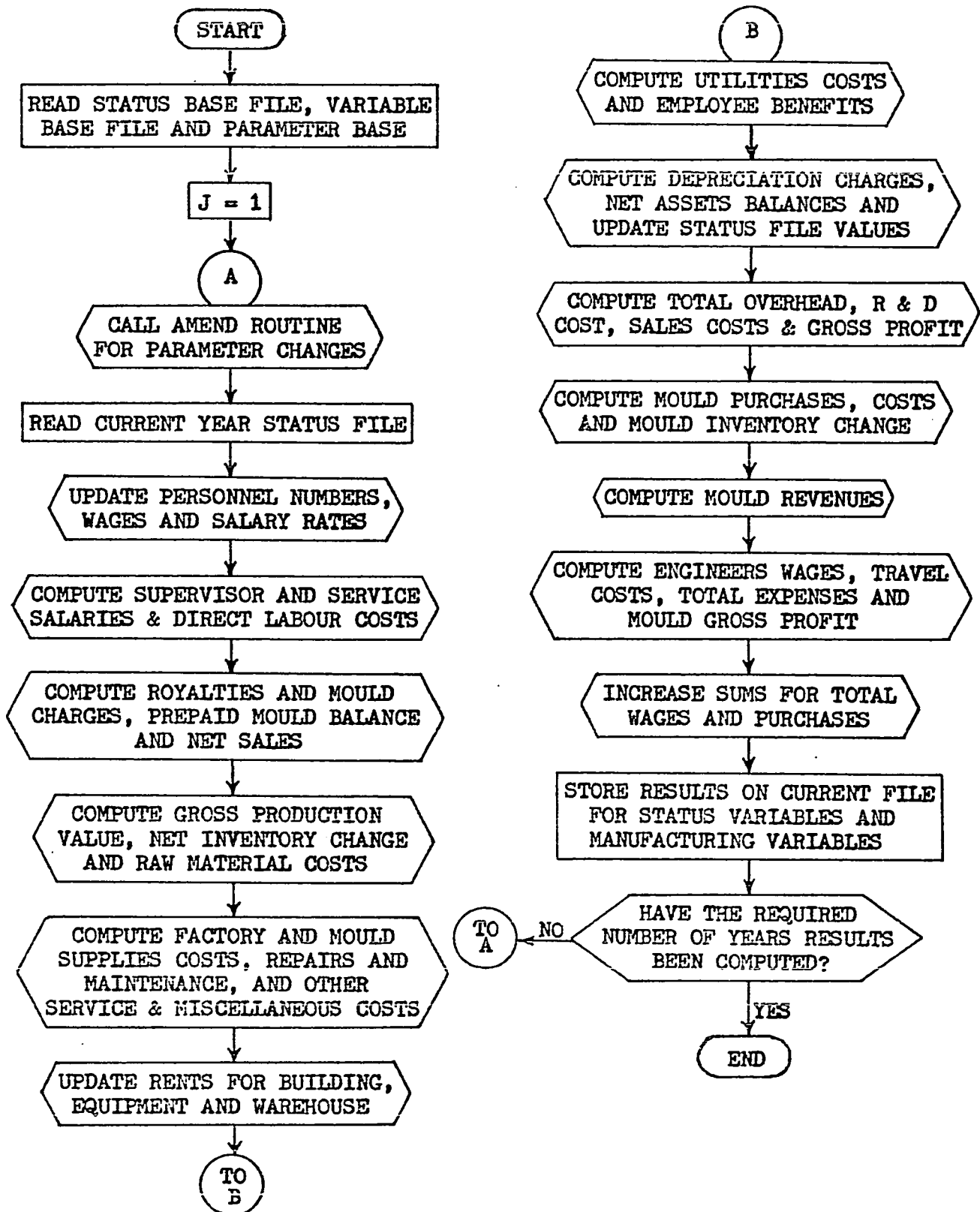
T(1)	Gross Production Value
T(2)	Plant Building and Parking Depreciation
T(3)	Warehouse Building Depreciation
T(4)	Total Royalties and Mould Charges

Status Variables Used or Affected

S(3)	Total Gross Sales Forecast
S(4)	Total Gross Inventory Change Value
S(5)	Total Number of Workers
S(6)	Total Plant Rent
S(7)	Total Warehouse Rent
S(8)	Total Equipment Leases
S(9)	Total Number of Machines
S(10)	Building and Parking Lot Assets (Net)
S(11)	Warehouse Building Assets (Net)
S(12)	Equipment and Machine Assets (Net)
S(13)	Total Wages and Salaries
S(14)	Total Source of Payables
S(15)	Prepaid Mould Expenses (Net)

MODIFICATIONS

MANUFACTURING COMPONENT FLOW DIAGRAM



MANUFACTURING COMPONENT COMPUTER PROGRAM

```

10  FILES PARAM,CHANGE,RESULT
20  DIM F[40],D[40],G[40]
25  DIM S[15],U[15],W[15]
30  DIM Z[5],A[3],N[12],L[12]
32  DIM T[4],X[3],Y[3]
33  DIM A[1,1],C[1,1]
35  MAT READ #1,1;N[12]
37  READ #1;L$
40  MAT READ #1;S[15],U[15]
75  REM TO READ INITIAL VALUES & CHANGE INDICATOR
77  READ #1,N[7]
80  MAT READ #1;F[40],T[4]
85  MAT READ #1;D[40]
90  LET H1=-59.629
91  LET H2=-1.156
93  LET H3=38.909
94  LET K=30000
95  REM TO COMMENCE YEARLY COMPUTATIONS
100  FOR J=1 TO N[1]
105  REM TO INITIALIZE CHANGE PARAMETERS
125  MAT G=ZER
130  MAT W=ZER
140  GOSUB 3000
145  FOR I=1 TO 3
150  LET Y[I]=S[I+9]
155  NEXT I
315  REM TO READ STATUS VAR. VALUES
317  LET X1=S[15]
320  MAT READ #3,N[2]+J-1;S
325  LET S[15]=X1
330  FOR I=1 TO 3
335  IF J>1 THEN 350
340  LET X[I]=S[I+9]
345  GOTO 365
350  IF S[I+9]=X[I] THEN 362
352  LET Y1=S[I+9]-X[I]
355  LET X[I]=S[I+9]
357  LET S[I+9]=Y[I]+Y1
360  GOTO 365
362  LET S[I+9]=Y[I]
365  NEXT I
370  MAT READ #3,N[4]+(J-1)*2;Q[1,8]
395  FOR I=29 TO 30
400  LET F[I]=F[I]+G[I]
405  NEXT I
410  REM TO UPDATE WAGE & SALARY RATES
415  FOR I=31 TO 33
420  LET F[I]=D[I]*F[I]+G[I]
425  NEXT I

```

Manufacturing Component (cont'd)

```

430 REM SUPERVISOR, SERVICE & LABOUR PAY
435 FOR I=16 TO 17
440 LET F[I]=INT(F[I+13]*F[I+15]+G[I]+.5)
445 NEXT I
450 LET F[28]=INT(F[33]*S[5]+G[28]+.5)
455 REM ROYALTIES & MOULD CHGS AND NET SALES
460 LET F[3]=S[3]
462 LET S[15]=S[15]+W[15]
463 LET F[5]=INT(D[5]*S[15]+G[5]+.5)
464 LET S[15]=S[15]-F[5]
465 LET F[4]=INT(D[4]*F[4]+G[4]+.5)
470 LET F[6]=F[3]-(F[4]+F[5])
475 REM GROSS INVENTORY + GROSS SALES & NET INV. CHG.
485 LET T[1]=F[3]+S[4]
490 LET F[9]=INT(D[9]*S[4]+G[9]+.5)
495 REM MATERIAL COSTS
500 LET F[27]=INT(H1+D[27]*T[1]+G[27]+.5)
505 REM F&M SUPPLIES AND REP & MAINT
510 LET F[18]=H3+D[18]*T[1]+G[18]
515 LET F[19]=INT(D[19]*F[18]+G[19]+.5)
520 LET F[18]=INT(F[18]-F[19]+.5)
525 REM OTHER SERVICE EXP & MISC
530 LET F[20]=F[20]+G[20]
535 REM BUILDING, WAREHOUSE, & EQUIPT RENTS
540 FOR I=21 TO 23
545 LET F[I]=S[I-15]
550 NEXT I
555 REM FUEL, POWER, WATER
560 LET F[24]=INT(D[24]*S[9]+G[24]+.5)
565 REM EMPLOYEE BENEFITS
570 LET F[25]=INT(H2+D[25]*(F[28]+F[16]+F[17])+G[25]+.5)
575 REM BLDG & WHSE DEPRECIATION & CHANGE STATUS
577 LET D1=D[12]-J
580 FOR I=2 TO 3
585 LET T[I]=S[I+8]/D1+G[12]
590 LET S[I+8]=S[I+8]-T[I]
595 NEXT I
600 LET F[14]=INT(T[2]+T[3]+.5)
605 LET F[12]=S[10]+S[11]
610 REM EQUIPT DEPR. & ASSETS & CHANGE STATUS
615 LET F[15]=INT(D[15]*S[12]+G[15]+.5)
620 LET S[12]=S[12]-F[15]
625 LET F[13]=S[12]
627 REM ENGINEERING CONSULTING
628 LET F[26]=INT(D[26]*F[26]+G[26]+.5)
630 REM TOTAL PLANT OVERHEAD
635 LET F[10]=0
640 FOR I=14 TO 26
645 LET F[10]=F[10]+F[I]
650 NEXT I

```

Manufacturing Component (cont'd)

```

655 REM R&D COSTS, COST OF SALES, AND GROSS PROFIT
660 LET F[11]=INT(D[11]*F[11]+G[11]+.5)
670 LET F[7]=F[10]+F[27]+F[28]-(F[9]+F[11])
675 LET F[8]=F[6]-F[7]
680 REM MOULD DIVISION COSTS
685 REM MOULD INV. CHG. & MOULD COSTS & PURCHASES
690 LET F[2]=INT(G[2]+.5)
695 LET F[36]=INT(D[36]*F[36]+G[36]+.5)
705 LET F[35]=F[36]+F[2]
710 REM MOULD REVENUE & NET MOULD REV.
715 LET F[34]=INT(D[34]*F[36]+G[34]+.5)
720 LET F[37]=F[34]-F[36]
725 REM ENG WAGES, TRAVEL COSTS & TOTAL EXPENSES
730 LET F[38]=INT(D[38]*F[38]+G[38]+.5)
735 LET F[39]=INT(D[39]*F[38]+G[39]+.5)
740 LET F[40]=F[38]+F[39]
745 REM MOULD GROSS PROFIT
750 LET F[1]=F[37]-F[40]
755 REM TO CUMULATE WAGES & PAYABLES
760 LET S[13]=S[13]+F[16]+F[17]+F[25]+F[26]+F[28]+F[38]
765 FOR I=18 TO 24
770 LET S[14]=S[14]+F[1]
777 NEXT I
780 LET S[14]=S[14]+F[27]+F[36]+F[39]
785 REM TO STORE RESULTS
790 READ #3,N[8]+(J-1)*2
795 MAT PRINT #3;F,T
800 MAT PRINT #3,N[2]+J-1;S
810 REM END OF MFG YEAR
815 NEXT J
820 STOP
825 REM PERCENT CHANGES
830 LET D[1]=D[1]*(1+C1)
835 IF I=25 THEN 860
837 IF I=18 THEN 870
850 LET H1=H1*(1+C1)
855 GOTO 3125
860 LET H2=H2*(1+C1)
865 GOTO 3125
870 LET H3=H3*(1+C1)
875 GOTO 3125

```

ADMINISTRATION COMPONENT

Program Name: ADMIN

Purpose:

This program is used with the AMEND subroutine to calculate all items for the general and administration expenses statement. It also updates office space and equipment needs and costs.

Operation:

When run this program first updates administrative and office personnel numbers in accordance with changes that have been entered. It then calculates average salaries and travel expenses at stated growth rates. These averages are used to determine total salaries and travel expenses in accordance with the number of people in the administration and office categories.

The program next calculates supplies, telephones, legal and sundry costs from the previous year's levels in accordance with a forecast growth rate and any decided, lump-sum changes. It then determines office space needs for personnel and any office building assets changes (or rental costs if space is being leased).

Office machine numbers; rents and assets are updated in accordance with changes entered (no growth factors are included). Then the program determines building and equipment depreciation charges and updates the assets balances. Administration employee benefits are next computed in relation to total salaries and total administration expenses are cumulated. Finally, the program assesses estimated expenses in relation to the desired level, and updates the sums for total company wages and source of payables for each forecast year.

Variable Contents:

This program has 21 operating variables (F(I)'s), 3 internal variables (T(I)'s), and uses or modifies 3 status variables (S(I)'s) numbered 2, 13 and 14.

Procedure:

Load and run as follows:
GET - ADMIN
APP - AMEND
RUN

Storage of Results:

The computed values are stored on the RESULTS file in 1 record per year starting in record #46. That is, the values are stored in records no. 46 through 50.

Administration Variables Listing:Operating Variables

F(1)	Total Administration Expenses
F(2)	Office Equipment Assets (Net)
F(3)	Office Building Assets (Net)
F(4)	Office Equipment Depreciation
F(5)	Office Building Depreciation
F(6)	Total Administration Salaries
F(7)	Total Office Salaries
F(8)	Total Travel Costs
F(9)	Supplies and Postage Costs
F(10)	Telephones and Telegrams Costs
F(11)	Legal and Audit Costs
F(12)	Sundry and Bad Debt Expenses
F(15)	Number of Executives
F(16)	Number of Office Personnel
F(17)	Total Office Space
F(18)	Rented Office Space
F(19)	Desired Office Space
F(20)	Office Equipment Rents
F(21)	Total Number of Office Machines

Internal Variables

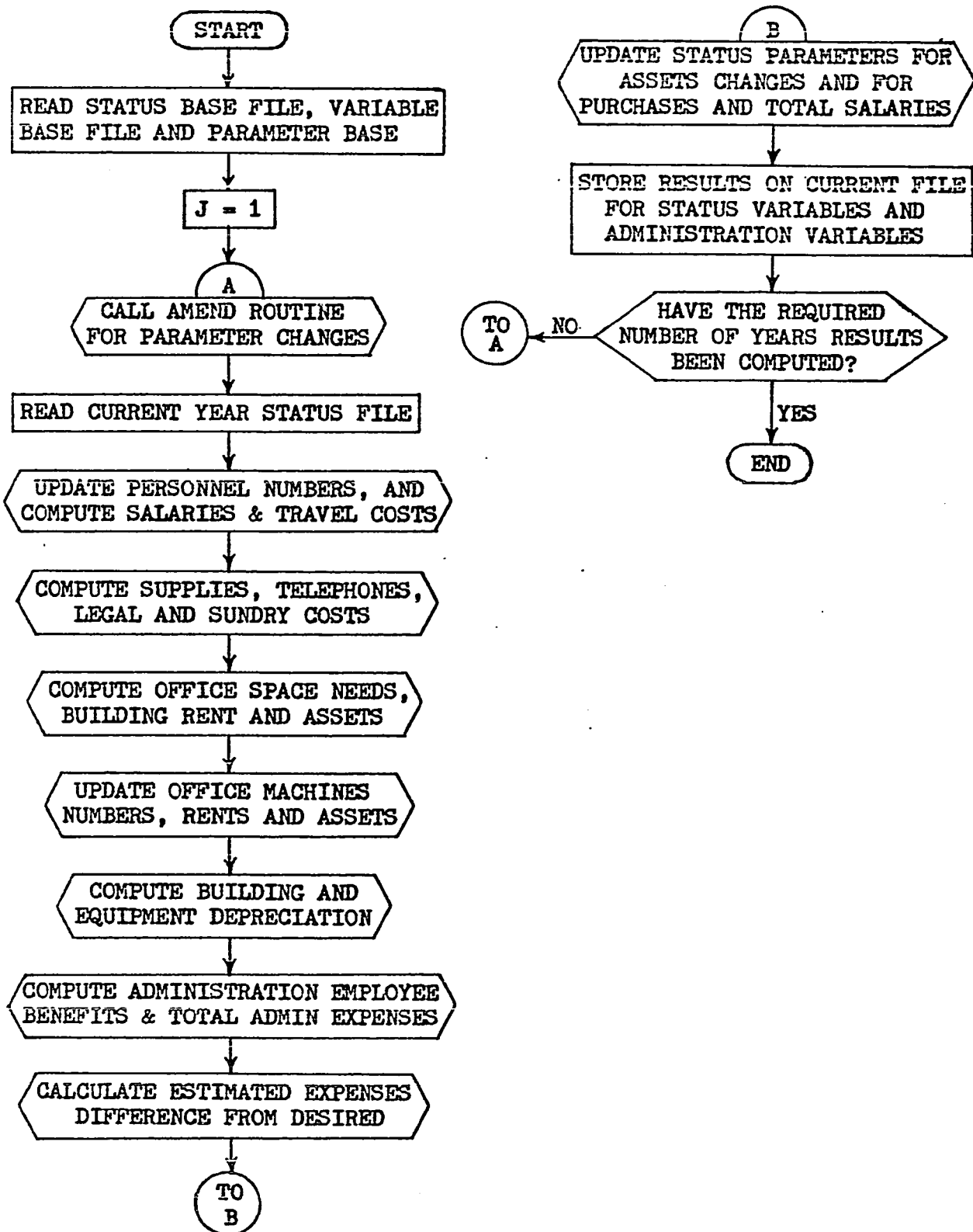
T(1)	Expenses Difference over Desired Level
T(2)	Percentage Expenses Difference
T(3)	New Office Space in Year

Status Variables Used and Affected

S(2)	Desired Administration Expenses Level
S(13)	Total Wages and Salaries
S(14)	Total Source of Payables

MODIFICATIONS

ADMINISTRATION COMPONENT FLOW DIAGRAM



ADMINISTRATION COMPONENT COMPUTER PROGRAM

```

10  FILES PARAM,CHANGE,RESULT
15  DIM F[21],D[21],G[21]
20  DIM S[15],U[15],W[15]
25  DIM Z[5],AS[3],N[12],LS[12]
30  DIM T[3]
35  DIM A[1,1],C[1,1]
40  MAT READ #1,1;N[12]
45  READ #1;LS
50  MAT READ #1;S[15],U[15]
55  REM TO READ INITIAL VALUES & CHANGE INDICATOR
65  READ #1,N[9]
70  MAT READ #1;F[21],T[3],D[21]
75  LET H1=2.375
80  LET H2=.2
85  LET H3=-2.142
90  LET K=40000.
95  REM TO COMMENCE YEARLY COMPUTATIONS
100 FOR J=1 TO N[1]
105 REM TO INITIALIZE CHANGE PARAMETERS
110 MAT G=ZER
115 GOSUB 3000
120 REM TO READ STATUS VAR. VALUES
125 MAT READ #3,N[2]+J-1;S
130 REM TO UPDATE PERSONNEL NUMBERS & CHANGE PARAMETERS
135 LET F[15]=F[15]+G[15]
140 LET F[16]=F[16]+G[16]
145 REM COMPUTE SALARIES & TRAVEL COSTS
150 FOR I=6 TO 7
155 LET D[I]=D[I]*D[I+9]
160 LET F[I]=INT(D[I]*F[I+9]+G[I]+.5)
165 NEXT I
170 LET H1=H1+G[8]
175 LET F[8]=INT(H1*F[15]+D[8]*(F[15]+F[16])+.5)
180 REM SUPPLIES, TELEPHONE, LEGAL, & SUNDRY
185 FOR I=9 TO 12
190 LET F[I]=INT(D[I]*F[I]+G[I]+.5)
195 NEXT I
200 REM OFFICE SPACE NEEDS
205 LET H2=H2+G[19]
210 LET F[19]=H2*F[15]+D[19]*(F[15]+F[16])
215 LET T[3]=T[3]+G[17]
220 LET F[17]=F[17]+G[17]
225 REM CHECK FOR GREATER SPACE NEEDS
230 IF F[17] >= F[19] THEN 245
235 LET T[3]=T[3]+F[19]-F[17]
240 LET F[17]=F[17]+T[3]-G[17]
242 LET F[18]=F[18]-G[18]
245 IF LS[4,6]# "YES" THEN 270

```

Administration Component (cont'd)

```

250 REM RENTED OFFICE AREA
255 LET F[18]=F[18]+T[3]
260 GOTO 280
265 REM TO INCREASE OFFICE BLDG ASSETS
270 LET F[3]=F[3]+INT(D[3]*T[3]+G[3]+.5)
275 REM OFFICE BLDG RENT
280 LET F[13]=D[13]*F[18]+G[13]
285 LET F[3]=F[3]+INT(D[18]*G[18]+.5)
290 REM OFFICE EQUIPT ASSETS, RENT, NUMBERS
295 LET F[2]=F[2]+G[2]
300 LET F[20]=D[20]*F[20]+G[20]
305 LET F[21]=F[21]+G[21]
307 LET F[13]=INT(F[13]+F[20]+.5)
310 REM BLDG & EQUIPT DEPR., & ASSETS ADJUSTMENT
312 LET D1=D[5]-J+1
315 LET F[5]=F[3]/D1+G[5]
317 LET F[3]=F[3]-F[5]
320 LET F[4]=D[4]*F[2]+G[4]
325 LET F[2]=F[2]-F[4]
335 REM EMPLOYEE BENEFITS
340 LET F[14]=INT(H3+D[14]*(F[6]+F[7])+G[14]+.5)
345 REM TOTAL ADMIN EXPENSES
350 LET F[1]=0
355 FOR I=4 TO 14
360 LET F[1]=F[1]+F[I]
365 NEXT I
370 REM DIFFERENCE & %DIFF OF ACTUAL/DESIRED EXP
375 LET T[1]=F[1]-S[2]
380 LET T[2]=T[1]*100/S[2]
385 REM TO INCREASE WAGES & PAYABLES
390 LET S[13]=S[13]+F[6]+F[7]+F[14]
395 FOR I=8 TO 13
400 LET S[14]=S[14]+F[I]
405 NEXT I
410 REM TO STORE RESULTS
415 READ #3,N[10]+(J-1)*1
420 MAT PRINT #3;F,T
425 MAT PRINT #3,N[21]+J-1;S
430 REM END OF ADMIN ROUTINE
435 NEXT J
440 STOP
445 REM PERCENT CHANGES
710 LET D[1]=D[1]*(1+C1)
715 LET H3=H3*(1+C1)
720 GOTO 3125
830 REM THIS IS A DUMMY

```

FINANCIAL COMPONENT

Program Name: INCOM

Purpose:

This program is used with the AMEND subroutine to calculate all items for the income statement, balance sheet and funds flow statements.

