A MANUFACTURING PLANNING AND CONTROL SYSTEM FOR A SMALL FAST GROWING MANUFACTURING COMPANY

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I declare that this project report is my own, unaided work. It is being submitted for the Degree of Master of Science in Engineering in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

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25 day of July 1988

ABSTRACT

The Small Business Development Corporation estimates that there are 150,000 to 200,000 "small businesses" in South Africa. Of these, approximately seventy per cent are involved in manufacturing of some kind. Most of these businesses are operated by an owner/manager who is personally involved in all aspects of the business such as Debtors, Stock Control, Marketing, S[illegible]ing, Production Scheduling, etc. However, many of these businesses are sufficiently large and diverse in their operations to require a greater degree of sophistication, than purely visual checks to ensure maximum operating efficiency.

The advent of smaller and cheaper computers has revolutionised the operation of small and medium sized businesses in South Africa, allowing them greatly enhanced information on the firm's financial status. Unfortunately, while there are many financial software "packages" available off-the-shelf today, the development "manufacturing packages" to assist the small manufacturer o optimise his production planning and minimise excessive work-in-progress or inventories has proceeded at a much slower pace.

The development in the 1960's of the concept of Mat[illegible]ls Requirements Planning was an important advancement in production management. Although the concept was very well understood in the past, it could not be generally imp[illegible]ed

without the use of an on-line computer with considerable processing power and extensive storage. Continuous developments in computer hardware have now brought these techniques within the reach of even the smallest manufacturing concern.

The report is geard towards companies that have the following distinguishing characteristics. The company:

- produces to stock, and has a order winning criteria of supplying a good service level to their customers.
- experiences a line production process, were the production routings are simple and easy to control.
- is at an early stage of the business cycle, hence it is experiencing major growth and increases in product demand.

This report will examine the current status of production planning as well as different systems proposed by various authors for production planning and control. These systems are then analysed with respect of their applicability towards the small fast growing business environment under consideration. It presents a simplified approach to production planning which would be more applicable to small fast growing businesses. The theory will then be applied in a small fast growing manufacturing concern with which the writer is familiar.

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CONTENTS

Page

APPENDICES (Cont) Page

LIST OF FIGURES

1. INTRODUCTION

1.1 Definition Of The Problem Area

Manufacturing planning and control systems exist in both large and small organisations, but there is a tendency for informal systems to predominate in smaller organisations. The Small Business Development Corporation cites reasons for this to be:

- the company is in a growth phase and systems are time-consuming and costly to set up;
- very small organisations, owned and operated by a single person, do not necessarily need formalised systems and it is difficult to determine at what point they become necessary; and
- small companies are not normally able to commit one person to handle such a small facet of the business - the business requires generalists rather than specialists.

Production control systems, are usually a low priority for a small manufacturer, they may be willing to devote effort to setting up suitable financial controls long before production controls.

In addition, small companies suffer from management problems that hinder the development of production systems. The Small Business Development Corporation believes that management hierachy is usually very centralised and inflexible. When the company undergoes cash flow problems as a result of rapid growth, management becomes less and less inclined to commit funds to projects that do not produce rapid results. As a result of this situation, small business managers are forced to make decisions on the basis of poor information, usually manually produced and thus often out of date.

1.2. Objectives

The purpose of this report is to examine current developments in manufacturing planning and control. It will propose modifications to these systems with the intention of developing a model to aid in the implementation of a production planning and control system for a small fast growing manufacturing concern.

The report will begin by examining systems that have been developed for manufacturing planning and control and critically analyse them in the light of the business environment under consideration. A generalised model for the implementation of a manufacturing planning and control system, applicable to the company environment under consideration, will then be designed.

The proposed system will be applied to a small fast growing manufacturing concern, Avroy Shlain Cosmetics (Pty) Ltd. This company encounters all the problems of production and inventory management that would be found in larger organisations, but lacks the staff or the expertise to fully implement present-day production planning techniques.

1.3. The Goals Of Production Planning And Control

Effective production planning and control allows a company to schedule and expedite orders at the earliest due date without incurring high inventory or work-in-progress costs. According to Burton (1), the cost of backlogs is extremely high. Not only are there the costs of maintaining high inventories, which clutter up the work space, but of greater importance is the cost of customer dissatisfaction which may ultimately leads to lost orders. Furthermore, Gomersall (2) illustrates that once a backlog has been built up it becomes more difficult to reduce as employees "get used" to a particular backlog level.

The basic aims of production planning according to Burton (3) may thus be summarised as follows:

1. to expedite orders at the earliest due date;
2. to minimise inventories of finished goods, components, raw materials, tools and obsolete items;
3. to increase productivity through better utilisation of resources;
4. to reduce material shortages, work-in-progress, inventory and purchasing costs;
5. to balance loads on work centers;
6. to obtain better control over engineering changes and related documentation; and
7. to increase customer confidence in the company and its products.

1.4 Company Environment

N. Churchill and V.L. Lewis (4) describe five distinct stages in an organisation's growth, as typified by the graph in Figure 1.

The stages in Figure 1 are broadly characterised as follows:

STAGE 1 : EXISTENCE : Major emphasis on obtaining customer and delivering the goods.

STAGE 2 : SURVIVAL : The company concentrates on cash and cash flow.

STAGE 3 : SUCCESS : At this point the company may decide to expand or can stay where it is.

STAGE 4 : TAKE OFF : Rapid growth and the development of formalised systems (Delegation).

STAGE 5 : RESOURCE MATURITY : Consolidation stage, professional techniques fully adopted.

The majority of small businesses will not be able to develop past Stage 3 without undergoing a "crisis of control" where delegation of responsibility and formalisation of systems must take place. This report concerns companies between Stages 3

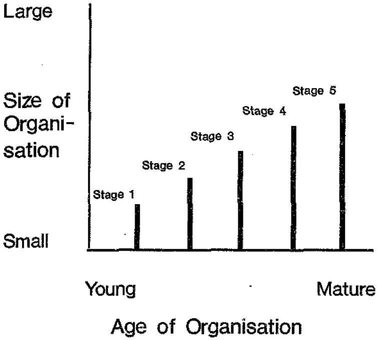


Figure 1: The Stages of Small Business Growth

an. 4. These companies are likely to be the most succeptable to improved control systems, simply because they lack any formal systems and therefore do not have a "vested interest" in maintaining their old systems. It is at this stage that, for the first time professional managers enter the company, bringing with them new ideas and the ability to implement them.

It will be assumed that the companies under consideration produce to stock and have a policy to provide a high customer service level. T-- companies have a line production process, where the manufacturing procedures are very simple and easy to control.

1.5 Scope And Limitations

The report will cover physical methods of production planning and control and will not examine financial or personnel implications, except by inference. The system proposed in this project has only been aplied to one company (Avroy Shlain Cosmetics), however, it is considered to be a generalised model applicable to all manufacturing concerns within a similar business environment.

To achieve an efficient manufacturing planning and control system, the system should be monitored and changed continuously. The model described in this report was only implemented and monitored for approximately seven months. No changes could be made to the system to improve it over such a short period of time.

1.6 Report Outline

Section 2 deals with the more established methods of production planning and control, proposed by different authors. In section 3, comments are made on each system described in section 2, when applying them to the business environment under consideration.

In section 4, a system is proposed for production planning and control for the business environment under study.

The next two sections, 5 and 6, discuss the application of the proposed system within the environment of a small manufacturing concern. Section 5 provides background to the company, while section 6 proposes and discusses the implementation of a production planning and control system.

The results achieved by the implementation of the system, are discussed in section 7.

In Section 8, suggests future changes that can be made to the system, and Sections 9 concludes the report.

2. THE STUDY OF MANUFACTURING PLANNING AND CONTROL MODELS PROPOSED BY DIFFERENT AUTHORS.

2.1 Vollmann, Berry And Whybark's Model

Vollman, Berry and Whybark in their book Manufacturing Planning and Control Systems (5), propose a system for Manufacturing Planning and Control. This system can be seen in Figure 2

The authors' believe that in any firm, Manufacturing Planning and Control (MPC) encompasses three distinct activities or phases. The first activity is the establishment of the overall direction for the firm, with the resulting management plans stated in manufacturing terms such as end items or product options. The second MPC activity is the detailed planning of material flows and capacity to support the overall plans. The third and final MPC activity is the execution of these plans in terms of detailed shop scheduling and purchasing actions.

As can be seen from Figure 2 the system is divided into three parts. The top third or front end, is the set of activities and systems for overall direction setting. This phase establishes the company objectives for manufacturing planning and control. The middle third, or engine, is the set of systems for accomplishing the detailed material and capacity

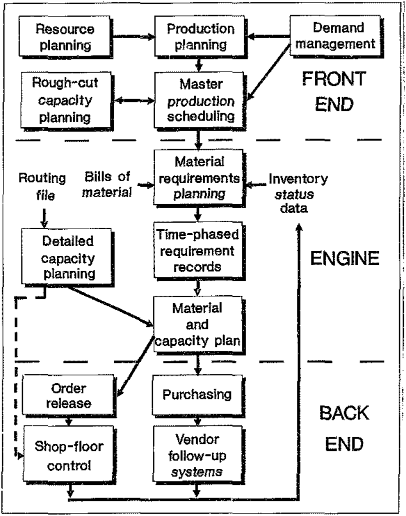


Figure 2: Manufacturing Planning and Control System

planning. The bottom third, or back end, depicts the execution systems.

What follows is a discussion of the different models of the MPC system, and the linkages of these models with each other.

FRONT END

Demand Management

Demand management encompasses forecasting, order entry, order delivery-date promising, physical distribution and other customer-contact-related activities.

The proper planning of all externally and internally generated demands means that capacity can be better planned and controlled. Timely and honest customer order promises can be made.

As can be seen in Figure 2 demand management is linked to the production planning and master production scheduling activities.

Production Planning

The production plan states the mission that manufacturing must accomplish if the overall objectives of the firm are to be met. How the production plan is to be accomplished in terms of detailed manufacturing and procurement decisions is a problem for manufacturing management.

The production plan provides key communication links from the management to manufacturing. It determines the basis for focusing the detailed production resources to achieve the strategic objectives of the firm.

To provide executive support to the production plan, it is necessary to have linkages to the MPC system. The most fundamental linkage is the master production schedule which is a disaggregation of the production plan.

Another critical linkage, shown in Figure 2, is the link with demand management. Demand management relates to production planning to ensure that the influence of all aspects of demand are included and properly co-ordinated.

The other MPC linkage to production planning is with resource planning. This activity encompasses the long-range planning of facilities. A key goal of the linkage between production planning and resource planning is to answer "What if" questions.

Master Production Scheduling

The effective master production schedule provides the basis for making customer delivery promises, utilising the capacity of the plant effectively, attaining the strategic objectives of the firm as reflected in the production plan and resolving trade-offs between manufacturing and marketing.