Operation:

When run this program first reads the financial results from the status variables list and the sales manufacturing and administration components. The gross and sales, manufacturing costs, gross profits, selling and administration expenses are entered; and operating profits determined. Other expenses, other income and before bonus profits are calculated next. Then administration bonus, before tax profits, income taxes and after tax income is calculated to complete the proforma income statement.

These results, along with those from other components, are used to determine assets balances. Current assets are established in accordance with management policies, fixed assets from changes previously determined and the balance cumulated. Next, current liabilities are determined in accordance with management policies and agreements made for the repayment of long-term financing. The debt payments due and any forecasted financing changes are used in calculating long-term debt balances for mortgages and debentures. Total equity capital is determined from common share changes, dividends and after tax income. Then the liabilities balance is cumulated.

Any difference between computed total assets and total liabilities is used to establish whether excess cash should be available (assets less than liabilities), or extra financing needed (assets greater than liabilities). The program uses the above result to estimate extra interest should be earned or paid. The interest estimate is then used to adjust the income statement and balance sheet for any change in income or expenses from interest.

When the final income statement and balance sheet is established, the program proceeds to compute fund sources and applications, and the working capital balance. Final financial results are then stored for reports.

Variable Contents:

In this program the designation of operating and internal variables was reversed relative to other component programs. There are 49 internal variables (designated F(I)'s), 49 operating variables (designated T(I)'s), and uses values from 10 status variables (S(I)'s) numbered 3, 6, 7, 8, 10, 11, 12, 13, 14 and 15.

Procedure:

Load and run as follows:

GET - INCOM
APP - AMEND
RUN

Storage of Results:

The computed values are stored on the RESULTS file in 4 records per year starting in record #51. That is, the values are stored in records no. 51 through 70.

Financial Variables Listings:Internal Variables Income Statement

F(1)	Total Gross Sales
F(2)	Total Royalties and Mould Charges
F(3)	Total Net Sales
F(4)	Total Cost of Sales
F(5)	Total Manufacturing Gross Profits
F(6)	Total Selling Expenses
F(7)	Total Administration Expenses
F(8)	Total Sell and Admin. Expenses
F(9)	Operating Profits
F(10)	Total Other Expenses
F(11)	R & D Amortization, Adjustments and Losses
F(12)	Net Profit
F(13)	Total Other Income
F(14)	Before Bonus Income
F(15)	Administration Salary Bonus
F(16)	Before Tax Profits
F(17)	Income Taxes
F(18)	After Tax Income

Operating Variables--Income Statement

T(1)	Gross Profit Percentage of Gross Sales
T(2)	Operating Profit Percent of Gross Sales
T(3)	Before Tax Profit Percent of Gross Sales
T(4)	After Tax Profit Percent of Gross Sales
T(5)	Bank Notes Interest
T(6)	Mortgage Interest
T(7)	Debenture Notes Interest
T(8)	Bank Exchange
T(9)	Discounts Given
T(10)	Insurance Premiums
T(11)	Research and Development Amortization
T(12)	Non-Cash Adjustments
T(13)	Accidental Losses
T(14)	Licensing Fees (Net)
T(15)	Technical and Service Fees (Net)

T(16)	Sundry Income
T(17)	Administration Salary Bonus
T(18)	Low Tax Income Level
T(19)	Income Tax at Low Rate
T(20)	Income Tax at High Rate

Internal Variables--Balance Sheet

F(19)	Cash Balance
F(20)	Accounts Receivable (Net)
F(21)	Taxes Recoverable
F(22)	Due from Others
F(23)	Total Inventories
F(24)	Prepaid Assets
F(25)	Non-Cash Assets
F(26)	Total Current Assets
F(27)	Total Fixed Assets
F(28)	Accumulated Depreciation
F(29)	Net Fixed Assets
F(30)	Excess Cash Balance
F(31)	Total Assets
F(32)	Due to Bank (On Account and Loan)
F(33)	Accounts Payable (Net) and Accrueds
F(34)	Other Payables
F(35)	Long-Term Debt Payment Due
F(36)	Total Current Liabilities
F(37)	Deferred Taxes
F(38)	Mortgage Loans (Net)
F(39)	Debenture Notes (Net)
F(40)	Total Long-Term Debt
F(41)	Common Shares Capital
F(42)	Retained Earnings
F(43)	Shareholders Equity
F(44)	Extra Financing Required
F(45)	Total Liabilities

Operating Variables--Balance Sheet

T(21)	Minimum Cash Balance
T(22)	Total Accounts Receivable
T(23)	Allowance for Doubtful Accounts
T(24)	Other Receivables
T(25)	Computed Taxes Recoverable
T(26)	Due from Directors
T(27)	Due from Associated Plastics, Inc.
T(28)	Due from Kemp Products, Inc.
T(29)	Prepaid Expenses
T(30)	Recoverable Deposits
T(31)	Deferred R & D Expenses
T(32)	Life Insurance Cash Value
T(33)	Other Funds Sources

T(34)	Total Depreciation in Year
T(35)	Change in Net Fixed Assets
T(36)	Accounts Payable
T(37)	Accrueds Payable
T(38)	Royalties Payable
T(39)	Dividends Payable
T(40)	Mortgage Payment Due
T(41)	Debentures Payment Due
T(42)	Number of Common Shares Issued
T(43)	Shares Capital Change
T(44)	Assets Sale Profits (Losses)
T(45)	Government Grants Expected
T(46)	Bank Notes Limit
T(47)	Deferred Taxes Computed
T(48)	Extra Interest Earned
T(49)	Extra Interest Paid

Internal Variables--Funds Items

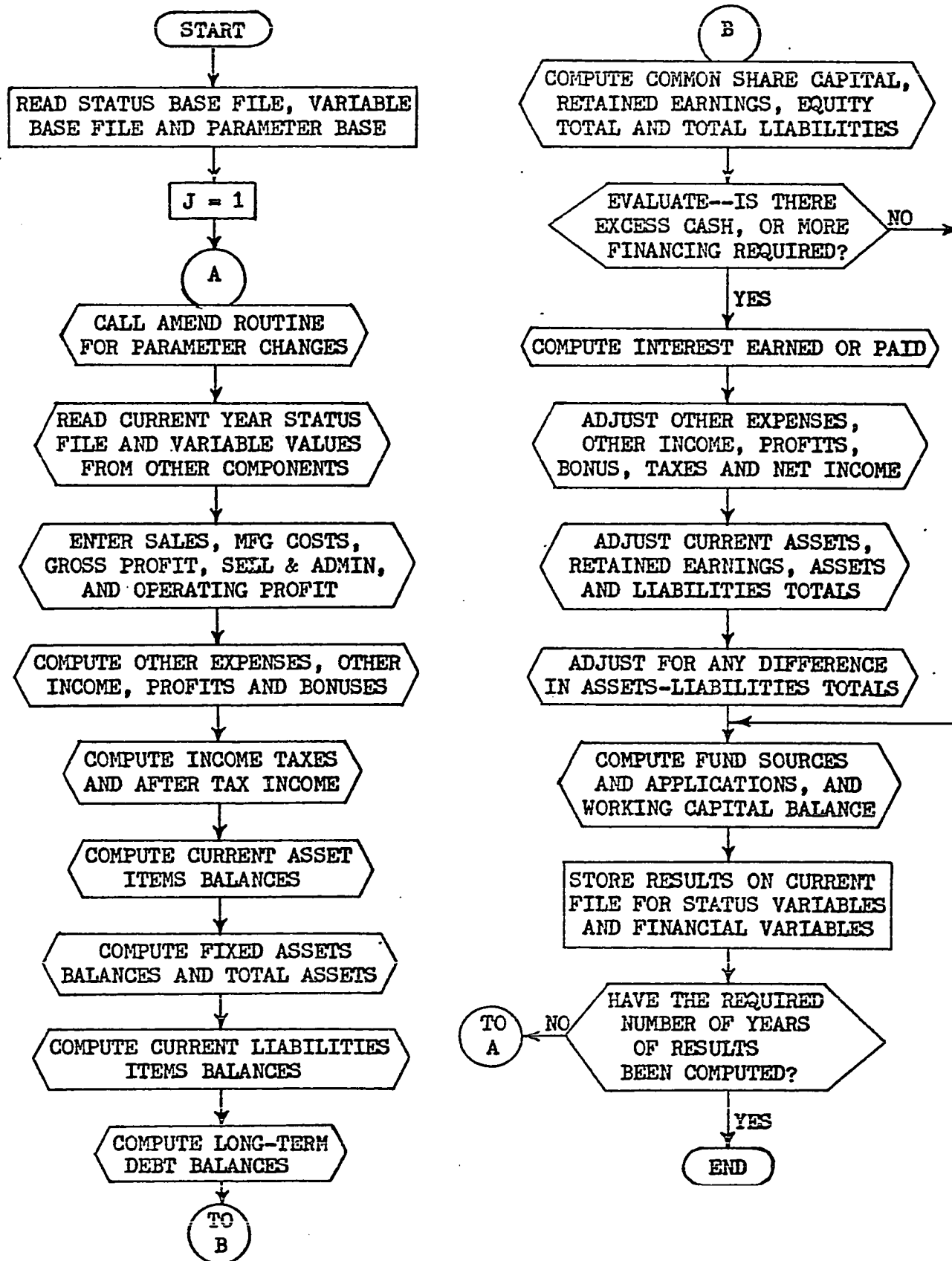
F(46)	Total Funds Sources
F(47)	Total Funds Applications
F(48)	Change in Working Capital
F(49)	Working Capital Balance

Status Variables Used

S(3)	Total Gross Sales Forecast
S(6)	Total Plant Rent
S(7)	Total Warehouse Rent
S(8)	Total Equipment Leases
S(10)	Building and Parking Lot Assets (Net)
S(11)	Warehouse Building Assets (Net)
S(12)	Equipment and Machine Assets (Net)
S(13)	Total Wages and Salaries
S(14)	Total Source of Payables

MODIFICATIONS

FINANCIAL COMPONENT (INCOM) FLOW DIAGRAM



FINANCIAL COMPONENT COMPUTER PROGRAM

```

10  FILES PARAM,CHANGE,RESULT
20  DIM F[49],Q[15],R[5]
25  DIM S[15],U[15],W[15]
30  DIM Z[5],A$[3],N[12],L$[12]
32  DIM T[49],D[49],G[49]
33  DIM A[1,1],C[1,1]
35  MAT READ #1,1;N[12]
37  READ #1;L$
40  MAT READ #1;S[15],U[15]
75  REM TO READ INITIAL VALUES & CHANGE INDICATOR
77  READ #1,N[11]
80  MAT READ #1;F[49],T[49]
85  MAT READ #1;D[49]
92  LET K=50000.
95  REM TO COMMENCE YEARLY COMPUTATIONS
100 FOR J=1 TO N[1]
105 REM TO INITIALIZE CHANGE PARAMETERS
125 MAT G=ZER
140 GOSUB 3000
315 REM TO READ STATUS VAR. VALUES
320 MAT READ #3,N[2]+J-1;S
355 READ #3,N[4]+(J-1)*2
357 FOR I=1 TO 41
358 READ #3;T1
359 NEXT I
360 MAT READ #3,N[8]+(J-1)*2;Q[15]
365 MAT READ #3,N[10]+J-1;R[5]
370 REM SALES TO GROSS PROFIT & GP%
372 LET F[1]=Q[3]
373 LET F[2]=Q[4]+Q[5]
375 FOR I=3 TO 5
380 LET F[I]=Q[I+3]
385 NEXT I
400 REM SELL EXP TO OPERATING PROFIT & OP%
405 LET F[6]=T1
410 LET F[7]=R[1]
420 LET I=8
422 GOSUB 1810
425 LET F[9]=F[5]-F[8]
435 REM BANK (NOTES AT LIMIT) AND DEBT INTEREST
436 FOR I=38 TO 39
437 LET F[I]=F[I]+G[I-4]
438 NEXT I
440 LET T[46]=INT(D[46]*T[46]+G[46]+.5)
445 LET T[5]=D[5]*(F[32]+T[46])/2+G[5]
447 LET F[32]=T[46]
455 LET T[6]=D[6]*(F[38]+T[40]/2)+G[6]
460 LET T[7]=D[7]*(F[39]+T[41]/2)+G[7]

```

Financial Component (cont'd)

```
470 REM EXCHG, DISCTS, INS. & OTHER EXP.
475 FOR I=8 TO 10
480 GOSUB 2000
485 NEXT I
490 LET F[10]=0
495 FOR I=5 TO 10
500 LET F[10]=F[10]+T[I]
505 NEXT I
510 LET F[10]=INT(F[10]+.5)
515 REM R&D EXPENSES & AMORT
520 LET T[45]=G[45]
525 LET T[31]=T[31]+Q[11]-T[45]+G[31]
530 LET T[11]=D[11]*T[31]+G[11]
540 LET T[31]=T[31]-T[11]
545 LET T[12]=G[12]
550 LET T[13]=G[13]
555 LET F[11]=INT(T[11]+T[12]+T[13]+.5)
565 LET F[12]=F[9]-(F[10]+F[11])
570 REM TOTAL OTHER INCOME & PRE-BONUS INCOME
575 LET F[13]=0
580 FOR I=14 TO 16
585 GOSUB 2000
590 LET F[13]=F[13]+T[I]
595 NEXT I
600 LET T[44]=G[44]
605 LET F[13]=INT(F[13]+Q[1]+T[44]+.5)
610 LET I=14
612 GOSUB 1810
620 REM ADMIN BONUS, BT PROFIT, & BTP%
625 IF F[14] <= 0 THEN 650
640 LET F[15]=T[17]=INT(D[17]*F[14]+G[17]+.5)
645 GOTO 655
650 LET F[15]=T[17]=0
655 LET F[16]=F[14]-F[15]
670 REM INCOME TAX & TAX RECOVER
675 LET I=18
680 GOSUB 2000
685 LET I=19
690 IF T[18]<ABS(F[16]) THEN 715
695 LET T[11]=ABS(F[16])
700 GOSUB 2000
705 LET T[20]=0
710 GOTO 740
715 LET T[11]=T[18]
720 GOSUB 2000
725 LET I=20
730 LET T[11]=ABS(F[16])-T[18]
735 GOSUB 2000
740 IF F[16] <= 0 THEN 760
745 LET F[17]=INT(T[19]+T[20]+.5)
```

Financial Component (cont'd)

```

750 LET T[25]=0
755 GOTO 775
760 LET F[17]=INT(T[19]+T[20]+.5)
765 LET T[25]=INT(T[19]+T[20]+.5)
775 LET F[18]=F[16]-F[17]
830 REM ACCTS REC. COMPS & TOTAL AR
840 FOR I=22 TO 23
850 LET T[I]=D[I]*F[I]+G[I]
855 NEXT I
860 LET I=24
865 GOSUB 2000
870 LET F[20]=INT(T[22]-T[23]+T[24]+.5)
885 REM DUE FROM OTHERS
890 FOR I=26 TO 28
895 GOSUB 2000
900 NEXT I
905 LET F[22]=INT(T[26]+T[27]+T[28]+.5)
920 REM TAX RECOVER & INVENTORIES
925 LET F[21]=T[25]
930 LET F[23]=F[23]+Q[2]+Q[9]
940 REM TOTAL DEPR, PREPAIDS & RECOV. DEPOSITS
945 LET T[34]=Q[14]+Q[15]+R[4]+R[5]
960 FOR I=29 TO 30
965 GOSUB 2000
970 NEXT I
975 LET F[24]=INT(S[15]+T[29]+T[30]+.5)
1005 LET T[32]=INT(D[32]+T[32]+G[32]+.5)
1010 LET F[25]=INT(T[32]+.5)
1015 REM MINIMUM & PRELIM CASH BALANCE
1020 LET T[21]=INT(D[21]*T[21]+G[21]+.5)
1030 LET F[19]=T[21]
1040 LET F[26]=0
1045 FOR I=19 TO 25
1050 LET F[26]=F[26]+F[I]
1055 NEXT I
1065 REM NET F.A. & CHANGE IN F.A.
1070 LET T[35]=-F[29]
1075 LET F[29]=Q[12]+Q[13]+R[2]+R[3]
1080 LET T[35]=T[35]+F[29]
1095 LET F[28]=F[28]+T[34]
1105 LET F[27]=F[29]+F[28]
1110 GOSUB 1790
1140 REM ACCTS PAY, ACCRUEDS & SUM
1145 LET T[36]=D[36]*S[14]+G[36]
1150 LET T[37]=D[37]*S[13]+G[37]
1155 LET F[33]=INT(T[36]+T[37]+.5)
1165 REM ROYALTIES, SHARES, DIVIDENDS & PAYABLES
1170 LET T[38]=D[38]*Q[4]+G[38]
1175 LET I=42
1177 GOSUB 2000
1180 LET T[39]=D[39]*T[42]+G[39]

```

Financial Component (cont'd)

```

1182 IF F[17] >= 0 THEN 1190
1184 LET F[34]=INT(T[38]+T[39]+.5)
1186 GOTO 1205
1190 LET F[34]=INT(F[17]*.2+T[38]+T[39]+.5)
1200 REM MORT & DEBEN PAY & LTD PAY
1205 FOR I=40 TO 41
1210 GOSUB 2000
1212 IF F[I-2] >= T[I] THEN 1215
1213 LET T[I]=F[I-2]
1215 NEXT I
1220 LET F[35]=INT(T[40]+T[41]+.5)
1230 LET F[36]=0
1235 FOR I=32 TO 35
1240 LET F[36]=F[36]+F[I]
1245 NEXT I
1250 REM DEFERRED TAXES, & MORT, DEBEN & LTD BAL.
1255 LET F[37]=T[47]=INT(T[47]+G[47]+.5)
1260 FOR I=38 TO 39
1265 LET F[I]=F[I]-T[I+2]
1267 NEXT I
1270 LET I=40
1272 GOSUB 1810
1275 REM COMMON SHARES CAPITAL, RET EARN & EQUITY
1280 LET T[43]=INT(D[43]*G[42]+G[43]+.5)
1285 LET F[41]=F[41]+T[43]
1290 LET F[42]=F[42]+F[18]-T[39]+G[4]
1295 LET I=43
1297 GOSUB 1810
1305 GOSUB 1800
1310 REM EXCESS CASH OR FINANCING
1315 IF F[31]<F[45] THEN 1390
1320 IF F[31]=F[45] THEN 1375
1325 LET B8=F[31]-F[45]
1327 LET B7=0
1330 IF F[30]=0 THEN 1445
1335 IF F[30] >= B8 THEN 1355
1340 LET B8=B8-F[30]
1345 LET B7=-F[30]
1350 GOTO 1445
1355 LET B7=-B8
1360 LET B8=0
1365 GOTO 1445
1375 LET B7=B8=0
1380 GOTO 1445
1390 LET B7=F[45]-F[31]
1395 LET B8=0
1400 IF F[44]=0 THEN 1445
1405 IF F[44] >= B7 THEN 1430
1415 LET B8=-F[44]
1420 LET B7=B7-F[44]
1425 GOTO 1445

```

Financial Component (cont'd)

```

1430 LET B8=-B7
1435 LET B7=0
1442 REM EXTRA INTEREST EARNED OR PAID
1445 LET T[48]=INT(D[48]*(F[30]*2+B7)/2+G[48]+.5)
1450 LET T[49]=INT(D[49]*(F[44]*2+B8)/2+G[49]+.5)
1452 LET F[30]=F[30]+B7
1453 LET F[44]=F[44]+B8
1455 REM ADJUST INCOME STATEMENT
1460 LET F[10]=F[10]+T[49]
1465 LET F[12]=F[12]-T[49]
1470 LET F[13]=F[13]+T[48]
1475 LET F[14]=F[14]+T[48]-T[49]
1485 IF F[14] <= 0 THEN 1510
1490 LET B1=INT(D[17]*(T[48]-T[49])+.5)
1495 LET T[17]=T[17]+B1
1500 LET F[15]=F[15]+B1
1505 GOTO 1515
1510 LET F[15]=T[17]=0
1512 REM BEFORE TAX INCOME ADJUSTMENT
1515 LET B2=F[14]-F[15]
1520 LET B2=B2-F[16]
1525 IF ABS(F[16])>T[18] THEN 1540
1530 LET B3=INT(D[19]*B2+.5)
1535 GOTO 1545
1540 LET B3=INT(D[20]*B2+.5)
1545 LET F[16]=F[16]+B2
1560 LET F[17]=F[17]+B3
1565 LET I=18
1567 GOSUB 1820
1575 IF F[17] >= 0 THEN 1595
1580 FOR I=21 TO 26 STEP 5
1585 GOSUB 1820
1587 NEXT I
1590 REM NEW ASSET, RET EARN & LIABILITY TOTALS
1595 GOSUB 1790
1600 FOR I=42 TO 43
1605 GOSUB 1820
1607 NEXT I
1610 GOSUB 1800
1611 FOR I=1 TO 4
1612 LET I1=5+(I-1)*4
1613 GOTO I OF 1617,1617,1614,1616
1614 LET I1=I1+3
1615 GOTO 1617
1616 LET I1=I1+1
1617 LET T[I]=F[I1]*100/F[1]
1618 NEXT I
1620 IF F[31]=F[45] THEN 1675
1625 IF F[31]<F[45] THEN 1655
1630 LET B4=F[31]-F[45]

```

Financial Component (cont'd)

```
1635 FOR I=44 TO 45
1640 LET F[I]=F[I]+B4
1642 NEXT I
1645 GOTO 1675
1655 LET B4=F[45]-F[31]
1660 FOR I=30 TO 31
1665 LET F[I]=F[I]+B4
1667 NEXT I
1670 REM FUNDS & WORKING CAPITAL
1675 LET F[46]=INT(F[18]+T[34]+.5)
1680 LET F[47]=INT(T[35]+F[35]-(G[40]+G[41])+T[39]+.5)
1685 LET F[48]=F[46]-F[47]
1687 LET B6=F[49]+F[48]
1690 LET B9=F[26]+F[30]-F[36]
1700 LET B6=B9-B6
1705 FOR I=46 TO 48 STEP 2
1710 LET F[I]=F[I]+B6
1712 NEXT I
1715 LET T[33]=B6
1720 LET F[49]=B9
1727 READ #3,N[12]+(J-1)*4
1730 MAT PRINT #3;F,T
1749 NEXT J
1760 STOP
1790 LET F[31]=F[26]+F[29]+F[30]+T[31]
1795 RETURN
1800 LET F[45]=F[36]+F[37]+F[40]+F[43]+F[44]
1805 RETURN
1810 LET F[I]=F[I-2]+F[I-1]
1815 RETURN
1820 LET F[I]=F[I]-B3
1825 RETURN
2000 LET T[I]=D[I]*T[I]+G[I]
2005 RETURN
```

REPORT GENERATOR COMPONENT

Program Name: REPORT

Purpose:

This program has been set up to print out information desired after any evaluation of a plan has been made using the model. It can be used to print-out the base and all forecast year values for a specific factor (or variable), a standard type of financial statement, or a complete sequential listing of all results for any model component. The program was designed to be as flexible as possible to save the user time in obtaining results.