The Master Production Schedule (MPS) is the disaggregated version of the production plan. That is the MPS is a statement to manufacturing of which end items or product options they will build in the future.

The detailed plan or schedule produced by the MPS drives all the engine and back-end systems as well as the rough-cut capacity planning.

Rough-Cut Capacity Planning

Rough-cut capacity planning involves an analysis of the master production schedule to determine the existence of manufacturing facilities which represent potential bottlenecks in the flow of production. That is the linkage provides a rough evaluation of potential capacity problems from a particular MPS.

ENGINE

Capacity Planning

A critical activity that parallels the development of the material plan is the development of capacity plans. Without the provision of adaquate capacity or recognition of the existence of excess capacity, the benefits of an otherwise effective MPC system cannot be fully realised. On the one hand, insufficient capacity will quickly lead to deteriorating delivery performance and escalating work-in-process inventories. On the other hand, excess capacity is a needless expense that should be reduced.

The relationship of capacity planning decisions to the other modules of an integrated MPC system is shown in Figure 2

The resource planning activity is directly linked to the production planning module. It is the most highly aggretated and longest-range capacity planning decision. Resource planning typically involves converting monthly, quarterly, or even annual data from the production plan into aggregate resources such as gross labour hours, floor space, machine hours, etc.

The master production schedule is the primary information source for rough-cut capacity planning. Rough-cut capacity planning provides information with which to modify the resource levels or material plans in the medium range to ensure efficient execution of the master production schedule.

Substantially more detailed capacity planning is possible using the Capacity Requirements Planning (CRP) technique. To provide this detail, the material plans produced by the material requirements planning system serve as the basis for calculating time-phased capacity requirements. The information provided by the CRP technique can be used to determine the short-term capacity needs for both key machine centers and labour skills.

Material Requirements Planning

The front end section of the MPC system produces the master production schedule. The back end, or execution systems deal with detailed scheduling of the factory and with managing materials coming from vendor plants.

Material Requirements Plannir ... n is the central system in the engine portion of Figure ... the primary purpose of taking a period-by-period ... r production schedule requirements and producing a ... ent time-phased set of component/raw material requirements.

In addition to master production schedule inputs, MRP has two other basic inputs. A bill of material shows for each part number what other part numbers are required as direct components. The second basic input to MRP is inventory status.

The MRP data make it possible to construct a time-phased requirement record for any part number. The data can also be used as input to the detailed capacity planning modules.

The MRP system serves a central role in material planning and control. It acts as a translator of the overall plans for production into the detailed individual steps necessary to accomplish those plans. It provides information for developing capacity plans and it links to the systems that actually get the production accomplished.

BACK END

Shop-Floor Control

Shop-Floor Control (SFC) is one of the back-end modules in the material planning and control system. It is concerned with managing the detailed flow of material inside the plant. An effective shop-floor control system can lead to due date performance that ensures meeting the company's customer service goals. Management of the system can lead to reduction in work-in-process inventories and in production lead times.

The primary connection between SFC and the rest of the MPC systems shown in Figure 2 comes from Material and Capacity Plans. The capacity plan is especially critical to manage the detailed shop-floor flow of material.

The importance of capacity for SFC is illustrated by considering two extremes. If insufficient capacity is provided, no SFC system will be able to decrease backlogs, improve delivery performance, or improve output. On the other hand if more than enough capacity exists to produce the peak loads, almost any SFC system will achieve material flow objectives. It is in the case where there are bottlenecks and where effective utilisation of capacity is important, that we see the best utilisation of SFC systems.

The material plan provides information to the SFC system and sets performance objectives. The essential objective of SFC is to execute the material plan - to build the right part at the right time. This will result in being able to hit the master production schedule and to satisfy customer service objectives.

There is an important feedback from the shop floor to the engine. The feedback is of two types. Firstly, status information, this includes where things are, notification of operation completion, count variations, accounting data, etc. Secondly, warning signals, which are to help flag inadequacies in material and capacity plans.

IMPLEMENTATION

The MPC model is based upon a computer-supported, integrated data base. This model is generally understood by MPC professionals, computer software exists to support this model and it represents an overall system objective. Furthermore, the MPC model presents a useful way to divide the overall system objectives into subsystem projects. According to

Vollmann, Berry and Whybark, the critical implementation question is which projects to take on and in what order.

The company environment and the different aspects of each company, makes some system models more appropriate than others for implementation.

One key to successful implementation is goal setting. Specific targets must be set and evaluated. A second key to implementation is organisation design. The need is to create an organisational structure consistent with the MPC system activities and interfunctional integrations. (Senior management's attitude must be directed toward the MPC system).

A third key to successful implementation is the proper design and use of project teams in design. A basic feature of good project team design is to have representation from all groups that will later be using the system to do their jobs.

A fourth key to implementation, implicit in every phase of the project, is education. It is necessary for all people at all levels of the company to know how the system works, who will process certain kinds of transactions and how their own jobs will be changed as a result of the MPC system.

The final key to success is monitoring the MPC system implementation process itself. It is necessary to periodically audit actual results in relation to plans, look for roadblocks to success, measure costs and benefits and re-establish direction.

2.2 Terry Hill's Model

Terry Hill, in his book Manufacturing Strategy (6), discusses the strategic management of the manufacturing function.

Terry Hill suggests that there are two important roles which manufacturing can offer as part of the strategic strengths of a company.

The first is to provide manufacturing processes which will give the business a distinct advantage in the market-place. In this way manufacturing will provide a marketing edge through distinct unique technology developments in its process and manufacturing operations, which competitors are unable to match.