Operation:

When run this program asks the user to specify the information he wants from results computed in a particular component of the model. It must be rerun each time results are desired from a different part of the model, and each time a different type of print-out (selective, statement or complete listing) is desired. The details of the report generator operation are clarified in the procedure section below.

Procedure:

Load and run as follows:

GET - REPORT
RUN

The program will then ask the user to specify:

COMPONENT CODE NO.?
REPORT MODE NO.?
NUMBER OF STATEMENTS or NUMBER OF VARIABLES?
STATEMENT or VARIABLE INDEX NUMBERS?

Particular types of responses must be made to each of these questions. The user provides these through the teletype keyboard. The program will then instruct the computer to print-out the information that has been asked for. The following outline details the answers that can be given to the questions:

(a) The Model Component Codes are:

1--SALES	3--MANFG	5--INCOM
2--PRODN	4--ADMIN	

(The numbers are used in answering the questions; the names correspond to the model programs)

(b) The Report Printing Modes are:

1--Selective (for individual variable values).
2--Statement (for particular standard statements).
3--Complete (to list all variable values for any component).

- (i) In the SELECTIVE mode the user can ask for results of up to 20 variables from one component at a time. He must specify the number of variables and then enter their index numbers. The variable numbers to use are those listed in the MODEL INDEX and not enclosed in brackets --the variables are selected from the INDEX descriptions given.
- (ii) In the STATEMENT mode the following statements can be asked for:

<u>COMPONENT</u>	<u>STATEMENT NO.</u>	<u>DESCRIPTIONS</u>
Sales	1	Selling Expenses
Prod'n	2	Production Conditions
Manfg	3	Manufacturing Costs
"	4	Mould Division Costs
Admin	5	Administration Expenses
Incom	6	Income Statement
"	7	Balance Sheet
"	8	Retained Earnings, Funds, Work Cap
**	9	Status Variables

**The Status Variables statement can be requested in conjunction with statements from any of the model components. Status variable values can only be obtained in the statement mode.

- (iii) In the COMPLETE printing mode the program does not ask for statement or variable numbers. When this mode (#3) is specified the computer begins to print-out a sequential listing of all results for the model component specified.

Method of Printing:

The report generating program contains a specially designed routine to convert numerical values into another form (known as "string variables" in the BASIC programming language) to pack them together on the page. This enables the computer to print variable descriptions followed by up to six columns of computed results. The columns are lined up so that the right-hand digits are vertically above one another as in the example below (a partial statement print-out):

KEMP PRODUCTS LIMITED
 INCOME STATEMENT
 FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
TOTAL GROSS SALES	1900	1723	1961	2262	2611
TOTL RLTY&MOULD CH	107	63	55	39	37
TOTAL NET SALES	1793	1660	1906	2223	2574
TOTL COST OF SALES	1528	1311	1412	1675	1989
TOTL MFG GROSS PFT	265	349	494	548	585
TOTAL SELL EXPENSE	116	94	113	130	144
TOTL ADMIN EXPENSE	233	209	212	236	255
TOTL SELL&ADM EXPS	349	303	325	366	399
OPERATING PROFIT	-84	46	169	182	186

The above statement heading and those of other statements are contained in the report generator program. Headings are selected by the program for particular statements, or for a complete variable listing, from the printing instructions given. No headings are printed in the SELECTIVE mode.

The program includes data that specifies which variables are to be printed for particular statements. The spacing of variables down the page and any underlining needed for column subtotals and totals is also controlled by data included in the program. Therefore, new statement entries and spacings can be made relatively easily as desired by the managers.

Program Control Variables:

A matrix defined as $M(5,5)$ was set up to specify the numbers of each type of variable contained in the model components. These are used in the Report Generator to control results reading and printing in accordance with the component contents. The numbers are stored in data statements 1335, 1340 and 1345. The matrix is set up as follows:

Model Component Type of Variable M(I,J)		Sales 1	Prodn 2	Manfg 3	Admin 4	Incom 5
Product	1	5	13	0	0	0
Operating	2	7	9	40	21	49
Internal	3	2	6	4	3	49
Status	4	15	15	15	15	15
Total Number	5	29	43	59	39	113

A matrix defined as $T(2,5)$ was set up to specify the NAME file record numbers for the descriptions of variables to read for each component. One number specifies the record in which descriptions start, the second specifies the record in which descriptions end for a particular model component. The numbers are stored in data statement 1350.

The matrix is set up as follows:

Model Component Name Record T(I,J)		Sales 1	Prodn 2	Manfg 3	Admin 4	Incom 5
Start Descriptions	1	1	4	9	17	22
End Descriptions	2	3	8	16	21	38

The starting and ending name record numbers for the status variables are permanently stored in statements 525 and 530 as $K4 = 39$ and $K5 = 41$.

A vector defined as $Y(5)$ was set up to specify the number of records used to store results from each year for each model component. The numbers are stored in data statement 1352. The vector is set up as follows:

Model Component Y(I)		Sales 1	Prodn 2	Manfg 3	Admin 4	Incom 5
Number of Records Per Year		2	4	2	1	4

A variable defined as $L1$ was set up to specify the number of factors (or variables) for which the values are to be printed out in any run of the model. For the standard print-out statements these numbers are stored in the Results program data lines 1355, 1370, 1395, 1420,

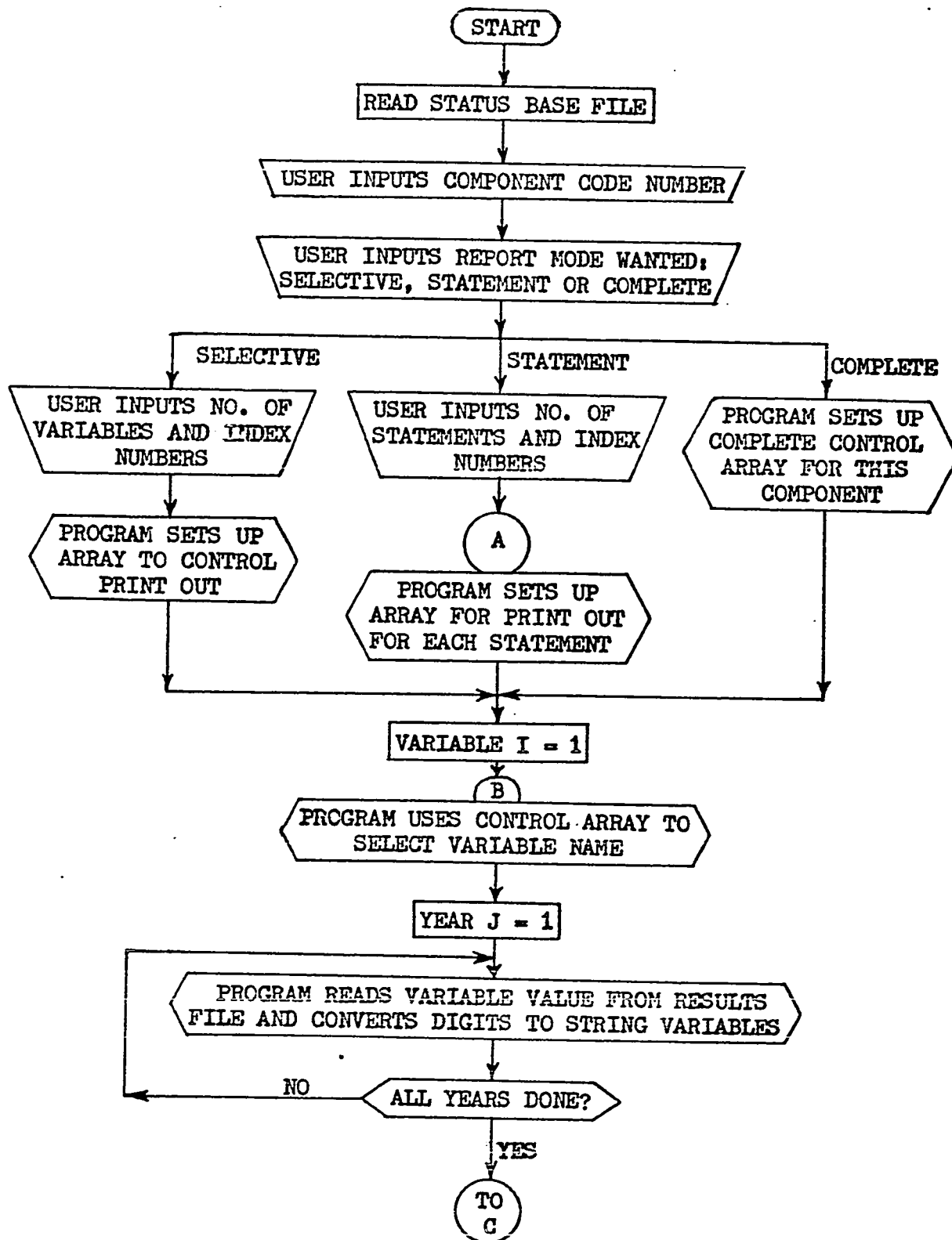
1435, 1450, 1465, 1490 and 1505. They are listed in order for the 9 possible standard statements detailed in the procedure section (a) (ii) above.

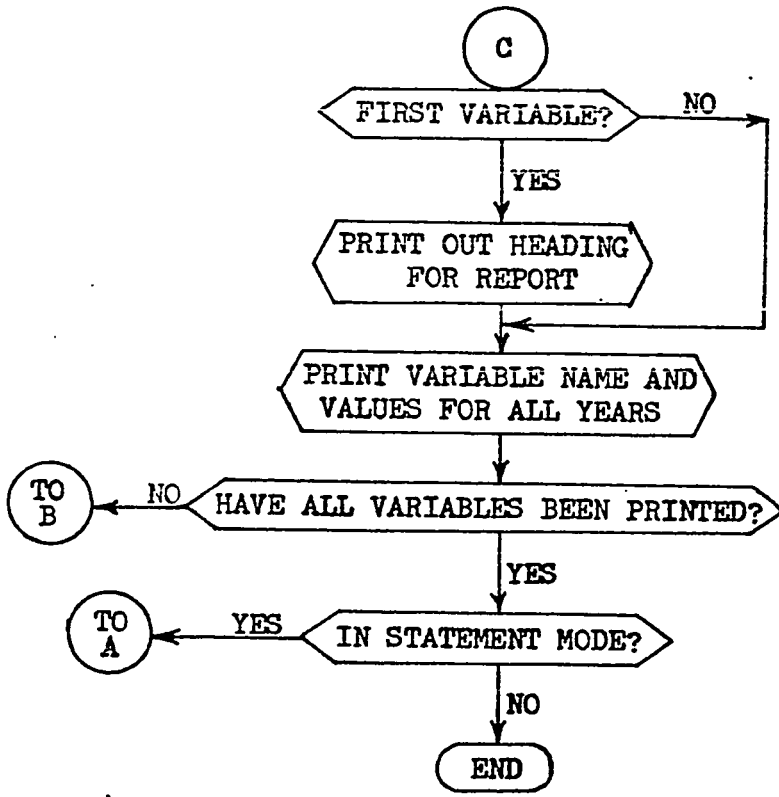
In the Report program the data statement (or statements) immediately following an L1 number contains the numbers of the variables from a particular model component that are to be printed in the statement. These are followed by a data statement (or statements) specifying spacing and underlining. The spacing numbers are defined as follows:

- 1--Single space for a single underlining "-----".
- 2--Single space for a double underlining "=====" followed by 3 line spaces.
- 3--Single space for next result print-out line.
- 4--Double space for next result print-out line.
- 5--Triple space for next result print-out line.

MODIFICATIONS

REPORT GENERATOR FLOW DIAGRAM





REPORT GENERATOR COMPUTER PROGRAM

```

10 FILES PARAM,RESULT,NAMES
15 DIM X[20],W[28],Y[5]
20 DIM P[32],U[119],V[4]
25 DIM M[5,5],T[2,5],N[12],S[15]
30 DIM AS[8],BS[3],LS[12],MS[25],NS[12]
35 DIM PS[66],VS[54],WS[54],XS[8],YS[48],ZS[8]
40 REM LOAD STRING VARIABLES
45 LET AS=""
50 LET MS="SALESPRODNMANFGADMININCOM"
55 LET NS="1234567890- "
60 LET XS=""
65 LET ZS=""
70 LET YS=" 1970    1971    1972    1973    1974    1975"
75 REM LOAD STATUS PARAMETERS
80 MAT READ #1,1;N[12]
85 READ #1;L$
90 MAT READ #1;S[15]
95 MAT READ M[5,5],T[2,5],Y[5]
100 PRINT "COMPONENT CODE NO. ";
105 INPUT K
110 PRINT "REPORT MODE NO. ";
115 INPUT L
120 LET K1=(K-1)*5+1
125 LET K2=K1+4
130 GOTO L OF 135,335,420
135 PRINT
140 PRINT "SELECT--HOW MANY VARS ";
145 INPUT L1
150 PRINT MS[K1,K2];" VAR INDEX NO. IS ";
160 MAT INPUT X[L1]
165 REM ADJUST U(I) AND L1 FOR PRODUCT VARIABLES
170 LET I=1
175 LET I1=0
180 IF M[1,K1]=0 THEN 220
185 FOR I=1 TO L1
190 IF X[I]>M[1,K1] THEN 220
195 FOR I2=1 TO 8
200 LET I1=I1+1
205 NEXT I2
210 NEXT I
215 REM SHIFT BALANCE OF U(I)
220 LET I3=L1-I+1
225 IF I3=0 THEN 250
230 FOR I2=I TO L1
235 LET I1=I1+1
240 NEXT I2
245 REM RELOAD U(I) AND L1
250 LET I4=0

```

Report Generator (cont'd)

```

255 IF I3=0 THEN 285
260 FOR I=I1-I3+1 TO I1
265 LET U[I1-I4]=X[L1-I4]
270 LET I4=I4+1
275 NEXT I
280 IF M[1,K]=0 THEN 490
285 LET I8=0
290 FOR I=8 TO I1-I3 STEP 8
295 FOR I2=1 TO 8
300 LET U[I1-I3-I2+1-I8]=X[L1-I4]
305 NEXT I2
310 LET I8=I8+8
315 LET I4=I4+1
320 NEXT I
325 LET L1=I1
330 GOTO 490
335 PRINT
340 PRINT "HOW MANY STATEMENTS ";
345 INPUT L2
350 PRINT M[K1,K2];" STATEMENT NO.'S ";
360 MAT INPUT V[L2]
365 FOR M2=1 TO L2
370 REM READ TO STATEMENT CONTENTS
375 FOR M3=1 TO V[M2]
380 READ L1
385 MAT READ U[L1],W[L1]
390 NEXT M3
395 GOTO 490
400 RESTORE 1355
405 NEXT M2
410 GOTO 1025
415 REM SET U(I) FOR COMPLETE PRINT OUT
420 LET L1=M[5,K]+M[1,K]*8-M[1,K]-M[4,K]
425 LET I1=0
430 IF M[1,K]=0 THEN 470
435 FOR I2=1 TO M[1,K]
440 FOR I3=1 TO 8
445 LET I1=I1+1
450 LET U[I1]=I2
455 NEXT I3
460 NEXT I2
465 REM ADD SINGLE VARS
470 FOR I=I1+1 TO L1
475 LET U[I]=I-M[1,K]*8+M[1,K]
480 NEXT I
485 REM SET RECORD FOR NAME READ
490 LET A1=M[1,K]*8-M[1,K]
495 LET A2=A1-M[4,K]+M[5,K]
500 LET K4=T[1,K]
505 LET K5=T[2,K]

```


Report Generator (cont'd)

```

510  FOR I=1 TO L1
515  IF L#2 THEN 540
520  IF VCM2J#9 THEN 540
525  LET K4=39
530  LET K5=41
535  REM READ NAME FILE
540  LET K8=0
545  FOR K6=K4 TO K5
550  READ #3,K6;VS,WS
555  FOR K7=1 TO 6
560  LET K8=K8+1
565  IF U[I]#K8 THEN 595
570  IF K7>3 THEN 585
575  LET PS=VS[(K7-1)*18+1,(K7-1)*18+18]
580  GOTO 610
585  LET PS=WS[(K7-4)*18+1,(K7-4)*18+18]
590  GOTO 610
595  NEXT K7
600  NEXT K6
605  REM NUMBER CONVERSION
610  FOR J=1 TO N[I]+1
615  IF J>1 THEN 630
620  LET K3=1
625  GOTO 635
630  LET K3=2
635  LET N=N3=N4=0
640  REM READ VAR VALUE
645  IF K4=39 THEN 725
650  LET I9=N[K3+2*K]+(J-K3)*Y[K]
655  IF M[1,K]#0 THEN 670
660  LET I8=U[I]
665  GOTO 695
670  IF U[I] <= M[1,K] THEN 685
675  LET I8=U[I]+A1
680  GOTO 695
685  LET I8=(U[I]-1)*8+I-INT((I-1)/8)*8
695  READ #K3,I9+INT((I8-1)/32)
700  FOR Q2=1 TO I8-INT((I8-1)/32)*32
705  READ #K3;P[Q2]
710  NEXT Q2
715  LET N1=P[Q2-1]
720  GOTO 755
725  IF J>1 THEN 740
730  LET N1=S[U[I]]
735  GOTO 755
740  MAT READ #K3,N[K3+J-K3];P[M[4,K]]
745  LET N1=P[U[I]]
750  REM CHECK FOR NEGATIVE
755  IF N1 >= 0 THEN 767
760  LET N3=1
765  LET N1=ABS(N1)

```

Report Generator (cont'd)

```

767 LET N1=INT(N1+.5)
770 FOR Q=1 TO 8
775 LET N=N+1
780 IF N1<.1 AND N>1 THEN 820
785 LET N2=(N1/10-INT(N1/10))*10
790 IF N2<.5 THEN 805
795 LET A$(9-Q,9-Q)=N$(N2,N2)
800 GOTO 810
805 LET A$(9-Q,9-Q)=N$(10,10)
810 LET N1=(N1-N2)/10
815 GOTO 845
820 LET N4=N4+1
825 IF N3=1 AND N4=1 THEN 840
830 LET A$(9-Q,9-Q)=N$(12,12)
835 GOTO 845
840 LET A$(9-Q,9-Q)=N$(11,11)
845 NEXT Q
850 LET P$(LEN(P$)+1)=A$
855 NEXT J
860 REM PRINT OUT ROUTINE
865 IF I>1 THEN 875
870 GOSUB 1080
875 IF L=2 THEN 920
880 REM SELECTIVE OR COMPLETE PRINT OUT
885 PRINT P$
890 IF I=L1 THEN 905
895 IF M[1,K]=0 OR U[I]>M[1,K] THEN 1015
900 IF U[I]=U[I+1] THEN 1015
905 PRINT
910 GOTO 1015
915 REM STATEMENT PRINT OUT
920 PRINT P$
925 GOTO W[I] OF 930,940,1015,1005,1000
930 GOSUB 1140
935 GOTO 1015
940 PRINT TAB(18);
945 FOR Z1=1 TO N[I]+1
950 PRINT Z$;
955 NEXT Z1
960 FOR Z2=1 TO 3
965 PRINT
970 NEXT Z2
975 IF V[M2]#7 THEN 1015
980 IF I=L1 THEN 1015
985 PRINT "LIABILITIES BALANCE";
990 GOSUB 1135
995 GOTO 1015
1000 PRINT
1005 PRINT
1010 REM RESULTS PRINTED FOR VAR
1015 NEXT I

```

Report Generator (cont'd)

```

1020 IF L=2 THEN 400
1025 FOR Z2=1 TO 3
1030 PRINT
1035 NEXT Z2
1040 STOP
1075 REM TITLES ROUTINES
1080 FOR Q=1 TO 4
1085 PRINT
1090 NEXT Q
1092 IF L=1 THEN 1165
1095 LET C1=(18+8*(N[1]+1))/2
1100 PRINT TAB(C1-10);"KEMP PRODUCTS LIMITED"
1105 PRINT
1110 GOTO L OF 1115,1185,1170
1115 PRINT TAB(C1-11);MS[K1,K2];" SELECTIVE OUTPUT"
1117 GOTO 1130
1120 PRINT TAB(C1-12);"FOR THE *";MS[K1,K2];"* ROUTINE"
1125 PRINT TAB(C1-5);"*****"
1130 PRINT
1135 PRINT TAB(19);YS[1,(N[1]+1)*8]
1140 PRINT TAB(18);
1145 FOR X=1 TO N[1]+1
1150 PRINT X$;
1155 NEXT X
1160 PRINT
1165 RETURN
1170 PRINT TAB(C1-11);"COMPLETE OUTPUT REPORT"
1175 GOTO 1120
1180 REM STATEMENT TITLES
1185 IF V[2]>6 THEN 1195
1190 GOTO V[2] OF 1200,1215,1225,1235,1245,1255
1195 GOTO V[2]-6 OF 1265,1300,1320
1200 PRINT TAB(C1-13);"SELLING EXPENSES STATEMENT"
1205 PRINT TAB(C1-13);"FOR THE YEAR ENDING MAY 31"
1210 GOTO 1125
1215 PRINT TAB(C1-16);"PRODUCTION CONDITIONS STATEMENT"
1220 GOTO 1205
1225 PRINT TAB(C1-15);"MANUFACTURING COSTS STATEMENT"
1230 GOTO 1205
1235 PRINT TAB(C1-15);"MOULD DIVISION COSTS STATEMENT"
1240 GOTO 1205
1245 PRINT TAB(C1-16);"ADMINISTRATION EXPENSE STATEMENT"
1250 GOTO 1205
1255 PRINT TAB(C1-8);"INCOME STATEMENT"
1260 GOTO 1205
1265 PRINT TAB(C1-7);"BALANCE SHEET"
1270 PRINT TAB(C1-14);"AS AT THE YEAR ENDING MAY 31"
1275 PRINT TAB(C1-5);"*****"
1280 PRINT
1285 PRINT

```

Report Generator (cont'd)

```

1290 PRINT "ASSETS BALANCE";
1295 GOTO 1135
1300 PRINT TAB(C1-12);"RETAINED EARNINGS CHANGE;"
1305 PRINT TAB(C1-16);"FUNDS SOURCES & APPLICATIONS, AND"
1310 PRINT TAB(C1-13);"WORKING CAPITAL STATEMENTS"
1315 GOTO 1205
1320 PRINT TAB(C1-12);"STATUS VARIABLES REPORT"
1325 PRINT TAB(C1-14);"AS AT THE YEAR ENDING MAY 31"
1330 GOTO 1125
1335 DATA 5,13,0,0,0,7,9,40,26,49
1340 DATA 2,6,4,3,49,15,15,15,15,15
1345 DATA 29,43,59,44,113
1350 DATA 1,4,9,17,22,3,8,16,21,38
1352 DATA 2,4,2,1,4
1355 DATA 8
1360 DATA 8,10,9,11,12,6,13,14
1365 DATA 3,3,3,3,1,2,3,5
1370 DATA 26
1375 DATA 8,8,8,8,8,8,8,8,ii,ii,ii,ii,ii,ii,ii,ii
1380 DATA 25,15,16,20,22,24,23,17,18,19
1385 DATA 3,3,3,3,3,3,3,4,3,3,3,3,3,3,3
1390 DATA 4,3,3,4,3,3,4,4,3,3,5
1395 DATA 24
1400 DATA 3,4,5,6,9,27,28,16,17,18,19,20,21,22,23
1405 DATA 14,15,24,25,26,10,11,7,8
1410 DATA 3,3,1,4,3,3,4,3,3,3,3,3,3,3,3
1415 DATA 3,3,3,3,1,4,1,1,2
1420 DATA 9
1425 DATA 34,35,2,36,37,38,39,40,1
1430 DATA 4,3,1,1,4,3,1,1,2
1435 DATA 14
1440 DATA 6,7,9,10,8,11,12,13,4,5,14,1,22,23
1445 DATA 3,3,3,3,3,3,3,3,3,3,1,2,3,5
1450 DATA 22
1455 DATA 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18
1457 DATA 50,51,52,53
1460 DATA 3,1,3,1,4,3,1,1,4,3,1,4,1,3,1,3,1,2
1462 DATA 3,3,3,5
1465 DATA 28
1470 DATA 19,20,21,22,23,24,25,26,27,28,29,80,30
1475 DATA 31,32,33,34,35,36,37,38,39,40,41,42,43,44,45
1480 DATA 3,3,3,3,3,3,1,4,3,1,4,4,1,2,3,3
1485 DATA 3,1,4,4,3,1,4,3,1,4,1,2
1490 DATA 17,18,88,42
1495 DATA 18,83,82,46,84,35,88,47,48,49,26,30,36,49
1497 DATA 4,1,2
1500 DATA 3,3,1,2,3,3,1,2,1,2,3,3,1,2
1505 DATA 15
1510 DATA 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
1515 DATA 3,3,3,3,3,3,3,3,3,3,3,3,3,3,5
1520 END

```

AMEND SUBROUTINE

Program Name: AMEND

Purpose:

This program is the major subroutine attached to SALES, PRODN, MANFG, ADMIN and INCOM during each model run. It is used to enter parameter changes for each forecast year before the calculations are made.

Operation:

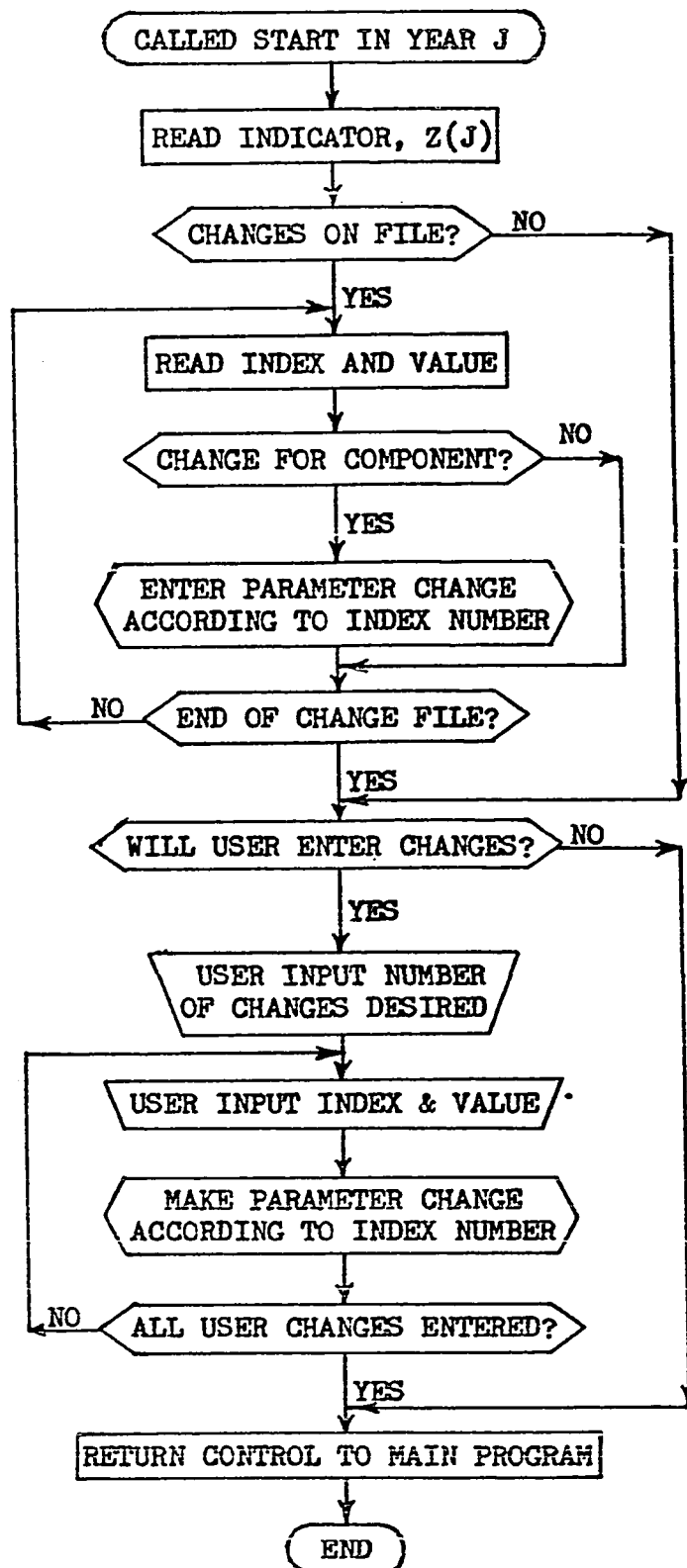
When called up, this subroutine reads the CHANGE file contents for the appropriate forecast year. It then searches those contents for parameter code numbers that match the particular model component being run. Recorded changes are then made to the appropriate parameters utilizing the six-digit code, as explained in the MODEL CHANGE COMPONENT write-up.

Variables:

The AMEND routine does not contain any new variables.

MODIFICATIONS

AMEND SUBROUTINE FLOW DIAGRAM



AMEND SUBROUTINE COMPUTER PROGRAM

```

2995 REM SUBROUTINE TO ENTER PARAMETER CHANGES
2997 DIM NS[25],BS[3]
3000 LET NS="SALESPRODNMANFGADMININCOM"
3010 LET K1=(K/10000-1)*5+1
3015 LET K2=K1+4
3020 LET J1=(J-1)*4+1
3025 READ #2,J1;Z[J]
3035 IF Z[J]=0 THEN 3165
3040 FOR I1=1 TO Z[J]
3045 READ #2;I2,C1
3050 IF I2<K OR I2>K+9999 THEN 3060
3055 GOSUB 3070
3060 NEXT I1
3065 GOTO 3165
3070 LET I=I2-INT(I2/1000)*1000
3072 LET I=INT(I/10)
3075 LET I3=(I2-INT(I2))*10-2
3080 GOTO (I2-K)/1000 OF 3085,3115,3115,3140
3085 LET L=I2-INT(I2/10)*10
3090 GOTO I3 OF 3095,3105
3095 LET A[I,L]=A[I,L]+C1
3100 RETURN
3105 LET C[I,L]=C1
3110 RETURN
3115 GOTO I3 OF 3120,3130
3120 IF K=30000 AND I=18 OR I=25 OR I=27 THEN 830
3121 IF K=40000 AND I=14 THEN 710
3123 LET D[I]=D[I]+C1
3125 RETURN
3130 LET G[I]=C1
3135 RETURN
3140 GOTO I3 OF 3145,3155
3145 LET U[I]=U[I]+C1
3150 RETURN
3155 LET W[I]=C1
3160 RETURN
3165 IF LS[10,12]#"YES" THEN 3225
3167 PRINT
3170 PRINT "MORE ";NS[K1,K2];" CHANGES FOR YEAR";J;
3175 INPUT BS
3180 IF BS#"YES" THEN 3225
3185 PRINT "HOW MANY ";
3190 INPUT I4
3195 PRINT
3200 PRINT "ENTER INDEX NO. AND NEW VALUE FOR EACH"
3205 FOR I1=1 TO I4
3210 INPUT I2,C1
3215 GOSUB 3070
3220 NEXT I1
3225 RETURN
3230 END

```

APPENDIX H

INDEX TO ORGANIZATION MODEL
VARIABLES AND PARAMETERS

INDEX TO ORGANIZATION MODEL

VARIABLES, PARAMETERS AND CHANGE CODES

This index to the model has been set up for two purposes. The first is to provide a coded, sequential listing of all of the variables in each model component together with their associated parameters and possible changes. The second is to provide the mechanism for maintaining an updated record of the changes that have been made in the model to calculate the forecasts for plans that have been proposed.

The variables are listed according to the components in which they are used. The exception is that the status variables are listed separately after the Financial variables. The contents of the index are for:

- Sales Component
- Production Component
- Manufacturing Component
- Administration Component
- Financial Component
- Status Variables

Within each component the index lists the variables and parameters in groups. Each grouping consists of a variable, its parameter(s) and change parameters. If there are no parameters and no possible changes that can be made a variable is listed by itself.

Each index entry includes a "Variable Index No.", "Parameter Code No.", "Program Symbol" and "Description". The variable index number which is not enclosed in brackets is the number used to specify the variable for a print-out by the Report component of the model in the selective printing mode. The variable index numbers enclosed in brackets are the sequential numbers of the base variable and parameter values for the order in which they are stored on the PARAM file for each model component. The parameter code number does not apply to any variable. Each parameter, though, has a six-digit code (as explained in the MODCHG write-up) by which it can be identified. Those ending in .3 or .4 are the ones used for entering parameter changes. The program symbol is the coding used within the particular model component program to designate a specific variable. Only the status variables (the S(I)'s) refer to the same values in all of the model programs. The descriptions are self explanatory.

The variable and parameter values are then listed in columns. The first column initially was reserved for the Base Values at May 31, 1970. These were the variable and parameter values in accordance with the actual, audited results of Kemp's operations at that time and form the basis for all subsequent calculations. That column is followed by pairs of columns for each year to be forecasted. In each pair the first

is for the entry of changes and the second is for the resulting value calculated by the model.

The pairs of columns have been provided for ease of keeping up a record of changes made in the model for particular evaluations. The two columns have been provided for ease of separation and calculation of modified parameter values. Variable results can be printed by the computer as desired. However, the computer does not store the parameter values for each year. These can only be determined by hand calculation in the index according to the nature of a change that has been made. There are two types of changes that can affect rate or multiplier parameters (all are designated with a parameter code number ending in .3):

1. Percentage Change--when made indicates that the new parameter value should be calculated by multiplying the previous year's value by $1 +$ the percentage change:
 e.g. If change = .02, multiply by 1.02
 If change = -.05, multiply by 0.95
2. Discrete or Continuous Change--when made indicates that the new parameter value should be calculated by adding the change to the previous year's value:
 e.g. If change = .023, new value = old + .023
 If change = -.031, new value = old -.031

It is very important to ensure that revised parameter values are extended across all years in the index as changes are made. It will also be beneficial if the new variable values are extended across--particularly after a major set of revisions have been made in the model. The parameter calculations are necessary to enable the determination of exact change values when a revised evaluation is to be developed. Updated results can be beneficial for the same purpose.

A complete listing of all variable results can be obtained by running the REPORT generator in the complete print mode (#3) for each component of the model (i.e. a total of 5 runs). The status variable results can then be obtained by running REPORT in the Statement mode (#2), for any component, and asking for statement number 9.

Note that the Base Values will have to be updated when the next set of audited financial results for the company is available. This will have to be done each year per the Model Updating instructions. That is, when the audited May 31, 1971 statements are available, they will form the Base Values. Similarly in 1972, 1973, and so on.

SALES COMPONENT

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
1 (1) (50)	--	P(1,1)	Sales Forecast for Product 1
	11011.2	A(1,1)	Product 1 Sales Growth Factor
	11011.3	--	Growth Factor--Continuous Change
	11011.4	C(1,1)	Sales Forecast--Discrete Change
1 (2) (51)	--	P(1,2)	Sales Forecast for Product 2
	11012.2	A(1,2)	Product 2 Sales Growth Factor
	11012.3	--	Growth Factor--Continuous Change
	11012.4	C(1,2)	Sales Forecast--Discrete Change
1 (3) (52)	--	P(1,3)	Sales Forecast for Product 3
	11013.2	A(1,3)	Product 3 Sales Growth Factor
	11013.3	--	Growth Factor--Continuous Change
	11013.4	C(1,3)	Sales Forecast--Discrete Change
1 (4) (53)	--	P(1,4)	Sales Forecast for Product 4
	11014.2	A(1,4)	Product 4 Sales Growth Factor
	11014.3	--	Growth Factor--Continuous Change
	11014.4	C(1,4)	Sales Forecast--Discrete Change
1 (5) (54)	--	P(1,5)	Sales Forecast for Product 5
	11015.2	A(1,5)	Product 5 Sales Growth Factor
	11015.3	--	Growth Factor--Continuous Change
	11015.4	C(1,5)	Sales Forecast--Discrete Change
1 (6) (55)	--	P(1,6)	Sales Forecast for Product 6
	11016.2	A(1,6)	Product 6 Sales Growth Factor
	11016.3	--	Growth Factor--Continuous Change
	11016.4	C(1,6)	Sales Forecast--Discrete Change
1 (7) (56)	--	P(1,7)	Sales Forecast for Product 7
	11017.2	A(1,7)	Product 7 Sales Growth Factor
	11017.3	--	Growth Factor--Continuous Change
	11017.4	C(1,7)	Sales Forecast--Discrete Change
1 (8) (57)	--	P(1,8)	Sales Forecast for Product 8
	11018.2	A(1,8)	Product 8 Sales Growth Factor
	11018.3	--	Growth Factor--Continuous Change
	11018.4	C(1,8)	Sales Forecast--Discrete Change
2 (9) (58)	--	P(2,1)	Desired Selling Expenses--Product 1
	11021.2	A(2,1)	Product 1 Sell.Exp.Proportion of Sales
	11021.3	--	Sell.Exp.Proportion--Continuous Change
	11021.4	C(2,1)	Desired Sell.Exp.--Unique Change

Sales Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
2 (10) (59)	--	P(2,2)	Desired Selling Expenses--Product 2
	11022.2	A(2,2)	Product 2 Sell.Exp.Proportion of Sales
	11022.3	--	Sell.Exp.Proportion--Continuous Change
	11022.4	C(2,2)	Desired Sell.Exp.--Unique Change
2 (11) (60)	--	P(2,3)	Desired Selling Expenses--Product 3
	11023.2	A(2,3)	Product 3 Sell.Exp.Proportion of Sales
	11023.3	--	Sell.Exp.Proportion--Continuous Change
	11023.4	C(2,3)	Desired Sell.Exp.--Unique Change
2 (12) (61)	--	P(2,4)	Desired Selling Expenses--Product 4
	11024.2	A(2,4)	Product 4 Sell.Exp.Proportion of Sales
	11024.3	--	Sell.Exp.Proportion--Continuous Change
	11024.4	C(2,4)	Desired Sell.Exp.--Unique Change
2 (13) (62)	--	P(2,5)	Desired Selling Expenses--Product 5
	11025.2	A(2,5)	Product 5 Sell.Exp.Proportion of Sales
	11025.3	--	Sell.Exp.Proportion--Continuous Change
	11025.4	C(2,5)	Desired Sell.Exp.--Unique Change
2 (14) (63)	--	P(2,6)	Desired Selling Expenses--Product 6
	11026.2	A(2,6)	Product 6 Sell.Exp.Proportion of Sales
	11026.3	--	Sell.Exp.Proportion--Continuous Change
	11026.4	C(2,6)	Desired Sell.Exp.--Unique Change
2 (15) (64)	--	P(2,7)	Desired Selling Expenses--Product 7
	11027.2	A(2,7)	Product 7 Sell.Exp.Proportion of Sales
	11027.3	--	Sell.Exp.Proportion--Continuous Change
	11027.4	C(2,7)	Desired Sell.Exp.--Unique Change
2 (16) (65)	--	P(2,8)	Desired Selling Expenses--Product 8
	11028.2	A(2,8)	Product 8 Sell.Exp.Proportion of Sales
	11028.3	--	Sell.Exp.Proportion--Continuous Change
	11028.4	C(2,8)	Desired Sell.Exp.--Unique Change
3 (17) (66)	--	P(3,1)	Desired Admin. Expenses--Product 1
	11031.2	A(3,1)	Product 1 Adm.Exp.Proportion of Sales
	11031.3	--	Adm.Exp.Proportion--Continuous Change
	11031.4	C(3,1)	Desired Adm.Exp.--Unique Change
3 (18) (67)	--	P(3,2)	Desired Admin. Expenses--Product 2
	11032.2	A(3,2)	Product 2 Adm.Exp.Proportion of Sales
	11032.3	--	Adm.Exp.Proportion--Continuous Change
	11032.4	C(3,2)	Desired Adm.Exp.--Unique Change

Sales Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
3 (19) (68)	--	P(3,3)	Desired Admin.Expenses--Product 3
	11033.2	A(3,3)	Product 3 Adm.Exp.Proportion of Sales
	11033.3	--	Adm.Exp.Proportion--Continuous Change
	11033.4	C(3,3)	Desired Adm.Exp.--Unique Change
3 (20) (69)	--	P(3,4)	Desired Admin. Expenses--Product 4
	11034.2	A(3,4)	Product 4 Adm.Exp.Proportion of Sales
	11034.3	--	Adm.Exp.Proportion--Continuous Change
	11034.4	C(3,4)	Desired Adm.Exp.--Unique Change
3 (21) (70)	--	P(3,5)	Desired Admin. Expenses--Product 5
	11035.2	A(3,5)	Product 5 Adm.Exp.Proportion of Sales
	11035.3	--	Adm.Exp.Proportion--Continuous Change
	11035.4	C(3,5)	Desired Adm.Exp.--Unique Change
3 (22) (71)	--	P(3,6)	Desired Admin. Expenses--Product 6
	11036.2	A(3,6)	Product 6 Adm.Exp.Proportion of Sales
	11036.3	--	Adm.Exp.Proportion--Continuous Change
	11036.4	C(3,6)	Desired Adm.Exp.--Unique Change
3 (23) (72)	--	P(3,7)	Desired Admin. Expenses--Product 7
	11037.2	A(3,7)	Product 7 Adm.Exp.Proportion of Sales
	11037.3	--	Adm.Exp.Proportion--Continuous Change
	11037.4	C(3,7)	Desired Adm.Exp.--Unique Change
3 (24) (73)	--	P(3,8)	Desired Admin. Expenses--Product 8
	11038.2	A(3,8)	Product 8 Adm.Exp.Proportion of Sales
	11038.3	--	Adm.Exp.Proportion--Continuous Change
	11038.4	C(3,8)	Desired Adm.Exp.--Unique Change
4 (25) (74)	--	P(4,1)	Selling Price Per Pallet--Product 1
	11041.2	A(4,1)	Product 1 Selling Price Growth Factor
	11041.3	--	Growth Factor--Continuous Change
	11041.4	C(4,1)	Selling Price Per Pallet--Discrete Change
4 (26) (75)	--	P(4,2)	Selling Price Per Pallet--Product 2
	11042.2	A(4,2)	Product 2 Selling Price Growth Factor
	11042.3	--	Growth Factor--Continuous Change
	11042.4	C(4,2)	Selling Price/Pallet--Discrete Change
4 (27) (76)	--	P(4,3)	Selling Price Per Pallet--Product 3
	11043.2	A(4,3)	Product 3 Selling Price Growth Factor
	11043.3	--	Growth Factor--Continuous Change
	11043.4	C(4,3)	Selling Price/Pallet--Discrete Change

Sales Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
4 (28)	--	P(4,4)	Selling Price Per Pallet--Product 4
(77)	11044.2	A(4,4)	Product 4 Selling Price Growth Factor
	11044.3	--	Growth Factor--Continuous Change
	11044.4	C(4,4)	Selling Price/Pallet--Discrete Change
4 (29)	--	P(4,5)	Selling Price Per Pallet--Product 5
(78)	11045.2	A(4,5)	Product 5 Selling Price Growth Factor
	11045.3	--	Growth Factor--Continuous Change
	11045.4	C(4,5)	Selling Price/Pallet--Discrete Change
4 (30)	--	P(4,6)	Selling Price Per Pallet--Product 6
(79)	11046.2	A(4,6)	Product 6 Selling Price Growth Factor
	11046.3	--	Growth Factor--Continuous Change
	11046.4	C(4,6)	Selling Price/Pallet--Discrete Change
4 (31)	--	P(4,7)	Selling Price Per Pallet--Product 7
(80)	11047.2	A(4,7)	Product 7 Selling Price Growth Factor
	11047.3	--	Growth Factor--Continuous Change
	11047.4	C(4,7)	Selling Price/Pallet--Discrete Change
4 (32)	--	P(4,8)	Selling Price Per Pallet--Product 8
(81)	11048.2	A(4,8)	Product 8 Selling Price Growth Factor
	11048.3	--	Growth Factor--Continuous Change
	11048.4	C(4,8)	Selling Price/Pallet--Discrete Change
5 (33)	--	P(5,1)	Pallets of Sales Forecast--Product 1
5 (34)	--	P(5,2)	Pallets of Sales Forecast--Product 2
5 (35)	--	P(5,3)	Pallets of Sales Forecast--Product 3
5 (36)	--	P(5,4)	Pallets of Sales Forecast--Product 4
5 (37)	--	P(5,5)	Pallets of Sales Forecast--Product 5
5 (38)	--	P(5,6)	Pallets of Sales Forecast--Product 6
5 (39)	--	P(5,7)	Pallets of Sales Forecast--Product 7
5 (40)	--	P(5,8)	Pallets of Sales Forecast--Product 8
6 (41)	--	F(1)	Total Selling Expenses
7 (42)	--	F(2)	Number of Salaried Sales Personnel
	12020.4	G(2)	Change in Number of Sales Personnel
8 (43)	--	F(3)	Sales Salaries (Total)
(91)	12020.2	D(2)	Average Sales Salary
	12020.3	--	Average Sales Salary--Discrete Change
(92)	12030.2	D(3)	Sales Salaries Growth Factor
	12030.3	--	Salaries Growth Factor--Cont. Change
	12030.4	G(3)	Total Sales Salaries--Discrete Change