The second role is to provide co-ordinated manufacturing support for the ways in which products win orders in the market-place, at a level which is better than its competitors are able to do. In this way manufacturing develops a set of policies in both its process choice and infrastructure design which are consistent with the existing manner in which products win orders, whilst being able to reflect future developments in line with changing business needs.

According to Terry Hill, to do this effectively manufacturing has to be involved throughout the whole of the corporate strategy debate. In this way manufacturing will be able to explain, in business terms, the implications of corporate marketing proposals and, as a result, be able to influence strategy decisions for the good of the business as a whole.

The emphasis in successfully managed manufacturing functions is increasingly towards issues of strategy, and there is evidence of a growing awareness of this fact. The purpose of thinking and managing strategically is not just to improve operational performance or to defend market share. It is to gain competitive advantage and it implies an attempt to *mobilise manufacturing* capabilities to help gain this competitive edge.

In times of increased world competition, being left behind can be fatal. In many cases, averting the end is the only option left. Turning the business around, *however, will only* be achieved by switching from an operational to a strategic mode. This will require a corporate review of the marketing and manufacturing perspectives involved in the alternatives to be considered and the financial implications of the proposals involved.

Terry Hill discusses the different production processes available for manufacturing companies and continues by saying that the way in which a business decides to make its products is a choice which many executives believe to be based upon the single dimension of technology. As a consequence, this *decision is left to engineering/process* specialists on the assumption that they, being the custodians of technological understanding, are best able to draw the fine distinctions which need to be made. By designating those specialists as the appropriate people with whom this decision should rest, a situation is created in which the important manufacturing and business perspectives are at best given inadequate weight and in many instances are omitted altogether.

The principal manufacturing function is to take inputs and convert them into products. To complete this, a business usually has a range of choices to make between different modes of manufacturing. They usually choose one or, as is often the case, several ways. The fundamental rationale for arriving at this decision, however, must be to ensure that the choice of process is the one best able to support the company competitively *in the market-place*. There are *five* classic types of manufacturing processes: project, jobbing, batch, line and continuous process. However, in many situations, hybrids have been developed which blur the edges between one process and the next.

Project: Companies which produce large scale, one-off complex products will normally provide these on a project basis. The resource inputs will normally be taken to the point where the product is to be built and released for re-use elsewhere when they are no longer needed.

Jobbing unit or one-off : used for one-off products which can be moved once completed. The responsibility for making the product is normally given to a skilled person who decides how best to make it and then completes all or most of the operations involved including the quality control at each stage.

Batch: with an increase in volume and the repeat nature of products, companies select batch as the effective way to meet the requirements involved. Because the products are repeated, companies can consider investment at each of the manufacturing steps necessary to make them. However, the volumes involved do not warrant the purchase of dedicated equipment. The operations necessary to complete a product are, therefore, not linked and are said to be decoupled.

Line : when demand is sufficient to justify dedicating equipment solely to making a specified range of products, then a line process is normally chosen. The operations necessary to couple a product are *linked together so that each product* goes from one operation directly to the next and so on. The operations necessary to complete a product in this instance are said to be coupled.

Continuous process : when the demand for a product is such that the volume required necessitate a process being used all day and every day then futher investment is justified. The equipment in this instance is designed to automatically transfer the product from one stage to the next. The investment associated with this is warranted by the volumes involved.

The underlying factor when choosing the process most appropriate to manufacturing the product is volume. Hence, the procedure used is to first assess the market/volume dimension. This then forms the basis for choosing which process is appropriate to best meet these critical business needs.

Establishing the level of mismatch between current processes and current business, and then the adjustment to be made for the the appropriate choice of process for future products, are difficult and critical production management tasks. Difficult, in that the decision is complex. Critical, in that the process investment will be substantial and changes will be expensive and time-consuming to implement.

Terry Hill believes that corporate decisions on process choice entail going through the initial conceptualization, justification and finally implementation of the procedures described here. There are no short cuts. Understanding the complexity of a business and determining the strategic direction necessary for its success results from hard work and basing decisions on informed insights. The manufacturing inputs into the corporate strategy debate have invariably been too little and too late. To complete effectively in the future this will have to be redressed. Only when an informed corporate resolution of the interfunctional differences within a busir ss is achieved will a company be in charge of its own destiny.

The author then continues by having a look at *focused* manufacturing.

Focused Manufacturing

Manufacturing is inherently a complex task and managing this complexity is one of the key corporate roles. In all instances the *level of complexity* involved is derived largely from the corporate strategy decisions made within the business itself. The number and inter-related nature of the tasks and issues involved are more readily identified as a fundamental characteristic of complexity. The fit between the manufacturing strategy task and the internal process capability and infrastructure has only recently received close *attention*. It is these latter issues which come under the heading of "focused manufacturing."

Focused manufacturing deals with the issue of linking an organisations manufacturing facilities to the appropriate competitive factors of its business, with the aim of enabling the company to gain a greater control of its competitive position. Many companies are now finding that focusing the demands to which individual facilities must respond can achieve a marked reduction on the level of complexity involved in managing those operations. This, in turn, results in an improved overall performance. Thus, focusing the demand placed on manufacturing will enable resources, efforts and attention to be concentrated on a defined and homogeneous set of activities, so allowing management to identify the key tasks and priorities necessary to achieve a better performance.