Sales Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
9 (44) (93)	--	F(4)	Sales Travel Costs (Leases & Expenses)
	12040.2	D(4)	Avg. Travel Cost per Salaried Person
	12040.3	--	Avg. Travel Cost--Continuous Change
	12040.4	G(4)	Ttl.Sales Travel Costs--Discrete Change
10 (45) (94)	--	F(5)	Sales Commissions (Fixed & Variable)
	12050.2	D(5)	Avg.Commission Rate on Gross Sales
	12050.3	--	Avg.Commission Rate--Cont. Change
	12050.4	G(5)	Fixed Sales Comm.--Discrete Change
11 (46) (95)	--	F(6)	Freight-Out (Total)
	12060.2	D(6)	Freight-Out Proportion of Gross Sales
	12060.3	--	Freight-Out Proportion--Cont. Change
	12060.4	G(6)	Freight-Out Costs (Ttl.)--Disc.Change
12 (47) (96)	--	F(7)	Advertising and Promotion (Total)
	12070.2	D(7)	Advertising Proportion of Gross Sales
	12070.3	--	Advertising Proportion--Cont. Change
	12070.4	G(7)	Advertising Costs (Ttl.)--Disc. Change
13 (48)	--	T(1)	Total Expenses minus Desired
14 (49)	--	T(2)	Percent of Difference over Des.Expenses

PRODUCTION COMPONENT

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
1 (1) (120)	-- 21011.2 21011.3 21011.4	P(1,1) A(1,1) -- C(1,1)	Pallets for Inventory--Product 1 Product 1 Avg.Inv.Prop. of Sales Inventory Propn.of Sales--Disc.Change Inventory Pallets--Unique Change
1 (2) (121)	-- 21012.2 21012.3 21012.4	P(1,2) A(1,2) -- C(1,2)	Pallets for Inventory--Product 2 Product 2 Avg.Inv.Prop. of Sales Inventory Propn.of Sales--Disc.Change Inventory Pallets--Unique Change
1 (3) (122)	-- 21013.2 21013.3 21013.4	P(1,3) A(1,3) -- C(1,4)	Pallets for Inventory--Product 3 Product 3 Avg.Inv.Prop. of Sales Inventory Propn.of Sales--Disc.Change Inventory Pallets--Unique Change
1 (4) (123)	-- 21014.2 21014.3 21014.4	P(1,4) A(1,4) -- C(1,4)	Pallets for Inventory--Product 4 Product 4 Avg.Inv.Prop. of Sales Inventory Propn.of Sales--Disc.Change Inventory Pallets--Unique Change
1 (5) (124)	-- 21015.2 21015.3 21015.4	P(1,5) A(1,5) -- C(1,5)	Pallets for Inventory--Product 5 Product 5 Avg.Inv.Prop. of Sales Inventory Propn.of Sales--Disc.Change Inventory Pallets--Unique Change
1 (6) (125)	-- 21016.2 21016.3 21016.4	P(1,6) A(1,6) -- C(1,6)	Pallets for Inventory--Product 6 Product 6 Avg.Inv.Prop. of Sales Inventory Propn.of Sales--Disc.Change Inventory Pallets--Unique Change
1 (7) (126)	-- 21017.2 21017.3 21017.4	P(1,7) A(1,7) -- C(1,7)	Pallets for Inventory--Product 7 Product 7 Avg.Inv.Prop. of Sales Inventory Propn.of Sales--Disc.Change Inventory Pallets--Unique Change
1 (8) (127)	-- 21018.2 21018.3 21018.4	P(1,8) A(1,8) -- C(1,8)	Pallets for Inventory--Product 8 Product 8 Avg.Inv.Prop. of Sales Inventory Propn.of Sales--Disc.Change Inventory Pallets--Unique Change
2 (9)	--	P(2,1)	Dollars of Inventory Change--Prod. 1
2 (10)	--	P(2,2)	Dollars of Inventory Change--Prod. 2
2 (11)	--	P(2,3)	Dollars of Inventory Change--Prod. 3
2 (12)	--	P(2,4)	Dollars of Inventory Change--Prod. 4
2 (13)	--	P(2,5)	Dollars of Inventory Change--Prod. 5
2 (14)	--	P(2,6)	Dollars of Inventory Change--Prod. 6
2 (15)	--	P(2,7)	Dollars of Inventory Change--Prod. 7
2 (16)	--	P(2,8)	Dollars of Inventory Change--Prod. 8

Production Component (Cont'd.)

<u>VARIABLE INDEX NO.</u>	<u>PARAMETER CODE NO.</u>	<u>PROGRAM SYMBOL</u>	<u>DESCRIPTION</u>
3 (17)	--	P(3,1)	Production Pallets for Product 1
3 (18)	--	P(3,2)	Production Pallets for Product 2
3 (19)	--	P(3,3)	Production Pallets for Product 3
3 (20)	--	P(3,4)	Production Pallets for Product 4
3 (21)	--	P(3,5)	Production Pallets for Product 5
3 (22)	--	P(3,6)	Production Pallets for Product 6
3 (23)	--	P(3,7)	Production Pallets for Product 7
3 (24)	--	P(3,8)	Production Pallets for Product 8
4 (25)	--	P(4,1)	Production Hours for Product 1
(144)	21041.2	A(4,1)	Hours per Pallet for Product 1
	21041.3	--	Hours per Pallet--Discrete Change
	21041.4	C(4,1)	Production Hours--Unique Change
4 (26)	--	P(4,2)	Production Hours for Product 2
(145)	21042.2	A(4,2)	Hours per Pallet for Product 2
	21042.3	--	Hours per Pallet--Discrete Change
	21042.4	C(4,2)	Production Hours--Unique Change
4 (27)	--	P(4,3)	Production Hours for Product 3
(146)	21043.2	A(4,3)	Hours per Pallet for Product 3
	21043.3	--	Hours per Pallet--Discrete Change
	21043.4	C(4,3)	Production Hours--Unique Change
4 (28)	--	P(4,4)	Production Hours for Product 4
(147)	21044.2	A(4,4)	Hours per Pallet for Product 4
	21044.3	--	Hours per Pallet--Discrete Change
	21044.4	C(4,4)	Production Hours--Unique Change
4 (29)	--	P(4,5)	Production Hours for Product 5
(148)	21045.2	A(4,5)	Hours per Pallet for Product 5
	21045.3	--	Hours per Pallet--Discrete Change
	21045.4	C(4,5)	Production Hours--Unique Change
4 (30)	--	P(4,6)	Production Hours for Product 6
(149)	21046.2	A(4,6)	Hours Per Pallet for Product 6
	21046.3	--	Hours per Pallet--Discrete Change
	21046.4	C(4,6)	Production Hours--Unique Change
4 (31)	--	P(4,7)	Production Hours for Product 7
(150)	21047.2	A(4,7)	Hours per Pallet for Product 7
	21047.3	--	Hours per Pallet--Discrete Change
	21047.4	C(4,7)	Production Hours--Unique Change
4 (32)	--	P(4,8)	Production Hours for Product 8
(151)	21048.2	A(4,8)	Hours per Pallet for Product 8
	21048.3	--	Hours per Pallet--Discrete Change
	21048.4	C(4,8)	Production Hours--Unique Change

Production Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
5 (33) (152)	--	P(5,1)	Number of Machines Leased--Product 1
	21051.2	A(5,1)	Machine 1 Annual Lease Charges
	21051.3	--	Machine 1 Lease Rate--Discrete Change
	21051.4	C(5,1)	Machine 1 Lease Costs--Unique Change
	21021.4	C(2,1)	Number of Machines Leased--Disc.Change
5 (34) (153)	--	P(5,2)	Number of Machines Leased--Product 2
	21052.2	A(5,2)	Machine 2 Annual Lease Charges
	21052.3	--	Machine 2 Lease Rate--Discrete Change
	21052.4	C(5,2)	Machine 2 Lease Costs--Unique Change
	21022.4	C(2,2)	Number of Machines Leased--Disc.Change
5 (35) (154)	--	P(5,3)	Number of Machines Leased--Product 3
	21053.2	A(5,3)	Machine 3 Annual Lease Charges
	21053.3	--	Machine 3 Lease Rate--Discrete Change
	21053.4	C(5,3)	Machine 3 Lease Costs--Unique Change
	21023.4	C(2,3)	Number of Machines Leased--Disc.Change
5 (36) (155)	--	P(5,4)	Number of Machines Leased--Product 4
	21054.2	A(5,4)	Machine 4 Annual Lease Charges
	21054.3	--	Machine 4 Lease Rate--Discrete Change
	21054.4	C(5,4)	Machine 4 Lease Costs--Unique Change
	21024.4	C(2,4)	Number of Machines Leased--Disc.Change
5 (37) (156)	--	P(5,5)	Number of Machines Leased--Product 5
	21055.2	A(5,5)	Machine 5 Annual Lease Charges
	21055.3	--	Machine 5 Lease Rate--Discrete Change
	21055.4	C(5,5)	Machine 5 Lease Costs--Unique Change
	21025.4	C(2,5)	Number of Machines Leased--Disc. Change
5 (38) (157)	--	P(5,6)	Number of Machines Leased--Product 6
	21056.2	A(5,6)	Machine 6 Annual Lease Charges
	21056.3	--	Machine 6 Lease Rate--Discrete Change
	21056.4	C(5,6)	Machine 6 Lease Costs--Unique Change
	21026.4	C(2,6)	Number of Machines Leased--Disc.Change
5 (39) (158)	--	P(5,7)	Number of Machines Leased--Product 7
	21057.2	A(5,7)	Machine 7 Annual Lease Charges
	21057.3	--	Machine 7 Lease Rate--Discrete Change
	21057.4	C(5,7)	Machine 7 Lease Costs--Unique Change
	21027.4	C(2,7)	Number of Machines Leased--Disc.Change
5 (40) (159)	--	P(5,8)	Number of Machines Leased--Product 8
	21058.2	A(5,8)	Machine 8 Annual Lease Charges
	21058.3	--	Machine 8 Lease Rate--Discrete Change
	21058.4	C(5,8)	Machine 8 Lease Costs--Unique Change
	21028.4	C(2,8)	Number of Machines Leased--Disc.Change

Production Component (Cont'd.)

<u>VARIABLE INDEX NO.</u>	<u>PARAMETER CODE NO.</u>	<u>PROGRAM SYMBOL</u>	<u>DESCRIPTION</u>
6 (41)	-- 21061.4	P(6,1) C(6,1)	Lease Record Number--Machine 1 Lease Record Number--Discrete Change
6 (42)	-- 21062.4	P(6,2) C(6,2)	Lease Record Number--Machine 2 Lease Record Number--Discrete Change
6 (43)	-- 21063.4	P(6,3) C(6,3)	Lease Record Number--Machine 3 Lease Record Number--Discrete Change
6 (44)	-- 21064.4	P(6,4) C(6,4)	Lease Record Number--Machine 4 Lease Record Number--Discrete Change
6 (45)	-- 21065.4	P(6,5) C(6,5)	Lease Record Number--Machine 5 Lease Record Number--Discrete Change
6 (46)	-- 21066.4	P(6,6) C(6,6)	Lease Record Number--Machine 6 Lease Record Number--Discrete Change
6 (47)	-- 21067.4	P(6,7) C(6,7)	Lease Record Number--Machine 7 Lease Record Number--Discrete Change
6 (48)	-- 21068.4	P(6,8) C(6,8)	Lease Record Number--Machine 8 Lease Record Number--Discrete Change
7 (49) (168)	-- 21071.2 21071.3 21071.4	P(7,1) A(7,1) -- C(7,1)	Number off Lease this Year--Machine 1 Purchase Price of Prev. Leased Mach. 1 Old Mach. Purch. Price--Discrete Change Old Mach. Purch. Price--Unique Charge
7 (50) (169)	-- 21072.2 21072.3 21072.4	P(7,2) A(7,2) -- C(7,2)	Number off Lease this year--Machine 2 Purchase Price of Prev. Leased Mach. 2 Old Mach. Purch. Price--Discrete Change Old Mach. Purch. Price--Unique Charge
7 (51) (170)	-- 21073.2 21073.3 21073.4	P(7,3) A(7,3) -- C(7,3)	Number off Lease this Year--Machine 3 Purchase Price of Prev. Leased Mach. 3 Old Mach. Purch. Price--Discrete Change Old Mach. Purch. Price--Unique Charge
7 (52) (171)	-- 21074.2 21074.3 21074.4	P(7,4) A(7,4) -- C(7,4)	Number off Lease this Year--Machine 4 Purchase Price of Prev. Leased Mach. 4 Old Mach. Purch. Price--Discrete Change Old Mach. Purch. Price--Unique Charge
7 (53) (172)	-- 21075.2 21075.3 21075.4	P(7,5) A(7,5) -- C(7,5)	Number off Lease this Year--Machine 5 Purchase Price of Prev. Leased Mach. 5 Old Mach. Purch. Price--Discrete Change Old Mach. Purch. Price--Unique Charge

Production Component (Cont'd.)

<u>VARIABLE INDEX NO.</u>	<u>PARAMETER CODE NO.</u>	<u>PROGRAM SYMBOL</u>	<u>DESCRIPTION</u>
7 (54) (173)	--	P(7,6)	Number off Lease this Year--Machine 6
	21076.2	A(7,6)	Purchase Price of Prev.Leased Mach. 6
	21076.3	--	Old Mach.Purch.Price--Discrete Change
	21076.4	C(7,6)	Old Mach.Purch.Price--Unique Charge
7 (55) (174)	--	P(7,7)	Number off Lease this Year--Machine 7
	21077.2	A(7,7)	Purchase Price of Prev.Leased Mach. 7
	21077.3	--	Old Mach.Purch.Price--Discrete Change
	21077.4	C(7,7)	Old Mach.Purch.Price--Unique Charge
7 (56) (175)	--	P(7,8)	Number off Lease this Year--Machine 8
	21078.2	A(7,8)	Purchase Price of Frev.Leased Mach. 8
	21078.3	--	Old Mach.Purch.Price--Discrete Change
	21078.4	C(7,8)	Old Mach.Purch.Price--Unique Charge
8 (57) (184) (192)	--	P(8,1)	No. of Machines Available--Type 1
	21081.4	C(8,1)	No. of Machines--Discrete Change
	21091.2	A(9,1)	Installation Cost per Machine Type 1
	21091.3	--	Installation Cost--Discrete Change
	21091.4	C(9,1)	Installation Cost--Unique Charge
	21101.2	A(10,1)	Purchase Price of New Machine 1
	21101.3	--	New Machine Cost--Discrete Change
	21101.4	C(10,1)	New Machine Cost--Unique Charge
8 (58) (185) (193)	--	P(8,2)	No. of Machines Available--Type 2
	21082.4	C(8,2)	No. of Machines--Discrete Change
	21092.2	A(9,2)	Installation Cost per Machine Type 2
	21092.3	--	Installation Cost--Discrete Change
	21092.4	C(9,2)	Installation Cost--Unique Charge
	21102.2	A(10,2)	Purchase Price of New Machine 2
	21102.3	--	New Machine Cost--Discrete Change
	21102.4	C(10,2)	New Machine Cost--Unique Charge
8 (59) (186) (194)	--	P(8,3)	No. of Machines Available--Type 3
	21083.4	C(8,3)	No. of Machines--Discrete Change
	21093.2	A(9,3)	Installation Cost per Machine Type 3
	21093.3	--	Installation Cost--Discrete Change
	21093.4	C(9,3)	Installation Cost--Unique Charge
	21103.2	A(10,3)	Purchase Price of New Machine 3
	21103.3	--	New Machine Cost--Discrete Change
	21103.4	C(10,3)	New Machine Cost--Unique Charge

Production Component (Cont'd.)

<u>VARIABLE INDEX NO.</u>	<u>PARAMETER CODE NO.</u>	<u>PROGRAM SYMBOL</u>	<u>DESCRIPTION</u>
8 (60)	--	P(8,4)	No. of Machines Available--Type 4
	21084.4	C(8,4)	No. of Machines--Discrete Change
(187)	21094.2	A(9,4)	Installation Cost per Machine Type 4
	21094.3	--	Installation Cost--Discrete Change
	21094.4	C(9,4)	Installation Cost--Unique Charge
(195)	21104.2	A(10,4)	Purchase Price of New Machine 4
	21104.3	--	New Machine Cost--Discrete Change
	21104.4	C(10,4)	New Machine Cost--Unique Charge
8 (61)	--	P(8,5)	No. of Machines Available--Type 5
	21085.4	C(8,5)	No. of Machines--Discrete Change
(188)	21095.2	A(9,5)	Installation Cost per Machine--Type 5
	21095.3	--	Installation Cost--Discrete Change
	21095.4	C(9,5)	Installation Cost--Unique Charge
(196)	21105.2	A(10,5)	Purchase Price of New Machine 5
	21105.3	--	New Machine Cost--Discrete Change
	21105.4	C(10,5)	New Machine Cost--Unique Charge
8 (62)	--	P(8,6)	No. of Machines Available--Type 6
	21086.4	C(8,6)	No. of Machines--Discrete Change
(189)	21096.2	A(9,6)	Installation Cost per Machine Type 6
	21096.3	--	Installation Cost--Discrete Change
	21096.4	C(9,6)	Installation Cost--Unique Charge
(197)	21106.2	A(10,6)	Purchase Price of New Machine 6
	21106.3	--	New Machine Cost--Discrete Change
	21106.4	C(10,6)	New Machine Cost--Unique Charge
8 (63)	--	P(8,7)	No. of Machines Available--Type 7
	21087.4	C(8,7)	No. of Machines--Discrete Change
(190)	21097.2	A(9,7)	Installation Cost per Machine Type 7
	21097.3	--	Installation Cost--Discrete Change
	21097.4	C(9,7)	Installation Cost--Unique Charge
(198)	21107.2	A(10,7)	Purchase Price of New Machine 7
	21107.3	--	New Machine Cost--Discrete Change
	21107.4	C(10,7)	New Machine Cost--Unique Charge
8 (64)	--	P(8,8)	No. of Machines Available--Type 8
	21088.4	C(8,8)	No. of Machines--Discrete Change
(191)	21098.2	A(9,8)	Installation Cost per Machine Type 8
	21098.3	--	Installation Cost--Discrete Change
	21098.4	C(9,8)	Installation Cost--Unique Charge
(199)	21108.2	A(10,8)	Purchase Price of New Machine 8
	21108.3	--	New Machine Cost--Discrete Change
	21108.4	C(10,8)	New Machine Cost--Unique Charge

Production Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
9 (65)	--	P(9,1)	Number of Machines (Min.)--Type 1
9 (66)	--	P(9,2)	Number of Machines (Min.)--Type 2
9 (67)	--	P(9,3)	Number of Machines (Min.)--Type 3
9 (68)	--	P(9,4)	Number of Machines (Min.)--Type 4
9 (69)	--	P(9,5)	Number of Machines (Min.)--Type 5
9 (70)	--	P(9,6)	Number of Machines (Min.)--Type 6
9 (71)	--	P(9,7)	Number of Machines (Min.)--Type 7
9 (72)	--	P(9,8)	Number of Machines (Min.)--Type 8
10 (73)	--	P(10,1)	Number of Machines (Ideal)--Type 1
10 (74)	--	P(10,2)	Number of Machines (Ideal)--Type 2
10 (75)	--	P(10,3)	Number of Machines (Ideal)--Type 3
10 (76)	--	P(10,4)	Number of Machines (Ideal)--Type 4
10 (77)	--	P(10,5)	Number of Machines (Ideal)--Type 5
10 (78)	--	P(10,6)	Number of Machines (Ideal)--Type 6
10 (79)	--	P(10,7)	Number of Machines (Ideal)--Type 7
10 (80)	--	P(10,8)	Number of Machines (Ideal)--Type 8
11 (81)	--	F(11,1)	Hours Transferred from Machines 1
11 (82)	--	P(11,2)	Hours Transferred from Machines 2
11 (83)	--	P(11,3)	Hours Transferred from Machines 3
11 (84)	--	P(11,4)	Hours Transferred from Machines 4
11 (85)	--	P(11,5)	Hours Transferred from Machine 5
11 (86)	--	P(11,6)	Hours Transferred from Machine 6
11 (87)	--	P(11,7)	Hours Transferred from Machines 7
11 (88)	--	P(11,8)	Hours Transferred from Machines 8
12 (89)	--	P(12,1)	Desired Plant Space for Machines 1
(208)	21121.2	A(12,1)	Plant Space Needed per Machine 1
	21121.3	--	Space per Machine--Discrete Change
	21121.4	C(12,1)	Space for Machine 1--Extra Area Need
12 (90)	--	P(12,2)	Desired Plant Space for Machines 2
(209)	21122.2	A(12,2)	Plant Space Needed per Machine 2
	21122.3	--	Space per Machine--Discrete Change
	21133.4	C(12,2)	Space for Machines 2--Extra Area Need
12 (91)	--	P(12,3)	Desired Plant Space for Machines 3
(210)	21123.2	A(12,3)	Plant Space Needed per Machine 3
	21123.3	--	Space per Machine--Discrete Change
	21123.4	C(12,3)	Space for Machine 3--Extra Area Need
12 (92)	--	P(12,4)	Desired Plant Space for Machines 4
(211)	21124.2	A(12,4)	Plant Space Needed per Machine 4
	21124.3	--	Space per Machine--Discrete Change
	21124.4	C(12,4)	Space for Machines 4--Extra area Need

Production Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
12 (93) (212)	--	P(12,5)	Desired Plant Space for Machines 5
	21125.2	A(12,5)	Plant Space Needed per Machine 5
	21125.3	--	Space per Machine--Discrete Change
	21125.4	C(12,5)	Space for Machines 5--Extra Area Need
12 (94) (213)	--	P(12,6)	Desired Plant Space for Machines 6
	21126.2	A(12,6)	Plant Space Needed per Machine 6
	21126.3	--	Space per Machine--Discrete Change
	21126.4	C(12,6)	Space for Machines 6--Extra Area Need
12 (95) (214)	--	P(12,7)	Desired Plant Space for Machines 7
	21127.2	A(12,7)	Plant Space Needed per Machine 7
	21127.3	--	Space per Machine--Discrete Change
	21127.4	C(12,7)	Space for Machines 7--Extra Area Need
12 (96) (215)	--	P(12,8)	Desired Plant Space for Machines 8
	21128.2	A(12,8)	Plant Space Needed per Machine 8
	21128.3	--	Space per Machine--Discrete Change
	21128.4	C(12,8)	Space for Machines 8--Extra Area Need
13 (97) (216)	--	P(13,1)	Desired Net Warehouse Space--Product 1
	21131.2	A(13,1)	Average Space per Pallet--Product 1
	21131.3	--	Storage Space per Pallet--Disc.Change
	21131.4	C(13,1)	Storage Space Needed--Extra Addition
13 (98) (217)	--	P(13,2)	Desired Net Warehouse Space--Product 2
	21132.2	A(13,2)	Average Space per Pallet--Product 2
	21132.3	--	Storage Space per Pallet--Disc.Change
	21132.4	C(13,2)	Storage Space Needed--Extra Addition
13 (99) (218)	--	P(13,3)	Desired Net Warehouse Space--Product 3
	21133.2	A(13,3)	Average Space per Pallet--Product 3
	21133.3	--	Storage Space per Pallet--Disc.Change
	21133.4	C(13,3)	Storage Space Needed--Extra Addition
13 (100) (219)	--	P(13,4)	Desired Net Warehouse Space--Product 4
	21134.2	A(13,4)	Average Space per Pallet--Product 4
	21134.3	--	Storage Space per Pallet--Disc. Change
	21134.4	C(13,4)	Storage Space Needed--Extra Addition
13 (101) (220)	--	P(13,5)	Desired Net Warehouse Space--Product 5
	21135.2	A(13,5)	Average Space per Pallet--Product 5
	21135.3	--	Storage Space per Pallet--Disc.Change
	21135.4	C(13,5)	Storage Space Needed--Extra Addition

Production Component (Cont'd.)