Terry Hill believes that achieving and maintaining focused manufacturing needs to be an overt corporate activity. Focus does not occur naturally and, in fact, there are normally forces at work which militate against it. These forces need to be recognised so that action may be consciously taken to ensure that improved focus is not inhibited due to corporate neglect or traditional views of what is best for the business.

Terry Hill argues that for a business to be successful it needs to resolve the issues to process choice in line with manufacturing strategy requirements. Process choise concerns the features of hardware, the tangible ways in which the products are manufactured. However, the supporting structures, control procedures and other systems within manufacturing are equally necessary to successful, competitive manufacturing performance.

These structures, controls, procedures and other systems are collectively known as the manufacturing infrastructure. It comprises the inner structure of manufacturing including controls, procedures, systems and communications combined with the attitudes, experience and skills of the people involved. Together they form the basis of the manufacturing organisation charged with the task of providing the necessary support functions to the areas of responsibility involved.

Hill treats the control of manufacturing from a strategic viewpoint. He aims to assist the manufacturing executive with those key strategic insights which enable him to direct the development of systems appropriate to both the market opportunities/needs and the manufacturing process requirements.

Hill deals with the strategic issues concerning the design and development of manufacturing control systems under the following headings:

- market related criteria;
- process requirement criteria;
- *levels of control within an organisation;* and
- choise between push or pull sustems;

The first two concern factors which influence the type of control systems required to support the corporate strategy, while the second two deal with strategic design principles.

Terry Hill then concludes that providing a clear manufacturing strategy for the business enables those responsible for infrastructure development to work from a common base in a common direction to meet a common requirement.

2.3 R.W.Hall's Model

R.W.Hall in his book Attaining Manufacturing Excellence (7) proposes a Just-In-Time (JIT) (That is, "To produce instantaneously with perfect quality and minimum waste), approach to manufacturing control.

Hall believes that to properly understand JIT manufacturing, the objectives need to be reviewed from time to time. These objectives are eliminate waste, improve quality, shorten lead times, reduce costs, improve morale and continue improvement of the manufacturing process. The subject cannot be discussed without reference to techniques, but techniques are not sacrosanct. The importance lies in attaining the objectives in context of the necessary manufacturing tasks.

Hall suggests that the improvement of operations through JIT manufacturing should start with the development of skills in Quality improvement.

Workplace Organization

Just-in-time begins with the fundamentals of company policies and practices as reflected in the shop activity not just shop methods. A first impression of workplace organization is that it *is shop-level piddling to which only workers and supervisors* need pay attention. However, staff and management should concentrate on systems and policy, the more complex and advanced ideas of just-in-time.

Workplace organization starts in the plant, but its reverberations extend to an entire manufacturing organization.

The purpose is to clarify problems wherever they may exist. Hall describes it in five steps: (1) clearing and simplifying, (2) location, (3) cleaning, (4) discipline, and (5) participation. Much of the power is in the first two steps, and the last three closely support them.

Hall believes that morale is an intangible benefit of workplace organization.

Visibility

Visibility is unwritten, unspoken communication, not only of shop floor conditions among shop floor people but a road map of company conditions to all who read the physical signs.

Visibility is a minimum-cost database made up of the real thing. Its major purpose is instant response from anyone who should take action. Visibility is akin to immediate feedback. On the shop floor, visibility is attained by many means:

- Posted schedules A common form in a JIT plant is a board showing the current day's assembly schedule and completions to schedule.

- Signal lights If a machine malfunctions, operators and maintanence respond quickly. A counter used on a machine can trigger a signal for setup change, tool change, or quality check.
- Charts, logs and goals Posted charts emphasise what is important. The purpose of charts are to convey matters of current direction and action.
- Layout While dirt, noise, materials handling and many other factors are important in plant layout, visibility certainly belongs among them. Simply designing an assembly line or fabrication line in a U-shape can encourage visibility, because the back end of the line can see what is happening at the front.

Production Control Systems

Hall suggests three alternatives to control the production in a factory, these are: the classic two card production control system used in the Kanban method of control; a one card system; and a production network using a "pull system". Material is pulled into a final assembly area from feeding operations as it is needed. In turn, each supplying operation pulls material into it as needed, and so on down through the series of operations until it reaches raw materials. The system may even reach into the operations of suppliers if they have been developed for it.

The system of production control is to replace exactly what has been consumed and no more. The two-card system is actually one of the more complex methods of control. Between two operations within sight of each other no cards are needed, only a strict restriction on the inventory between them. This can be done by making a space between operations, sometimes called a Kanban square. If all spaces are full, stop producing. If not, fill them up.

A one-card system uses only the move card. Space restrictions or visible limits sufficiently restrict the quantity of each part in its location specified for pick up. If the move cards are permanently attached to the containers, the returning empty containers serve as signals to be filled.

Hall suggests that pull systems are really a manifestation of the principle of visibility. It promotes direct immediate visibility of problems and conditions to the peole who can take immediate action. The most important rules of pull systems promote this:

- provide simple, visible, enforceable means to limit the inventory of each item;
- make only what is necessary;
- locate each part in only one place; and
- maintain the limit on inventory for each item at a level that stimulates improved performance.

Why a pull system? A properly developed pull system relates inventory to time through visibility. The pull system is simple. Using the outbound stock itself as the signal is simple. The outbound stock or simple presence of the intervening inventory between two operations is itself a signaling device. If parts are made and moved, rather than made and held, the feedback signaling to the producing operation is not so simple. The producer somehow has to know to have material ready when the using operation wants it. A computer may help but is not necessary for the shop floor part of the system.