<u>VARIABLE INDEX NO.</u>	<u>PARAMETER CODE NO.</u>	<u>PROGRAM SYMBOL</u>	<u>DESCRIPTION</u>
13 (102) (221)	-- 21136.2 21136.3 21136.4	P(13,6) A(13,6) -- C(13,6)	Desired Net Warehouse Space--Product 6 Average Space per Pallet--Product 6 Storage Space per Pallet--Disc.Change Storage Space Needed--Extra Addition
13 (103) (222)	-- 21137.2 21137.3 21137.4	P(13,7) A(13,7) -- C(13,7)	Desired Net Warehouse Space--Product 7 Average Space per Pallet--Product 7 Storage Space per Pallet--Disc.Change Storage Space Needed--Extra Addition
13 (104) (223)	-- 21138.2 21138.3 21138.4	P(13,8) A(13,8) -- C(13,8)	Desired Net Warehouse Space--Product 8 Average Space per Pallet--Product 8 Storage Space per Pallet--Disc.Change Storage Space Needed--Extra Addition
14 (105) (224)	-- 22010.2 22010.3 22010.4	F(1) D(1) -- G(1)	Minimum Plant Space Needed Min.Space Proportion of Total Desired Min.Plant Space Proportion--Disc.Change Min.Plant Space (Total)--Decided Change
15 (106)	-- 22020.4	F(2) G(2)	Total Plant Space Total Plant Space--Decided Change
16 (107) (226)	-- 22030.2 22030.3 22030.4	F(3) D(3) -- G(3)	Rented Plant Space Purch.Price/MSF--Prev. Rented Plant Old Plant Purch.Price--Discrete Change Rented Plant Space--MSF to Purchase
17 (108) (227)	-- 22040.2 22040.3	F(4) D(4) --	Min. Warehouse Space Needed Whse.Space(MSF) for Receiving & Office Receiving & Office Space--Disc. Change
18 (109)	-- 22050.4	F(5) G(5)	Total Warehouse Space Total Warehouse Space--Decided Change
19 (110) (229)	-- 22060.2 22060.3 22060.4	F(6) D(6) -- G(6)	Rented Warehouse Space Purch.Price/MSF--Prev. Rented Whse. Old Whse.Purchase Price--Disc. Change Rented Whse Space--MSF to Purchase
20 (111)	-- 22070.4	F(7) G(7)	Production Hours Available (Year) Production Hours Available--Disc.Change
21 (112) (231)	-- 22080.2 22080.3 22080.4	F(8) D(8) -- G(8)	Max. Usable Production Hours Max.Prodn.Hours Proportion of Total Max.Hours Proportion--Discrete Change Max.Production Hours--Unique Change

Production Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
22 (113)	--	F(9)	Desired Production Hours Loading
(232)	22090.2	D(9)	Desired Prod'n.Hours Propn. of Total
	22090.3	--	Desired Hours Propn.--Discrete Change
	22090.4	G(9)	Desired Production Hours--Unique Change
23 (114)	--	T(1)	Total Inventory Pallets
24 (115)	--	T(2)	Total Production Pallets
25 (116)	--	T(3)	Total Desired Plant Space
26 (117)	--	T(4)	Total Net Desired Warehouse Space
27 (118)	--	T(5)	New Plant Space Added
28 (119)	--	T(6)	New Warehouse Space Added
--	--	S(5)	Number of Production Workers (Total)
(128)	21021.2	A(2,1)	Labour Productivity Growth Fac.(All Types)
	21021.3	--	Labour Prod.Growth Fac.--Disc. Change*
(136)	21031.2	A(3,1)	Avg. Pallets per Worker/Yr. Prod. 1
	21031.4	C(3,1)	Pallets/Worker--Discrete Change
(137)	21032.2	A(3,2)	Avg. Pallets/Worker/Yr.--Product 2
	21032.4	C(3,2)	Pallets/Worker--Discrete Change
(138)	21033.2	A(3,3)	Avg. Pallets/Worker/Yr.--Product 3
	21033.4	C(3,3)	Pallets/Worker--Discrete Change
(139)	21034.2	A(3,4)	Avg. Pallets/Worker/Yr.--Product 4
	21034.4	C(3,4)	Pallets/Worker--Discrete Change
(140)	21035.2	A(3,5)	Avg. Pallets/Worker/Yr.--Product 5
	21035.4	C(3,5)	Pallets/Worker--Discrete Change
(141)	21036.2	A(3,6)	Avg. Pallets/Worker/Yr.--Product 6
	21036.4	C(3,6)	Pallets/Worker--Discrete Change
(142)	21037.2	A(3,7)	Avg. Pallets/Worker/Yr.--Product 7
	21037.4	C(3,7)	Pallets/Worker--Discrete Change
(143)	21038.2	A(3,8)	Avg. Pallets/Worker/Yr.--Product 8
	21038.4	C(3,8)	Pallets/Worker--Discrete Change
	24050.4	W(5)	No. of Workers--Decided, Unique Change

* When this change is made it induces a percentage change in all labour productivity figures (A (3,L)'s). If growth factor change does not apply to a particular machine or product category, offset by a discrete change through the appropriate C(3,L).

--	--	--	S(6)	Total Plant Rentals
			U(6)	Annual Rent per MSF Plant Space
	24060.3	--	--	Rent per MSF Plant--Discrete Change
	24060.4	W(6)	--	Rent for Plant--Unique Change
--	--	--	S(7)	Total Warehouse Rent
			U(7)	Annual Rent per MSF Warehouse
	24070.3	--	--	Rent per MSF Whse.--Discrete Change
	24070.4	W(7)	--	Rent for Warehouse--Unique Change

Production Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
--	--	S(8)	Total Production Equipment Leases
--	--	U(8)	Other Equipment Rent (Annual)
	24080.3	--	Other Equipment Rent--Discrete Change
--	--	S(10)	Plant & Parking Lot Assets (Net)
--	--	U(10)	Construction Cost per MSF of New Plant
	24100.3	--	Construction Cost per MSF--Disc.Change
	24100.4	W(10)	New Plant Assets Total--Disc. Change
--	--	S(11)	Warehouse Building Assets (Net)
--	--	U(11)	Construction Cost per MSF of New Whse.
	24110.3	--	Construction Cost per MSF--Disc.Change
	24110.4	W(11)	New Whse.Assets Ttl.--Discrete Change
--	--	S(12)	Equipment and Machine Assets (Net)
	24120.4	W(12)	Equipment Assets Total--Disc. Change

MANUFACTURING COMPONENT

<u>VARIABLE INDEX NO.</u>	<u>PARAMETER CODE NO.</u>	<u>PROGRAM SYMBOL</u>	<u>DESCRIPTION</u>
1 (1)	--	F(1)	Mould Division Gross Profit (Loss)
2 (2)	-- 32020.4	F(2) G(2)	Mould Inventory Change Mould Inventory Change in Year
3 (3)	--	F(3)	Gross Sales (Manufacturing)
4 (4) (48)	-- 32040.2 32040.3 32040.4	F(4) D(4) -- G(4)	Royalties Charged Royalties Propn. of Prev. Yr. Charge Royalties Proportion--Discrete Change Royalties Charged--Discrete Change
5 (5) (49)	-- 32050.2 32050.3 32050.4 34150.4	F(5) D(5) -- G(5) W(15)	Mould Expenses Charged Mould Expense Propn. of Prepaid Moulds Mould Expense Propn.--Discrete Change Mould Charges--Unique Change Prepaid Mould Exp.--Discrete Change
6 (6)	--	F(6)	Net Sales (Manufacturing)
7 (7)	--	F(7)	Total Manufacturing Cost of Sales
8 (8)	--	F(8)	Manufacturing Gross Profit (Loss)
9 (9) (53)	-- 32090.2 32090.3 32090.4	F(9) D(9) -- G(9)	Manufacturing Inventory Change Inventory Cost Propn. of Sales Value Inventory Cost Propn.--Disc. Change Inventory Change Value--Unique Gain(Loss)
10 (10)	--	F(10)	Total Plant Overhead
11 (11) (55)	-- 32110.2 32110.3 32110.4	F(11) D(11) -- G(11)	Research & Develop. Cost Transferred R & D Cost Propn. of Previous Year R & D Cost Propn.--Discrete Change R & D Costs--Unique Charge
12 (12) (56)	-- 32120.2 32120.3 32120.4	F(12) D(12) -- G(12)	Building and Parking Assets (Net) Bldgs. & Pkg. Depreciation Yrs. (or Rate) Bldgs. Change in Yrs. of Lease (or Rate) Bldgs. Depreciation--Unique Charge
13 (13)	--	F(13)	Equipment and Machine Assets (Net)
14 (14)	--	F(14)	Depreciation--Bldgs. & Parking Lot
15 (15) (59)	-- 32150.2 32150.3 32150.4	F(15) D(15) -- G(15)	Depreciation--Equipment & Machines Equipment Depreciation Rate Equipmt. Depreciation Rate--Disc. Change Equipmt. Depreciation--Unique Charge

Manufacturing Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
16 (16)	-- 32160.4	F(16) G(16)	Total Supervisor Salaries Supervisor Salaries--Unique Change
17 (17)	-- 32170.4	F(17) G(17)	Total Service Departments Wages Service Dept. Wages--Unique Change
18 (18)	-- 32180.1	F(18) H(3)	Factory & Mould Supplies(& Repair) Fixed Component of Factory Supplies
(62)	32180.2	D(18)	Variable Supplies Propn. of Gross Prodn.
	32180.3	--	Variable Supplies(Ttl)--Percent. Change
	32180.4	G(18)	Variable Supplies--Unique Charge
19 (19)	-- 32190.2	F(19) D(19)	Plant Repairs and Maintenance Repairs & Maint. Propn. of Ttl. Supp.
(63)	32190.3	--	Repairs & Maint. Propn.--Percent Change
	32190.4	G(19)	Repairs & Maint.--Unique Charge
20 (20)	-- 32200.4	F(20) G(20)	Other Service Exp. and Miscellaneous Other Service & Misc.--Discrete Change
21 (21)	--	F(21)	Rent--Plant Building
22 (22)	--	F(22)	Rent--Finished Goods Warehouse
23 (23)	--	F(23)	Rent--Equipment and Machines
24 (24)	-- 32240.2	F(24) D(24)	Fuel, Power and Water Costs F, P & W Multiple of Total Machines
(68)	32240.3	--	Fuel, Power, Water--Multiplier Change
	32240.4	G(24)	Fuel, Power, Water--Unique Charge
25 (25)	-- 32250.1	F(25) H(2)	Manufacturing Employee Benefits Employee Benefits Fixed Cost
(69)	32250.2	D(25)	Emp. Ben. Propn. of Ttl. Salary & Wages
	32250.3	--	Employee Benefits--Percentage Change
	32250.4	G(25)	Employee Benefits--Unique Charge
26 (26)	-- 32260.2	F(26) D(26)	Engineering Consulting Charges Eng. Consult. Propn. of Previous Year
(70)	32260.3	--	Eng. Consult. Propn.--Discrete Change
	32260.4	G(26)	Eng. Consult. Charges--Discrete Change
27 (27)	-- 32270.1	F(27) H(1)	Cost of Materials Used in Production Material Costs Fixed Component
(71)	32270.2	D(27)	Materials Propn. of Gross Production
	32270.3	--	Material Costs--Percentage Change
	32270.4	G(27)	Material Costs--Unique Charge

Manufacturing Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
28 (28)	-- 32280.4	F(28) G(28)	Direct Labour Costs Direct Labour Costs--Unique Charge
29 (29)	-- 32290.4	F(29) G(29)	Number of Supervisors Number of Supervisors--Disc.Change
30 (30)	-- 32300.4	F(30) G(30)	Number of Service Personnel Number of Serv.Personnel--Disc.Change
31 (31) (75)	-- 32310.2 32310.3 32310.4	F(31) D(31) -- G(31)	Average Annual Supervisor Salary Supervisor Salaries Growth Factor Salaries Growth Factor--Disc. Change Avg.Supervisor Salaries--Disc.Change
32 (32) (76)	-- 32320.2 32320.3 32320.4	F(32) D(32) -- G(32)	Average Service Wage (Annual) Service Wages Growth Factor Wages Growth Factor--Discrete Change Avg.Service Wage--Discrete Change
33 (33) (77)	-- 32330.2 32330.3 32330.4	F(33) D(33) -- G(33)	Average Direct Labour Wage (Annual) Direct Labour Wages Growth Factor Labour Wages Growth Factor--Disc.Change Avg.Direct Labour Wage--Discrete Change
34 (34) (78)	-- 32340.2 32340.3 32340.4	F(34) D(34) -- G(34)	Revenue from Moulds Mould Revenue Multiple of Costs Mould Revenue Multiple--Disc. Change Mould Revenues--Unique Gain
35 (35)	--	F(35)	Moulds Purchased
36 (36) (80)	-- 32360.2 32360.3 32360.4	F(36) D(36) -- G(36)	Cost of Moulds Used Mould Costs Growth Factor Mould Growth Factor--Discrete Change Mould Costs--Discrete Change
37 (37)	--	F(37)	Net Moulds Revenue
38 (38) (82)	-- 32380.2 32380.3 32380.4	F(38) D(38) -- G(38)	Engineering Wages Engineering Wages Growth Factor Engineering Growth Factor-Disc.Change Engineering Wages--Discrete Change
39 (39) (83)	-- 32390.2 32390.3 32390.4	F(39) D(39) -- G(39)	Engineer's Travel Costs Travel Costs Propn. of Eng. Wages Travel Costs Propn.--Discrete Change Travel Costs--Unique Charge

Manufacturing Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
40 (40)	--	F(40)	Total Mould Division Expenses
41 (41)	--	T(1)	Gross Prodn. Value (Sales & Inv.) Chg.
42 (42)	--	T(2)	Plant Bldg. & Parking Depreciation
43 (43)	--	T(3)	Warehouse Building Depreciation
44 (44)	--	T(4)	(Not Used in Program)

ADMINISTRATION COMPONENT

<u>VARIABLE INDEX NO.</u>	<u>PARAMETER CODE NO.</u>	<u>PROGRAM SYMBOL</u>	<u>DESCRIPTION</u>
1 (1)	--	F(1)	Total Administration Expenses
2 (2)	-- 42020.4	F(2) G(2)	Office Equipment Assets (Net) Office Equipment Assets--Disc. Change
3 (3) (27)	-- 42030.2 42030.3 42030.4	F(3) D(3) -- G(3)	Office Building Assets (Net) Cost per MSF of New Office Built Cost per MSF Const.--Discrete Change Construction Cost--Unique Charge
(42)	42180.2 42180.3 42180.4	D(18) -- G(18)	Purch.Price per MSF of Prev.Rented Old Office Price per MSF--Disc. Change Office MSF from Rent to Purchase
4 (4) (28)	-- 42040.2 42040.3 42040.4	F(4) D(4) -- G(4)	Depreciation--Office Equipment Office Equipment Depreciation Rate Equipt.Depreciation Rate--Disc.Change Equipt.Depreciation--Unique Change
5 (5) (29)	-- 42050.2 42050.3 42050.4	F(5) D(5) -- G(5)	Depreciation--Office Building Office Bldg.Yrs.in Lease(or Depr.Rate) Office Bldg.Change in Lease Years (or Depr. Rate) Office Bldg.Depreciation--Unique Change
6 (6) (30)	-- 42060.2 42060.3 42060.4	F(6) D(6) -- G(6)	Administration Salaries (Total) Average Administrative Salary Avg. Admin. Salary--Discrete Change Administrative Salaries--Unique Charge
(39)	42150.2 42150.3	D(15) --	Admin. Salaries Growth Factor Growth Factor--Discrete Change
7 (7) (31)	-- 42070.2 42070.3 42070.4	F(7) D(7) -- G(7)	Office Salaries (Total) Average Office Salary Avg. Office Salary--Discrete Change Office Salaries--Unique Charge
(40)	42160.2 42160.3	D(16) --	Office Salaries Growth Factor Growth Factor--Discrete Change
8 (8) (32)	-- 42080.1 42080.2 42080.3 42080.4	F(8) H1 D(8) -- G(8)	Travel Costs (Leases and Expenses) Average Auto Lease Cost Avg.Exp. per Admin. and Office Pers. Avg.Exp. per Person--Discrete Change Avg. Auto Lease -- Discrete Change

Administration Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
9 (9) (33)	--	F(9)	Supplies and Postage
	42090.2	D(9)	Supplies and Postage Growth Factor
	42090.3	--	Growth Factor--Discrete Change
	42090.4	G(9)	Supplies and Postage--Discrete Change
10 (10) (34)	--	F(10)	Telephones and Telegrams
	42100.2	D(10)	Telephones and Telegrams Growth Factor
	42100.3	--	Growth Factor--Discrete Change
	42100.4	G(10)	Telephones & Telegrams--Disc. Change
11 (11) (35)	--	F(11)	Legal and Audit Expenses
	42110.2	D(11)	Legal and Audit Growth Factor
	42110.3	--	Growth Factor--Discrete Change
	42110.4	G(11)	Legal and Audit--Discrete Change
12 (12) (36)	--	F(12)	Sundry and Bad Debt Expenses
	42120.2	D(12)	Sundry and Bad Debt Growth Factor
	42120.3	--	Growth Factor--Discrete Change
	42120.4	G(12)	Sundry and Bad Debt--Discrete Change
13 (13) (37)	--	F(13)	Rent--Equipment and Building
	42130.2	D(13)	Rental Cost per MSF of Office Space
	42130.3	--	Office Rent Rate--Discrete Change
	42130.4	G(13)	Office Building Rent--Unique Charge
14 (14) (38)	--	F(14)	Admin. Employee Benefits
	42140.1	H3	Fixed Employee Benefits Cost
	42140.2	D(14)	Employee Benefits Propn. of Salaries
	42140.3	--	Employee Benefits Propn--Percent Change
	42140.4	G(14)	Employee Benefits--Unique Charge
15 (15)	--	F(15)	Number of Executives
	42150.4	G(15)	Number of Executives--Discrete Change
16 (16)	--	F(16)	Number of Office Personnel
	42160.4	G(16)	Number of Personnel--Discrete Change
17 (17)	--	F(17)	Total Office Space
	42170.4	G(17)	Total Office Space--Decided Change
18 (18)	--	F(18)	Rented Office Space
19 (19) (43)	--	F(19)	Desired Office Space
	42190.1	H2	Avg.Extra Office Space per Executive
	42190.2	D(19)	Avg.MSF Office per Admin. Pers.
	42190.3	--	Avg. Space per Person--Discrete Change
	42190.4	G(19)	Extra Space per Exec.--Discrete Change

Administration Component (Cont'd.)

<u>VARIABLE</u>	<u>PARAMETER</u>	<u>PROGRAM</u>	<u>DESCRIPTION</u>
<u>INDEX NO.</u>	<u>CODE NO.</u>	<u>SYMBOL</u>	
20 (20)	--	F(20)	Office Equipment Rentals
(44)	42200.2	D(20)	Office Equipt. Rent Growth Factor
	42200.3	--	Growth Factor--Discrete Change
	42200.4	G(20)	Office Equipt.Rent--Discrete Change
21 (21)	--	F(21)	Total Number of Office Machines
	42210.4	G(21)	Number of Machines--Discrete Change
22 (22)	--	T(1)	Actual Expenses Minus Desired
23 (23)	--	T(2)	Percent of Difference Over Desired
24 (24)	--	T(3)	New Office Space Added

FINANCIAL COMPONENT

<u>VARIABLE INDEX NO.</u>	<u>PARAMETER CODE NO.</u>	<u>PROGRAM SYMBOL</u>	<u>DESCRIPTION</u>
1 (1)	--	F(1)	Gross Sales of Company
2 (2)	--	F(2)	Total Royalties and Mould Charges
3 (3)	--	F(3)	Net Sales of Company
4 (4)	--	F(4)	Total Cost of Sales
5 (5)	--	F(5)	Total Manufacturing Gross Profits
6 (6)	--	F(6)	Total Selling Expenses
7 (7)	--	F(7)	Total Administration Expenses
8 (8)	--	F(8)	Total Selling and Admin. Expenses
9 (9)	--	F(9)	Operating Profit
10 (10)	--	F(10)	Total Other Expenses
54 (54)	--	T(54)	Bank Notes Interest
(103)	53050.2	D(5)	Bank Notes Interest Rate
	53050.3	--	Bank Interest Rate--Discrete Change
	53050.4	G(5)	Bank Note Interest--Unique Charge
55 (55)	--	T(6)	Mortgage Loans Interest
(104)	53060.2	D(6)	Mortgage Loan Interest Rate
	53060.3	--	Mortgage Interest Rate--Disc. Change
	53060.4	G(6)	Mortgage Loan Interest--Unique Charge
56 (56)	--	T(7)	Debenture Notes Interest
(105)	53070.2	D(7)	Debenture Notes Interest Rate
	53070.3	--	Debenture Interest Rate--Disc. Change
	53070.4	G(7)	Debenture Notes Interest--Unique Charge
57 (57)	--	T(8)	Bank Exchange
(106)	53080.2	D(8)	Bank Exchange Growth Factor
	53080.3	--	Growth Factor--Discrete Change
	53080.4	G(8)	Bank Exchange--Discrete Change
58 (58)	--	T(9)	Discounts Given
(107)	53090.2	D(9)	Discounts Given Growth Factor
	53090.3	--	Growth Factor--Discrete Change
	53090.4	G(9)	Discounts Given--Discrete Change
59 (59)	--	T(10)	Insurance Premium Payments
(108)	53100.2	D(10)	Insurance Premiums Growth Factor
	53100.3	--	Growth Factor--Discrete Change
	53100.4	G(10)	Insurance Premiums--Discrete Change
11 (11)	--	F(11)	R & D Amortization, Adjustments, Losses
60 (60)	--	T(11)	Research & Development Amortization
(109)	53110.2	D(11)	R & D Amort. Propn. of R & D Expenses
	53110.3	--	R & D Amort. Propn.--Discrete Change
	53110.4	G(11)	R & D Amortization--Unique Charge

Financial Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
61 (61)	-- 53120.4	T(12) G(12)	Non-Cash Adjustments Non-Cash Adjustments to Make
62 (62)	-- 53130.4	T(13) G(13)	Accidental Losses Accidental Losses to be Charged
12 (12)	--	F(12)	Net Company Profit
13 (13)	--	F(13)	Total Other Income
63 (63)	--	T(14)	Licensing Fees Earned (Net)
(112)	53140.2	D(14)	Licensing Fees Growth Factor
	53140.3	--	Growth Factor--Discrete Change
	53140.4	G(14)	Licensing Fees (Net)--Discrete Change
64 (64)	--	T(15)	Technical and Service Fees (Net)
(113)	53150.2	D(15)	Tech. & Service Fees Growth Factor
	53150.3	--	Growth Factor--Discrete Change
	53150.4	G(15)	Tech. & Serv. Fees (Net)--Disc.Change
65 (65)	--	T(16)	Total Sundry Income
(114)	53160.2	D(16)	Sundry Income Growth Factor
	53160.3	--	Growth Factor--Discrete Change
	53160.4	G(16)	Sundry Income--Discrete Change
14 (14)	--	F(14)	Income Before Administration Bonus
15 (15)	--	F(15)	Administration Salary Bonus
66 (66)	--	T(17)	Admin. Salary Bonus Computed
(115)	53170.2	D(17)	Bonus Propn. of Before Bonus Income
	53170.3	--	Admin.Bonus Propn.--Discrete Change
	53170.4	G(17)	Admin.Salary Bonus--Unique Charge
16 (16)	--	F(16)	Before Tax Profit
17 (17)	--	F(17)	Federal & Provincial Income Taxes
67 (67)	--	T(18)	Low Tax Rate Income Level
(116)	53180.2	D(18)	Low Tax Income Growth Factor
	53180.3	--	Growth Factor--Discrete Change
	53180.4	G(18)	Low Tax Income Level--Discrete Change
68 (68)	--	T(19)	Taxes on First Part of Income
(117)	53190.2	D(19)	Low Tax Rate on First Part Income
	53190.3	--	Low Tax Rate--Discrete Change
	53190.4	G(19)	Income Taxes--Unique Charge

Financial Component (Cont'd.)

<u>VARIABLE INDEX NO.</u>	<u>PARAMETER CODE NO.</u>	<u>PROGRAM SYMBOL</u>	<u>DESCRIPTION</u>
69 (69)	--	T(20)	Taxes on Balance of Income
(118)	53200.2	D(20)	High Tax Rate on Balance of Income
	53200.3	--	High Tax Rate--Discrete Change
18 (18)	--	F(18)	After Tax Income
50 (50)	--	T(1)	Gross Profit Percent of Gross Sales
51 (51)	--	T(2)	Operating Profit Percent of Gr. Sales
52 (52)	--	T(3)	Before Tax Profit Percent of Gr.Sales
53 (53)	--	T(4)	After Tax Profit Percent of Gr. Sales
19 (19)	--	F(19)	Cash Balance
70 (70)	--	T(21)	Minimum Cash Balance Needed
(119)	53210.2	D(21)	Min. Cash Balance Growth Factor
	53210.3	--	Growth Factor--Discrete Change
	53210.4	G(21)	Min. Cash Balance--Discrete Change
20 (20)	--	F(20)	Accounts Receivable (Net)
71 (71)	--	T(22)	Total Accounts Receivable
(120)	53220.2	D(22)	Accounts Receivable Propn.of Gr. Sales
	53220.3	--	Accounts Receivable Propn--Disc.Change
	53220.4	G(22)	Accounts Receivable--Unique Change
72 (72)	--	T(23)	Allowance for Doubtful Accounts
(121)	53220.2	D(23)	Doubtful Accounts Propn. of Sales
	53220.3	--	Doubtful Accounts Propn.--Disc.Change
	53220.4	G(23)	Doubtful Accounts--Unique Charge
73 (73)	--	T(24)	Total Other Receivable
(122)	53240.2	D(24)	Other Receivables Growth Factor
	53240.3	--	Growth Factor--Discrete Change
	53240.4	G(24)	Other Receivables--Discrete Change
21 (21)	--	F(21)	Taxes Recoverable
74 (74)	--	T(25)	Computed Taxes Recoverable
22 (22)	--	F(22)	Due from Others
75 (75)	--	T(26)	Due from Kemp Directors
(124)	53260.2	D(26)	Due from Directors Growth Factor
	53260.3	--	Growth Factor--Discrete Change
	53260.4	G(26)	Due from Directors--Discrete Change
76 (76)	--	T(27)	Due from Associated Plastics Inc.
(125)	53270.2	D(27)	Due from Associated Growth Factor
	53270.3	--	Growth Factor--Discrete Change
	53270.4	G(27)	Due from A.P.I.--Discrete Change

Financial Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
77 (77)	--	T(28)	Due from Kemp Products, Inc.
(126)	53280.2	D(28)	Due from K.P.I. Growth Factor
	53280.3	--	Growth Factor--Discrete Change
	53280.4	G(28)	Due from K.P.I.--Discrete Change
23 (23)	--	F(23)	Total Inventories
24 (24)	--	F(24)	Total Prepaid Assets
78 (78)	--	T(29)	Prepaid Expenses Computed
(127)	53290.2	D(29)	Prepaid Expenses Growth Factor
	53290.3	--	Growth Factor--Discrete Change
	53290.4	G(29)	Prepaid Expenses--Discrete Change
79 (79)	--	T(30)	Total Recoverable Deposits
(128)	53300.2	D(30)	Recoverable Deposits Growth Factor
	53300.3	--	Growth Factor--Discrete Change
	53300.4	G(30)	Recoverable Deposits--Discrete Change
25 (25)	--	F(25)	Non-Cash (Current) Assets
81 (81)	--	T(32)	Life Insurance Cash Surrender Value
(130)	53320.2	D(32)	Insurance Cash Value Annual Increase
	53320.3	--	Annual Increase--Discrete Change
	53320.4	G(32)	Life Ins. Cash Value--Discrete Change
26 (26)	--	F(26)	Total Current Assets
80 (80)	--	T(31)	Deferred Research Expenses
(129)	53310.2	D(31)	Deferred Research Growth Factor
	53310.3	--	Growth Factor--Discrete Change
	53310.4	G(31)	Deferred Research--Discrete Change
27 (27)	--	F(27)	Total Fixed Assets
28 (28)	--	F(28)	Accumulated Depreciation
83 (83)	--	T(34)	Total Depreciation Charged
29 (29)	--	F(29)	Net Fixed Assets Book Value
84 (84)	--	T(35)	Change in Fixed Assets (Net)
30 (30)	--	F(30)	Excess Cash Balance
97 (97)	--	T(48)	Extra Interest Earned
(146)	53480.2	D(48)	Excess Cash Interest Rate
	53480.3	--	Interest Earned Rate--Discrete Change
	53480.4	G(48)	Excess Cash Interest--Unique Gain
31 (31)	--	F(31)	Total Assets

Financial Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
32 (32)	--	F(32)	Due to Bank (Notes and Accounts)
95 (95)	--	T(46)	Bank Notes and Accounts Limit
(144)	53460.2	D(46)	Bank Notes Limit Growth Factor
	53460.3	--	Growth Factor--Discrete Change
	53460.4	G(46)	Bank Notes Limit--Discrete Change
33 (33)	--	F(33)	Accounts Payable and Accrueds
85 (85)	--	T(36)	Total Accounts Payable
(134)	53360.2	D(36)	Accts. Pay. Propn. of Purchases
	53360.3	--	Accts. Pay. Propn.--Discrete Change
	53360.4	G(36)	Accounts Payable--Unique Change
86 (86)	--	T(37)	Total Accrueds Payable
(135)	53370.2	D(37)	Accrueds Pay.Propn. of Wages & Salaries
	53370.3	--	Accrueds Pay.Propn.--Discrete Change
	53370.4	G(37)	Accrueds Payable--Unique Change
34 (34)	--	F(34)	Total Other Payables
87 (87)	--	T(38)	Royalties Payable
(136)	53380.2	D(38)	Royalties Pay.Propn.of Total Royalties
	53380.3	--	Royalties Pay.Propn.--Discrete Change
	53380.4	G(38)	Royalties Payable--Unique Change
92 (92)	--	T(43)	Common Shares Capital Change
(141)	53430.2	D(43)	New Shares Price (M\$ Each)
	53430.3	--	New Shares Price--Discrete Change
	53430.4	G(43)	New Shares Capital--Unique Change
42 (42)	--	F(42)	Total Retained Earnings
	53040.4	G(4)	Retained Earnings--Discrete Change
43 (43)	--	F(43)	Total Shareholder's Equity
44 (44)	--	F(44)	Extra Financing Required
98 (98)	--	T(49)	Extra Interest Paid
(147)	53490.2	D(49)	Extra Financing Interest Rate
	53490.3	--	Financing Int. Rate--Discrete Change
	53490.4	G(49)	Extra Financing Int.--Unique Charge
45 (45)	--	F(45)	Total Liabilities
46 (46)	--	F(46)	Total Funds Sources
93 (93)	--	T(44)	Assets Sale Profits (Losses)
	53440.4	G(44)	Assets Sale Profits (Losses) in Year

Financial Component (Cont'd.)

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	<u>DESCRIPTION</u>
94 (94)	-- 53450.4	T(45) G(45)	Government Grants Received Government Grants Amount in Year
82 (82)	--	T(33)	Other Funds Sources
47 (47)	--	F(47)	Total Funds Applications
48 (48)	--	F(48)	Change in Working Capital
49 (49)	--	F(49)	Working Capital Balance

STATUS VARIABLES

<u>VARIABLE</u> <u>INDEX NO.</u>	<u>PARAMETER</u> <u>CODE NO.</u>	<u>PROGRAM</u> <u>SYMBOL</u>	
1 (1)	--	S(1)	Desired Selling Expenses Sum
2 (2)	--	S(2)	Desired Admin. Expenses Sum
3 (3)	--	S(3)	Total Sales Forecasted
4 (4)	--	S(4)	Gross Inventory Change Value
5 (5)	--	S(5)	Number of Production Workers
6 (6)	--	S(6)	Total Plant Rentals
(21)	24060.2	U(6)	Annual Rent per MSF of Plant
7 (7)	--	S(7)	Total Warehouse Rentals
(22)	24070.2	U(7)	Annual Rent per MSF of Warehouse
8 (8)	--	S(8)	Total Production Equipment Leases
(23)	24080.2	U(8)	Other Equipment Rent
9 (9)	--	S(9)	Total Number of Production Machines
10 (10)	--	S(10)	Plant and Parking Assets (Net)
(25)	24100.2	U(10)	Construction Cost per MSF of New Plant
11 (11)	--	S(11)	Warehouse Building Assets (Net)
(26)	24110.2	U(11)	Construction Cost per MSF of New Whse.
12 (12)	--	S(12)	Equipment and Machine Assets (Net)
13 (13)	--	S(13)	Total Company Wages and Salaries
14 (14)	--	S(14)	Total Source of Payables (Purchases)
15 (15)	--	S(15)	Prepaid Mould Expenses (Net)
	34150.4	W(15)	Ppd. Mould Expense--Discrete Change

APPENDIX I

A SAMPLE SET OF FOUR-YEAR FORECAST
STATEMENTS FOR NORMALLY EXPANDING COMPANY
OPERATION

KEMP PRODUCTS LIMITED

INCOME STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
TOTAL GROSS SALES	1900	1723	1961	2262	2611
TOTL RLTY&MOULD CH	107	63	55	39	37
TOTAL NET SALES	1793	1660	1906	2223	2574
TOTL COST OF SALES	1528	1311	1412	1675	1989
TOTL MFG GROSS PFT	265	349	494	548	585
TOTAL SELL EXPENSE	116	94	113	130	144
TOTL ADMIN EXPENSE	233	209	212	236	255
TOTL SELL&ADM EXPS	349	303	325	366	399
OPERATING PROFIT	-84	46	169	182	186
OTHER EXPENSES	48	51	31	26	24
R&D AMORT,ADJ,LOSS	35	15	14	11	9
NET PROFITS	-167	-20	124	145	153
TOTAL OTHER INCOME	75	73	86	84	82
BEFORE BONUS INCOM	-92	53	210	229	235
ADMIN SALARY BONUS	0	11	42	46	47
BEFORE TAX PROFITS	-92	42	168	183	188
INCOME TAXES	-31	0	60	87	90
AFTER TAX INCOME	-62	42	108	96	98
GROSS PROFIT %'GE	14	20	25	24	22
OPERTG PROFIT %'GE	-4	3	9	8	7
BEF TAX PROFIT %GE	-5	2	9	8	7
AFTER TAX PROF %GE	-3	2	5	4	4

KEMP PRODUCTS LIMITED

SELLING EXPENSES STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
	-----	-----	-----	-----	-----
SALES SALARIES	41	38	44	50	54
SALES COMMISSIONS	34	35	42	49	56
SALES TRAVEL COSTS	19	13	16	18	20
FREIGHT-OUT	15	5	6	7	8
ADVTISING & PROMTN	7	3	5	6	6
	-----	-----	-----	-----	-----
TOTAL SELLING EXPS	116	94	113	130	144
	=====	=====	=====	=====	=====
EXP DIFF FM DESIRE	21	8	13	16	12
ZGE DIFF OVER DESD	22	9	13	14	9

DONE
RUN
REPORT

COMPONENT CODE NO. ?1
REPORT MODE NO. ?1

SELECT--HOW MANY VARS ?1
SALES VAR INDEX NO.'S ?1

PROD SALES FORECST	122	134	134	134	134
PROD SALES FORECST	446	465	593	663	739
PROD SALES FORECST	329	337	412	478	551
PROD SALES FORECST	201	195	281	326	376
PROD SALES FORECST	228	225	191	191	191
PROD SALES FORECST	574	367	350	470	620
PROD SALES FORECST	0	0	0	0	0
PROD SALES FORECST	0	0	0	0	0

KEMP PRODUCTS LIMITED

ADMINISTRATION EXPENSE STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
	-----	-----	-----	-----	-----
ADMINISTRN SALARIES	88	80	85	95	103
OFFICE SALARIES	41	41	40	45	49
SUPPLIES & POSTAGE	12	10	10	11	12
TELEPHONE & TEGRMS	15	12	12	13	14
OFF. TRAVEL COSTS	26	25	27	29	32
LEGAL AND AUDIT	15	12	9	9	9
SUNDRY & BAD DEBT	19	12	12	13	14
ADMIN RENT CHARGES	7	8	8	9	9
OFF. EQUIPT DEPREC	2	1	1	1	1
OFF. BLDG DEPREC'N	0	0	0	0	0
ADM EMPLOYEE BENFT	9	8	8	11	12
	-----	-----	-----	-----	-----
TOTAL ADMIN EXPENS	233	209	212	236	255
	=====	=====	=====	=====	=====
ADM EXP DIF FM DES	62	54	36	33	19
ZGE DIFF OVER DESD	36	35	21	16	8

KEMP PRODUCTS LIMITED

STATUS VARIABLES REPORT
AS AT THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
	-----	-----	-----	-----	-----
DES SELL EXPS SUM	95	86	100	114	132
DES ADMIN EXPS SUM	171	155	176	203	236
TOTAL SALES F'CAST	1900	1723	1961	2262	2611
GROSS INVENTY CHGE	-4	1	16	38	43
NUMBER OF WORKERS	91	64	69	82	97
TOTAL PLANT RENT	42	33	33	35	48
TOTAL WAREHSE RENT	14	12	12	13	16
TOTAL EQUIPT LEASE	83	65	45	54	78
TOTAL NO. MACHINES	14	14	13	14	16
PLANT-PKG ATS(NET)	55	46	37	28	18
WHSE BLDG ATS(NET)	4	4	3	2	1
EQUIPT ASSETS(NET)	178	110	109	89	74
TOTAL WAGES&SALARY	775	648	707	879	1042
TOTAL SOURCE PAYLS	1174	1130	1215	1371	1564
PREPAID MOULD EXPS	98	71	46	37	30

KEMP PRODUCTS LIMITED

MANUFACTURING COSTS STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
	-----	-----	-----	-----	-----
MANFG GROSS SALES	1900	1723	1961	2262	2611
ROYALTIES CHARGES	84	36	30	30	30
MOULD EXP CHARGES	23	27	25	9	7
	-----	-----	-----	-----	-----
MANFG NET SALES	1793	1660	1906	2223	2574
MANFG INVENTY CHG	-4	1	12	29	32
COST OF MATERIALS	627	588	680	797	926
DIRECT LABOUR COST	337	266	303	405	514
SUPERVISOR SALARYS	68	43	41	46	50
SERV. DEPT. WAGES	84	72	75	84	91
FACTORY&MOULD EXPS	71	62	61	70	76
REPAIRS & MAINT'CE	38	25	34	39	43
OTHER SERV & MISC	17	17	18	18	18
BUILDING RENT	42	33	33	35	48
WAREHOUSE RENT	14	12	12	13	16
EQUIPMENT LEASES	83	65	45	54	78
BLDG-PKG DEPRECIAT	10	10	10	10	10
EQUIPT DEPRECIAT'N	44	38	27	22	18
FUEL,POWER & WATER	45	35	34	37	42
EMPLOYEE BENEFITS	55	46	51	74	91
ENGINEER CONSULT'G	3	0	0	0	0
	-----	-----	-----	-----	-----
TOTL PLANT OVERHED	574	458	441	502	581
R&D COSTS TRANSFER	13	0	0	0	0
	-----	-----	-----	-----	-----
MANFG COST OF SALES	1528	1311	1412	1675	1989
	-----	-----	-----	-----	-----
MANFG GROSS PROFIT	265	349	494	548	585
	=====	=====	=====	=====	=====

KEMP PRODUCTS LIMITED

MOULD DIVISION COSTS STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
	-----	-----	-----	-----	-----
MOULD GROSS REVENUE	208	208	208	208	208
MOULDS PURCHASED	180	189	189	189	189
MOULD INVENTY CHG	-9	0	0	0	0
	-----	-----	-----	-----	-----
COST OF MOULDS	189	189	189	189	189
	-----	-----	-----	-----	-----
NET MOULD REVENUE	19	19	19	19	19
ENGINEERING WAGES	18	19	18	20	22
ENG TRAVEL COSTS	4	4	4	4	4
	-----	-----	-----	-----	-----
TOTAL MOULD EXPENS	22	23	22	24	26
	-----	-----	-----	-----	-----
MOULD GROSS PROFIT	-3	-4	-3	-5	-7
	=====	=====	=====	=====	=====

KEMP PRODUCTS LIMITED

BALANCE SHEET
AS AT THE YEAR ENDING MAY 31

ASSETS BALANCE	1970	1971	1972	1973	1974
CASH BALANCE	0	0	0	0	0
ACCOUNTS REC (NET)	282	257	291	334	384
TAXES RECOVERABLE	0	0	0	0	0
DUE FROM OTHERS	140	140	140	140	140
TOTAL INVENTORIES	324	325	337	366	398
PREPAID ASSETS	117	90	65	56	49
NON-CASH ASSETS	8	9	10	11	12
TOTL CURRNT ASSETS	871	821	843	907	983
TOTAL FIXED ASSETS	534	505	531	533	536
ACCUMULATED DEPREC	290	339	378	411	439
NET FIXED ASSETS	244	166	154	123	97
DEFERRED R&D EXPNS	146	81	67	56	47
EXCESS CASH BALANC	0	9	7	96	167
TOTAL ASSETS	1261	1077	1071	1181	1294
LIABILITIES BALANCE	1970	1971	1972	1973	1974
DUE TO BANK	185	185	185	185	185
ACCTS PAY&ACCRUEDS	407	256	199	227	259
OTHER PAYABLES	58	6	17	22	23
L.T. DEBT PAYMENT	23	23	19	19	19
TOTL CURRENT LIABS	673	470	420	453	486
DEFERRED TAXES	80	80	80	80	80
MORTGAGE LOAN(NET)	105	86	68	49	30
DEBENTUR NOTE(NET)	49	45	0	0	0
TOTAL L.T. DEBT	154	131	68	49	30
COMMON SHARE CAPTL	109	109	109	109	109
RETAINED EARNINGS	245	287	394	490	589
SHAREHOLDER EQUITY	354	396	503	599	698
EXT FINANC'G REQ'D	0	0	0	0	0
TOTAL LIABILITIES	1261	1077	1071	1181	1294

KEMP PRODUCTS LIMITED

RETAINED EARNINGS CHANGE,
FUNDS SOURCES & APPLICATIONS, AND
WORKING CAPITAL STATEMENTS
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
AFTER TAX INCOME	-62	42	108	96	98
DIVIDENDS PAYABLE	27	0	0	0	0
RETAINED EARNINGS	245	287	394	490	589
AFTER TAX INCOME	-62	42	108	96	98
TOTAL DEPRECIATION	55	49	38	33	29
OTHER FUND SOURCES	180	16	-69	-21	-19
TOTAL FUND SOURCES	174	107	77	108	108
CHG IN NET FIXED A	22	-78	-12	-31	-26
L.T. DEBT PAYMENT	23	23	19	19	19
DIVIDENDS PAYABLE	27	0	0	0	0
TOTL FUND APPLICTS	72	-55	7	-12	-7
CHANGE IN WORK CAP	102	162	70	120	115
WORKING CAPITAL	198	360	430	550	664
TOTL CURRNT ASSETS	871	821	843	907	983
EXCESS CASH BALANC	0	9	7	96	167
TOTL CURRENT LIABS	673	470	420	453	486
WORKING CAPITAL	198	360	430	550	664