Users of materials are not overrun with what they do not need and do not have to store the excess. By keeping most materials in outbound stockpoints, users may send for a small amount of what they need when they need it. Suppliers instantly see what was taken, immediate feedback of real demand, eliminating as much advance forecasting and delayed feedback as possible.

Timing and Flexibility

The total manufacturing process should be developed for the necessary flexibility as well as for reducing cycle times of materials. Quality, short lead times and flexibility uncomplicates production planning. The total manufacturing process must be developed for flexibility, understanding customer needs, product design, process development. Flexibility is important in several different ways.

- Product Mix Flexibility

Ability to switch quickly from one product to another, one model to another, or one part to another is essential for product mix flexibility. Low set-up times allow this to be done at reasonable cost and also improve quality in the process. To attain flexibility, it is desirable to reduce set-up times on all the machines through which material must flow.

If lead times are short, all equipment must run at about the overall rate demanded by the market and must make the mix demanded. *Therefore, smart automation is not high-speed equipment but rather equipment that will do what is needed at the time needed.*

Hall suggests that one should *standardise and automate the set-up operations, not merely the running operations.*

- People Flexibility

People willing and able to do whatever is within their capabilities when it is needed are the people side of JIT. They make balancing tough sequences of operations possible. They respond to volume and mix changes. They do what humans are by nature idealy equipped to do, a variety of things.

Inflexible workers have the same opposite effect. Specialists stand around waiting for someone else to finish their part of a job. Specialists are necessary, but a company is better off if everything does not have to wait on them or keep them busy. It is ideal to cultivate specialists who believe that less specialised work is not beneath them.

<u>Summary</u>

Robert W Hall, sees just-in-time manufacturing as the pursuit of the very best management approach possible for a company to meet objectives from eliminating waste right on through continuous improvement in production processes. It should not be seen as only picking up techniques or, at best, making an addition to the management methods known to the company. It really is a way to run a company. Not all companies can use all the JIT techniques. However, most of the ideas can be used in some combination by any manufacturer dedicated to manufacturing excellence.

3.4 Bedworth And Bailey's Model

Bedworth and Bailey, in their book Integrated Production Control Systems (8), propose a system for the flow of materials and information in a typical manufacturing facility, in order to achieve effective production planning and control.

Bedworth and Bailey believe that the controlling activity of management is accomplished through the information system that monitors the production activity. This assists in identifying problems as they occur and communicates the corrective decisions to those who will implement them. Figure 3 illustrates a representative manufacturing operation.

Bedworth and Bailey describe how production control interfaces with the rest of the organisation and how it performs its function through a complex information system.

The demand forecasting activities of production control play the role of balancing future demands, as seen by sales, with the capabilities of manufacturing and the concerns of financing. The sales forecast information is represented in Figure 3 by the arrow marked (1). From this point on, the goal of the planning processes is to meet the latest published forecast.

The next block of interest in Figure 3 is that of long-range capacity planning. Forecasted demand has to be translated into a forecast of production and inventory needs. Any changes in

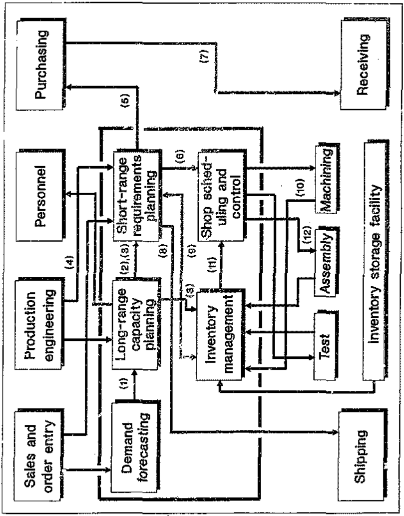


Figure 3: Flow Of Materials And Information In A Typical Manufacturing Facility

facility capacities are input from production engineering. Other inputs from production engineering include process routings and production time standards. These inputs allow the determination of how much capacity is needed for each forecasted product in every planning area.

The long-range planning group must convert the forecast for products into a forecast of labour hours required in each planning area. The information generated by the long-range capacity planning is transferred to top management and to short-range planning as (2) in Figure 3. During certain time periods, the production plan requires more labour capacity than indicated by demand. In other periods the reverse is true. The variance in manufacturing effort will represent either an increase or a decline in inventory levels, this detailed information flow is depicted by (3) in Figure 3.

Short-range planning, the next block of interest in Figure 3, is perhaps the most complex and demanding activity in production control. Next month's capacity plan has to be translated into purchase authorisations and a master schedule for production. In order to do this, short-range planning needs a bill of materials to know what materials and components are required for each unit of product. This information flow is represented by (4) in Figure 3. Short-range planning is charged with creating orders for efforts in the next week to satisfy a variety of needs many weeks into the future.

Once the plan is formulated, purchase and shop authorisations are written. Information flow represented by the purchase authorisation form is depicted by (5) and the shop-order master schedule information flow is (6) in Figure 3.

Finalisation of the shop and purchase plans allow the determination of expected receiving, shipping and inventory-distribution activities. The receiving activity information flow is (7) in the system flow of Figure 3. This report informs the receiving dock of what items to expect and what to do with these items as they arrive. The intent of this flow of information is to determine if the shipping plan is being met. If any item on the shipping plan is not available, exception action can be started. The information flow associated with this is (8) in Figure 3.

The last report to emanate from the short-range plan is the materials-requirement plan, which is a complete plan for each item under inventory control. The related information flow is represented in Figre 3 by (9). The flow of information into and out of the short-range requirements planning activity is the heart of the production control function is performed well, then all of the manufacturing activities will be co-ordinated and work together.

The next major block to be considered in Figure 3 is that encompassing inv ory management. The inventory management role is to monitor the flow of materials throughout the plan , which means knowing where everything is at all times. It should be pointed out that inventory control is a subfunction of inventory management. The inputs to inventory management, as seen in Figure 3, are from long-range and short-range planning. Inventory management does not have scheduling control over the various manufacturing departments, but it must monitor the manufacturing activities to see if they will satisfy the inventory plan. Therefore, inventory management must receive inventory transactions from the inventory storage facility and all production departments when items are moved from one location to another. This information flow is depicted by (10) in Figure 3. This information flow includes all information paths to inventory management from machining, assembly, testing, and inventory storage. The information with regards to inventory transaction activity depicted by (11) in Figure 3, is then transmitted to the shop scheduling operation so that manufacturing progress can be monitored.

The last block in Figure 3 to be discussed is that of shop scheduling, monitoring and control. The activity receives as input the weekly shop-order master schedule and the inventory activity report. Thus the shop scheduler knows every task that must be performed and the location of the raw materials for each task. The first role of the schedule is to determine the sequence in which the tasks should be performed. The sequencing decision is typically made by the shop supervisor. This information is passed on to the employee who will perform the task in the form of a work ticket. When the task is complete, the ticket is signed and the process of moving the material begins. The work ticket form is re…esented by (12) in Figure 3.

Bedworth and Baily suggest that the production control activity is a system and it must be viewed in its totality. It may not always be wise to require that production resources never be idle, or that inventory costs be minimised, or that due dates all be met. The objective of the production control system should be the objective of the total organisation. Decisions that complement sales, production and inventory are preferable to those that optimise one function.

Bedworth and Baily believe that any system with interacting components, such as that described in Figure 3, requires a syst…matic approach for planning and analysis if the objective is to benefit the overall organisation and not just to benefit a select few of the interacting components.

3 THE APPLICATION OF THE DIFFERENT MODELS PROPOSED IN SECTION 2, TO THE SMALL FAST GROWING BUSINESS ENVIRONMENT UNDER STUDY.

In this section, the different models proposed by the different authors in Section 2, are applied to the small fast growing business, in order to develop a Production Planning and Control System applicable to this environment.

When developing the system, comments are made at each stage of the development with respect to the applicability of the models presented in Section 2, to the business environment under study.

When examining Terry Hill's study of the strategic management *of the manufacturing function, a number of points can be made.*

1. Companies within the business environment under study, must ensure that the manufacturing function of the business meets and works in conjunction with the order winning criteria of the business.

2. It is important for companies to determine the order winning criteria to be applied to try and increase it's market share. The order winning criteria may be in one of the following forms:

- provide some new inovative product;
- provide good customer service;

- provide a specific method of sales, suitable to the customer (for example, selling at customers homes); and
- decide to compete on low prices.

The manufacturing technology required to produce the products that are manufactured within the company environment under study are not very complex and the manufacturing processes are simple. Thus the technology required to produce the different products will not vary very much during the life of the company.

As a result, companies in this environment would not require major manufacturing process technology strategies. Emphasis can rather be placed on developing an infrustructure to support the company's order winning criteria, were the company could benefit greatly.

In the early growth stages of the company it is necessary to focus the business strategy on both marketing and manufacturing, in order for it to be profitable. This can be very difficult if:

- management is not technically oriented and places large emphasis on increasing the growth of the company through sales; and
- there is a shortage of manufacturing skills and management is marketing oriented rather then production oriented.

The companies in this business environment should focus their manufacturing strategies on their particular order winning criteria. This would ensure that the company would meet its order winning criteria and thus increase it's market share.

When studying Vollmann, Berry and Whybark's manufacturing planning and control system, and Bedworth and Baily's system for the flow of materials and information, and applying their systems to the company environment under study, a number of points can be made.

The implementation of such systems, requires a large amount of time, committed management and technical skills. This is due to the large number of modules within the system and the complex interactions between these modules for the system to run effectively. Large and complex data ases are required as the backbone of such a system and the maintenance of the data base integrity is a costly task.

The management and control of some of the tasks within the system, would require a computer with a large amount of memory. This is necessary so that the large volume of data processing required in controlling the modules may be carried out accurately and quickly. The large investment in a computer is, however, not warrented in a small growing company were simplified controls and more informal procedures can still maintain the integrity of the manufacturing process, whilst achieving management objectives.

Vollman, Berry and Whybark's system structure, is a fundamental requirement to control the manufacturing function. One may find that the entire front end of the system is consolidated into the following formula:

Sales plan less inventory on hand = master production schedule.

This formula greatly simplifies the front end of the system. It can be achieved *in a small business, since* the processes required in the front end are simple enough to be manually managed. Within the business environment under consideration, the front end of the system can be simplified as illustrated in Figure 4.

3.1 <u>Demand Forecasts.</u>

The *demand forecasting* activities of production control play the role of balancing future demands as seen by sales, with the capabilities of manufacturing and the concerns of financing.

The demand forecast, in units (not *rands*), triggers *many* of the activities in managing operations and operating resources. The forecast provides advanced notice so that changes may be planned.