KEMP PRODUCTS LIMITED

PRODUCTION CONDITIONS STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
	-----	-----	-----	-----	-----
PROD INV PALLETS	9	13	13	13	13
PROD INV PALLETS	106	116	141	157	175
PROD INV PALLETS	95	105	119	138	159
PROD INV PALLETS	53	58	74	86	99
PROD INV PALLETS	34	53	40	40	40
PROD INV PALLETS	307	215	187	252	332
PROD INV PALLETS	0	0	0	0	0
PROD INV PALLETS	0	0	0	0	0
PROD HOURS--PRODN	5856	6388	6293	6293	6293
PROD HOURS--PRODN	12081	12629	16215	18022	20083
PROD HOURS--PRODN	13076	13468	16494	19217	22129
PROD HOURS--PRODN	4104	3955	5773	6638	7651
PROD HOURS--PRODN	2809	2789	2282	2320	2320
PROD HOURS--PRODN	9613	5943	5882	8267	10889
PROD HOURS--PRODN	0	0	0	0	0
PROD HOURS--PRODN	0	0	0	0	0
NO. M/C AVAILABLE	2	2	2	2	2
NO. M/C AVAILABLE	5	5	5	5	5
NO. M/C AVAILABLE	2	2	2	3	4
NO. M/C AVAILABLE	1	1	1	1	1
NO. M/C AVAILABLE	1	1	1	1	1
NO. M/C AVAILABLE	3	3	2	2	3
NO. M/C AVAILABLE	0	0	0	0	0
NO. M/C AVAILABLE	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	3076	3468	6494	4217	2129
HRS TRANS FROM M/C	0	0	773	1638	2651
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
MIN PLANT SPACE RQ	26	26	24	25	28
TOTAL PLANT SPACE	26	26	26	26	35
TOTL DES PLANT SPC	33	33	30	31	35
MIN WHSE SPACE REQ	12	11	11	13	16
TOTAL WHSE SPACE	12	12	12	13	16
TOTL DES WHSE--NET	11	10	10	12	15
TOTAL INVY PALLETS	604	560	573	685	817
TOTL PRODN PALLETS	5956	5007	5488	6540	7695

APPENDIX J

A SAMPLE SET OF FOUR-YEAR FORECASTS
STATEMENTS FOR THE COMPANY WITH THE
PLANNED ADDITION OF A GROWTH PRODUCT

KEMP PRODUCTS LIMITED

INCOME STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
TOTAL GROSS SALES	1900	1723	2236	2837	3586
TOTL RLTY&MOULD CH	107	63	55	39	37
TOTAL NET SALES	1793	1660	2181	2798	3549
TOTL COST OF SALES	1528	1311	1601	2104	2697
TOTL MFG GROSS PFT	265	349	580	694	852
TOTAL SELL EXPENSE	116	94	114	131	147
TOTL ADMIN EXPENSE	233	209	212	236	255
TOTL SELL&ADM EXPS	349	303	326	367	402
OPERATING PROFIT	-84	46	254	327	450
OTHER EXPENSES	48	51	31	26	24
R&D AMORT,ADJ,LOSS	35	15	24	20	16
NET PROFITS	-167	-20	199	281	410
TOTAL OTHER INCOME	75	73	86	84	82
BEFORE BONUS INCOM	-92	53	285	365	492
ADMIN SALARY BONUS	0	11	57	73	98
BEFORE TAX PROFITS	-92	42	228	292	394
INCOME TAXES	-31	0	92	146	200
AFTER TAX INCOME	-62	42	136	146	194
GROSS PROFIT %GE	14	20	26	24	24
OPERTG PROFIT %GE	-4	3	11	12	13
BEF TAX PROFIT %GE	-5	2	10	10	11
AFTER TAX PROF %GE	-3	2	6	5	5

KEMP PRODUCTS LIMITED

SELLING EXPENSES STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
SALES SALARIES	41	38	44	50	54
SALES COMMISSIONS	34	35	42	49	56
SALES TRAVEL COSTS	19	13	16	18	20
FREIGHT-OUT	15	5	7	8	10
ADVTISING & PROMTN	7	3	5	6	7
TOTAL SELLING EXPS	116	94	114	131	147
EXP DIFF FM DESIRE	21	8	6	0	-14
ZGE DIFF OVER DESD	22	9	6	0	-9

DONE
RUN
REPORT

COMPONENT CODE NO. ?1
REPORT MODE NO. ?1

SELECT--HOW MANY VARS ?1
SALES VAR INDEX NO. !S ?1

PROD SALES FORECST	122	134	134	134	134
PROD SALES FORECST	446	465	593	663	739
PROD SALES FORECST	329	337	412	478	551
PROD SALES FORECST	201	195	281	326	376
PROD SALES FORECST	228	225	191	191	191
PROD SALES FORECST	574	367	350	470	620
PROD SALES FORECST	0	0	275	575	975
PROD SALES FORECST	0	0	0	0	0

KEMP PRODUCTS LIMITED

ADMINISTRATION EXPENSE STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
	-----	-----	-----	-----	-----
ADMINISTRN SALARIES	88	80	85	95	103
OFFICE SALARIES	41	41	40	45	49
SUPPLIES & POSTAGE	12	10	10	11	12
TELEPHONE & TGRMS	15	12	12	13	14
OFF. TRAVEL COSTS	26	25	27	29	32
LEGAL AND AUDIT	15	12	9	9	9
SUNDRY & BAD DEBT	19	12	12	13	14
ADMIN RENT CHARGES	7	8	8	9	9
OFF. EQUIPT DEPREC	2	1	1	1	1
OFF. BLDG DEPREC'N	0	0	0	0	0
ADM EMPLOYEE BENFT	9	8	8	11	12
	-----	-----	-----	-----	-----
TOTAL ADMIN EXPENS	233	209	212	236	255
	=====	=====	=====	=====	=====
ADM EXP DIF FM DES	62	54	22	4	-30
ZGE DIFF OVER DESD	36	35	12	2	-11

KEMP PRODUCTS LIMITED

STATUS VARIABLES REPORT
AS AT THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
	-----	-----	-----	-----	-----
DES SELL EXPS SUM	95	86	108	131	161
DES ADMIN EXPS SUM	171	155	190	232	285
TOTAL SALES F'CAST	1900	1723	2236	2837	3586
GROSS INVENTY CHGE	-4	1	73	100	126
NUMBER OF WORKERS	91	64	72	88	107
TOTAL PLANT RENT	42	33	33	47	49
TOTAL WAREHSE RENT	14	12	22	35	52
TOTAL EQUIPT LEASE	83	65	65	94	138
TOTAL NO. MACHINES	14	14	14	16	19
PLANT-PKG ATS(NET)	55	46	37	28	18
WHSE BLDG ATS(NET)	4	4	3	2	1
EQUIPT ASSETS(NET)	178	110	109	89	74
TOTAL WAGES&SALARY	775	648	723	913	1103
TOTAL SOURCE PAYLS	1174	1130	1432	1813	2277
PREPAID MOULD EXPS	98	71	46	37	30

KEMP PRODUCTS LIMITED

MANUFACTURING COSTS STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
MANFG GROSS SALES	1900	1723	2236	2837	3586
ROYALTIES CHARGES	84	36	30	30	30
MOULD EXP CHARGES	23	27	25	9	7
MANFG NET SALES	1793	1660	2181	2798	3549
MANFG INVENTY CHG	-4	1	55	75	95
COST OF MATERIALS	627	588	857	1148	1512
DIRECT LABOUR COST	337	266	317	435	568
SUPERVISOR SALARYS	68	43	41	46	50
SERV. DEPT. WAGES	84	72	75	84	91
FACTORY&MOULD EXPS	71	62	65	77	89
REPAIRS & MAINT'CE	38	25	36	43	49
OTHER SERV & MISC	17	17	18	18	18
BUILDING RENT	42	33	33	47	49
WAREHOUSE RENT	14	12	22	35	52
EQUIPMENT LEASES	83	65	65	94	138
BLDG-PKG DEPRECIAT	10	10	10	10	10
EQUIPT DEPRECIAT'N	44	38	27	22	18
FUEL, POWER & WATER	45	35	37	42	50
EMPLOYEE BENEFITS	55	46	53	78	98
ENGINEER CONSULT'G	3	0	0	0	0
TOTL PLANT OVERHED	574	458	482	596	712
R&D COSTS TRANSFER	13	0	0	0	0
MNFG COST OF SALES	1528	1311	1601	2104	2697
MANFG GROSS PROFIT	265	349	580	694	852

KEMP PRODUCTS LIMITED

MOULD DIVISION COSTS STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
MOULD GROSS REVENUE	208	208	208	208	208
MOULDS PURCHASED	180	189	189	189	189
MOULD INVENTY CHG	-9	0	0	0	0
COST OF MOULDS	189	189	189	189	189
NET MOULD REVENUE	19	19	19	19	19
ENGINEERING WAGES	18	19	18	20	22
ENG TRAVEL COSTS	4	4	4	4	4
TOTAL MOULD EXPENS	22	23	22	24	26
MOULD GROSS PROFIT	-3	-4	-3	-5	-7

KEMP PRODUCTS LIMITED

BALANCE SHEET
AS AT THE YEAR ENDING MAY 31

ASSETS BALANCE	1970	1971	1972	1973	1974
CASH BALANCE	0	0	0	0	0
ACCOUNTS REC (NET)	282	257	330	416	523
TAXES RECOVERABLE	0	0	0	0	0
DUE FROM OTHERS	140	140	140	140	140
TOTAL INVENTORIES	324	325	380	455	550
PREPAID ASSETS	117	90	65	56	49
NON-CASH ASSETS	8	9	10	11	12
TOTL CURRNT ASSETS	871	821	925	1078	1274
TOTAL FIXED ASSETS	534	505	531	533	536
ACCUMULATED DEPREC	290	339	378	411	439
NET FIXED ASSETS	244	166	154	123	97
DEFERRED R&D EXPNS	146	81	116	96	80
EXCESS CASH BALANC	0	9	0	43	150
TOTAL ASSETS	1261	1077	1194	1339	1601
LIABILITIES BALANCE	1970	1971	1972	1973	1974
DUE TO BANK	185	185	185	185	185
ACCTS PAY&ACCRUEDS	407	256	233	295	370
OTHER PAYABLES	58	6	23	34	45
L.T. DEBT PAYMENT	23	23	19	19	19
TOTL CURRENT LIABS	673	470	460	533	619
DEFERRED TAXES	80	80	80	80	80
MORTGAGE LOAN(NET)	105	86	68	49	30
DEBENTUR NOTE(NET)	49	45	0	0	0
TOTAL L.T. DEBT	154	131	68	49	30
COMMON SHARE CAPTL	109	109	109	109	109
RETAINED EARNINGS	245	287	422	568	763
SHAREHOLDER EQUITY	354	396	531	677	872
EXT FINANC'G REQ'D	0	0	55	0	0
TOTAL LIABILITIES	1261	1077	1194	1339	1601

KEMP PRODUCTS LIMITED

RETAINED EARNINGS CHANGE,
FUNDS SOURCES & APPLICATIONS, AND
WORKING CAPITAL STATEMENTS
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
AFTER TAX INCOME	-62	42	136	146	194
DIVIDENDS PAYABLE	27	0	0	0	0
RETAINED EARNINGS	245	287	422	568	763
AFTER TAX INCOME	-62	42	136	146	194
TOTAL DEPRECIATION	55	49	38	33	29
OTHER FUND SOURCES	180	16	-62	-68	-12
TOTAL FUND SOURCES	174	107	112	111	211
CHG. IN NET FIXED A	22	-78	-12	-31	-26
L.T. DEBT PAYMENT	23	23	19	19	19
DIVIDENDS PAYABLE	27	0	0	0	0
TOTL FUND APPLICTS	72	-55	7	-12	-7
CHANGE IN WORK CAP	102	162	105	123	218
WORKING CAPITAL	198	360	465	588	805
TOTL CURRENT ASSETS	871	821	925	1078	1274
EXCESS CASH BALANC	0	9	0	43	150
TOTL CURRENT LIABS	673	470	460	533	619
WORKING CAPITAL	198	360	465	588	805

KEMP PRODUCTS LIMITED

PRODUCTION CONDITIONS STATEMENT
FOR THE YEAR ENDING MAY 31

	1970	1971	1972	1973	1974
	-----	-----	-----	-----	-----
PROD INV PALLETS	9	13	13	13	13
PROD INV PALLETS	106	116	141	157	175
PROD INV PALLETS	95	105	119	138	159
PROD INV PALLETS	53	58	74	86	99
PROD INV PALLETS	34	53	40	40	40
PROD INV PALLETS	307	215	187	252	332
PROD INV PALLETS	0	0	814	1703	2887
PROD INV PALLETS	0	0	0	0	0
PROD HOURS--PRODN	5856	6388	6293	6293	6293
PROD HOURS--PRODN	12081	12629	16215	18022	20083
PROD HOURS--PRODN	13076	13468	16494	19217	22129
PROD HOURS--PRODN	4104	3955	5773	6638	7651
PROD HOURS--PRODN	2809	2789	2282	2320	2320
PROD HOURS--PRODN	9613	5943	5882	8267	10889
PROD HOURS--PRODN	0	0	4813	9234	15331
PROD HOURS--PRODN	0	0	0	0	0
NO. M/C AVAILABLE	2	2	2	2	2
NO. M/C AVAILABLE	5	5	5	5	5
NO. M/C AVAILABLE	2	2	2	3	4
NO. M/C AVAILABLE	1	1	1	1	1
NO. M/C AVAILABLE	1	1	1	1	1
NO. M/C AVAILABLE	3	3	2	2	3
NO. M/C AVAILABLE	0	0	1	2	3
NO. M/C AVAILABLE	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	3076	3468	6494	4217	2129
HRS TRANS FROM M/C	0	0	773	1638	2651
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
HRS TRANS FROM M/C	0	0	0	0	0
MIN PLANT SPACE REQ	26	26	26	29	33
TOTAL PLANT SPACE	26	26	26	35	35
TOTL DES PLANT SPC	33	33	32	35	41
MIN WHSE SPACE REQ	12	11	22	35	52
TOTAL WHSE SPACE	12	12	22	35	52
TOTL DES WHSE--NET	11	10	21	34	51
TOTAL INVY PALLETS	604	560	1388	2388	3704
TOTL PRODN PALLETS	5956	5007	10215	15610	22753

APPENDIX K

QUESTIONNAIRES APPLIED TO
OBTAIN THE MANAGERS' ASSESSMENTS
OF THE COMPUTERIZED ORGANIZATION
MODEL

To:
From: Richard Nobbs

ASSESSMENT OF GROUP MEETINGS

I would like to have a record of your feelings about the group meetings held on January 25th and 8th where the company model was used to evaluate some of the ideas expressed. Please consider the meetings in relation to other regular management meetings you've held during which no evaluations were conducted. Attempt to give complete answers to the following questions in your own words (use an extra sheet if necessary and please return the memo to me tomorrow):

How did you feel about,

1. The extra time needed using the model?
2. The usefulness of the meetings in relation to other meetings?
3. The relevance and accuracy of the model's projections?
4. The relative value of having all of the statements rather than the Manufacturing Costs and Income Statements only?
5. Any new insights or ideas you obtained from the model?

To:
From: Richard Nobbs

KEMP PRODUCTS COMPUTER MODEL EVALUATION

The computerized organization model that I developed for use in evaluations of planning proposals is complete, has been used to evaluate several proposals, and you have had the opportunity to view the model results as they were produced. You have given me your assessment of the planning meetings where the model was used. Now I would like you to give me short answers to a series of questions that will form a more comprehensive assessment of the model for inclusion in my thesis report. Please return your assessment to me as quickly as possible.

Assessment of the Printed Statements and Model Use

Please answer the following questions by referring to the copies of the four-year forecast statements that you have. In the first three questions I would like you to place a check mark in the blank that you feel is most appropriate. For the last four questions please give brief, point form types of answers.

1. How do you rate the accuracy of the statements and predicted results produced by the model? Excellent __, Very Good __, Good __, Fair __, Poor __, or Very Poor __.
2. How difficult is it for you to read and understand the statements? Very Hard __, Hard __, Not too Hard __, Fairly Easy __, Easy __, or Very Easy __.
3. How useful do you think the information provided by the model can be for helping you make planning and other decisions? Very Useful __, Quite Useful __, Useful __, Not very Useful __, Of Little Use __, Of No Use __.
4. Are there any items or factors for which you would like to have estimates but that are not included in the statements?

5. Are there any statements or items in the statements that you feel should be eliminated or are not necessary?

6. Briefly list some ways in which you feel that the information provided in the statements is particularly useful to you.

7. Briefly list some ways in which you feel you could use the model's evaluations to help you make particular decisions or or to help you formulate particular long-range plans.

Assessment of the Value of Planning for the Company

The purpose of this section is to have you assign some form of subjective values to the various types of planning sessions that you might use to develop proposals and plans for the future operations and success of Kemp Products Limited as an on-going company. There are two steps which I would like you to consider separately filling in your answers in the space provided below:

1. Using a range of numbers from 0 to 100 please assign weights to the types of planning meetings suggested below in accordance with the relative values of the benefits that you feel can be obtained from each, and
2. Please estimate the amount of money that you would be willing to pay for one four-year plan (assuming that it suggests a continuously profitable operation for the company) if it was developed using each of the types of planning activity suggested.

	Number Weighting	Plan Purchase Value
a) No group planning meetings . . .	_____	_____
b) Informal group meetings with no minutes recorded	_____	_____
c) Regular formal group meetings with agendas and minutes kept. .	_____	_____
d) Formal meetings as above with the model being used to evaluate proposals presented.	_____	_____
e) Any other type that you can suggest (please describe).	_____	_____

Assessment of the Model's Future Value

Since its development the organization model has been applied to evaluate some particular planning proposals and developments. Five tests have been run with the model where Tom Doupe recorded (or estimated) the time he would need to conduct the evaluations by hand, and where the time was recorded for the same tasks using the model. The time record was kept for preparing the first evaluation of a particular proposal, and for making subsequent revisions to the results that should accrue from any proposal.

I have made estimates of the relative incremental costs of preparing the evaluations by each method. For these estimates I charged Tom's time at a rate of \$7.40 per hour (which I feel is low) and the cost of using the model at \$15.30 per hour which includes \$7.40 for Tom to run the model plus an hourly computer service charge of \$7.90. No allowance was made for the fact that the terminal would not have to be in operation while the information was being prepared to feed into the computer for any model run. The results of the time records and cost calculations are as follows:

	<u>Tom Doupe</u>	<u>Model</u>	<u>Model Saving</u>
Average Time for the First Evaluation (hrs)	12.54	1.99	10.55
Cost for the First Evaluation (\$)	92.80	30.45	62.35
Average Time for Revisions (hrs)	5.60	0.56	5.04
Cost for Revisions (\$)	41.44	8.57	32.87
Minimum Time for a Revision (hrs)	2.00	0.40	1.60
Cost for Minimum Time (\$)	14.80	6.12	8.68
Time to Revise the Forecast up to 1974 (hrs)	10.50	0.68	9.82
Cost to Revise the Forecast (\$)	77.70	10.40	67.30

The model time and cost savings may look very impressive to you and make you feel that the model should be retained by the company for future use. However, you must realize that there will be some fixed and variable costs attached to maintaining the model in condition to make planning proposal evaluations. Keeping the model available for future use will at least require:

1. That the computer service be transferred to a new account in Kemp Products name. This will involve the preparation of tapes of the information now stored on the computer in my name and the reloading of the information onto the new storage facilities for the Kemp account--this could involve up to 12 hours work.
2. That at least one person (and preferably two) on the staff be trained in computer programming so that he will be able to

update the model information as actual results become available and revise the model's computer programs as changes occur in the company. This will likely require two to three one-half day training and coaching sessions a week for two to three months.

3. That records of the computer program descriptions, operating procedures and instructions, and the twenty-six page index to the model variables, parameters and possible changes be typed and kept up to date as revisions are made.
4. That the computer terminal be rented on a continuing basis by Kemp Products (at a cost of approximately \$116 per month including tax) to provide access to the model.
5. That monthly charges be paid for the storage of the model and information on the computer, and for the usage of computer time while the terminal is in operation (as well as the minor cost of the paper and tapes needed for the terminal).
6. That the person maintaining the model keep a record of all information loaded onto the computer, all parameter changes made, and all program revisions made so that its operating state and conditions will be known at all times (by a consistent referencing method).

Note that it would also be possible to use the computer service for calculations other than those done by the company model.

In the above report of what will be needed for Kemp Products to maintain the model I have purposefully avoided the mention of all but one cost estimate. In view of the time-cost benefits and other advantages that you see in having the company model please prepare your own estimate (without consulting any of the other managers) of;

- a) The amount of money that you would be willing to pay on a continuing basis every month to have the model available for use, i.e. for the requirements mentioned in items 4, 5 and 6 above.
\$ _____/month
- b) Answer this only if you wish to do so. The amount of money that you would be willing to pay in total for the set-up type tasks mentioned under items 1, 2 and 3 above--do not provide an item by item breakdown but a lump sum only.
\$ _____

I would like you to give me these answers and estimates within a few days. They constitute a necessary step in the overall assessment of the model's value to be reported in my thesis. After I have received your written answers I will contact you to arrange a time at your convenience at which we can discuss the project generally. Thank you.

APPENDIX L

QUESTIONNAIRE USED TO RECORD
ASSESSMENTS FROM
OTHER ORGANIZATIONS

OTHER ORGANIZATIONS SURVEY QUESTIONNAIRE

Company Name _____

Respondent Name _____

1. Type of Management structure? _____.
2. Previous contact with computers and possible model uses?
_____.
3. Would the kind of model described be useful to the company?
Yes _____ No _____ Why? _____
_____.
4. How are plans and/or forecasts evaluated? _____.
5. Would the company be willing to participate in a replication of the
research project? Yes _____ No _____ Why? _____
_____.
6. Is the company Privately _____ or Publicly _____ held?
7. The general types of products or services produced are _____
_____.
8. Sell mainly to? _____.
9. Number of plants (_____) and warehouses (_____)?
10. Normal workforce size range? _____ to _____.
11. Approximate value of annual sales? _____ to _____.
12. Are long-range forecasts used? Yes _____ No _____.
Number of years considered? _____.
Are formal planning procedures used? Yes _____ No _____.
13. What kinds of information are included in the forecasts? Financial
accounting _____, Other _____.

14. What is the approximate value of the company's total assets?

_____ to _____.

15. Has the company been financially successful in the past? _____.

Now? _____.

General Comments from the Interview

Nature of market _____.

Nature of product lines _____.

Felt evaluation need _____.

Etc. _____.

_____.

Overall opinion of the model and its likely usefulness generally

_____.

_____.

_____.