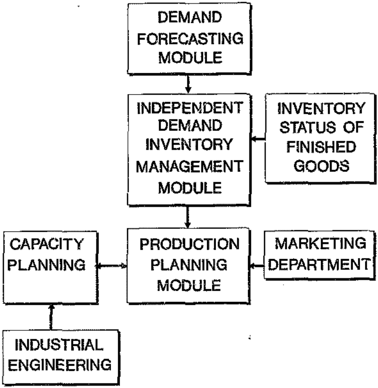


FIGURE 4: THE FRONT END OF THE SYSTEM PROPOSED

Vollmann, Berry and Whybark (9) look at models for "casting forward" historical information to make this "forecast". Implicit in this process is a belief that the conditions of the past which produce the historical data will not change.

Vollmann, Berry and Whybark believe that in companies demand forecasting is often a three pronged process, perhaps co-ordinated by the corporate department. This is shown in Figure 5. (10)

3.1.1 Marketing projection

Schonberger (11), in his section on marketing projection points out that marketing departments assemble demand projections, in rands, based on sales projections, sales force estimates, test market results, and market research. A sales promotion (for example), has a major impact on short term demand. Moving excessive inventory is one purpose of a sales promotion. Simply increasing cash flow, in the absence of excess, is a another purpose. The latter financial purpose can wreak havoc with production schedules. Schonberger states that it is important that promotions of products not yet produced be closely co-ord' ated with production scheduling. One of the duties of a master scheduler is to interact closely with marketing on such matters.

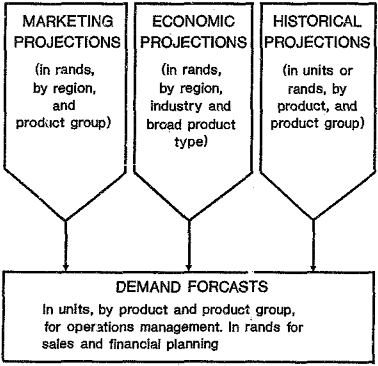


Figure 5: Three Determinants Of Demand Forecast

3.1.2 Economic projections.

Economic projections range from the educated guesses of economists to computer projections based on mathematical equations.

3.1.3 Historical demand projections.

The final basis of forecasting shown in Figure 5 is historical demand projection. There are a number of techniques used to determine the historical demand and they all rely on historical demand data. For operations management uses they express the forecast in units.

Three of the historical demand projection techniques will be discussed below: mean, trend and seasonal. These techniques search for a patern which can be projected as many periods into the future as is required (but with decreasing accuracy). Hence, they are referred to as multiperiod pattern projection techniques. They are useful for product scheduling, adjustable-capacity planning and facilities planning.

All the historical demand projection techniques rely on demand records. Firms that keep detailed records are likely to have product data on past demands for goods, but in other organizations recorded data on past demand may not exist. Small organizations are not likely to maintain detailed records.

Where records do not exist, historical demand projections can still be made, but they are totally judgemental. The manager or department head reflects on his or her past experience and comes to a decision on what future demands to expect. This is likely to result in rough forecasts. Lack of accuracy in the demand forecast could result in idle resources at some time and failure to meet customer demands at other times.

The forecasting methods discussed below are proven and widely used.

3.1.4 Multiperiod pattern projection.

Schonberger (12) states that mean, trend and seasonal analysis techniques may be used to project a past demand pattern several periods into the future. They are often used in the rolling forecast mode. A rolling forecast is one that is repeated or rolled over at intervals - every month, every quarter, or every year. The forecast horizon may be limited to weeks or months, or it may extend years into the future.

Vollmann, Berry and Whybark (13) highlight two important problems in using forecasting models in practice. First is determining the forcasting model parameters, and second is monitoring the forecasting model results. According to them one has to determine the demand patterns and to select the forecasting model that appears to provide minimum bias. It is also required to choose the smoothing constants and establish the base value, trend value and seasonal indeces before starting the forecasts. It is further necessary to continue evaluating the quality of the forecasts, this will ensure that the model chosen is still appropriate, to determine whether market conditions have changed, and to identify quickly when something has gone wrong.

While all of the historical techniques are potentially useful, demand forecasting is inherently inexact. No amount of statistical analysis can change that fact.

In the opinion of Nyles V Reinfeld (14) forecasts are used differently throughout a company because each division of the company has different objectives. There are six major management functions that make use of the sales forecast as a part of their own activity, these are: Finance and Accounting, Inventory Control, Production Control, Sales Analysis, Capital Equipment Planning and Personnel. It is thus noted that sales forecasts play a major role in the cycle of managerial control.

In the company environment under study, demand forecasts are used for setting up control systems for the management of independent demand inventory items. The monthly forecasts calculated are used when setting up the re-order point modules for each product that is used to control the inventory levels. Thus the demand forecasts are inputed into the Independent Demand Inventory Management Module.

3.2 The Independent Demand Inventory Management Module.

The prime inputs to this module are the monthly demand forecasts calculated for each product and the stock status for each product.

A large amount of emphasis is placed on the management and control of the independent demand inventory items, because the companies in the business environment under consideration produce to stock and depend upon a good service level. Most companies in this environment have an order winning criteria of high service levels.

It is thus important for companies to control the level of finished goods inventory in their distribution warehouses. In order to implement this it was believed necessary to incorporate an independent demand inventory management module into the front end of the system. This module controls the production requirements in the factory, (to be discussed later).

The companies under consideration are primarily concerned with the management of independent demand inventories. According to Vollmann, Berry and Whybark (15), there are major differences between the management of these inventories and manufacturing inventories. The differences occur mainly because of differences in the sources of demand for the items contained in independent demand inventories and those in manufacturing inventories. Therefore, end-product items, such as those stocked in the warehouse shown in Figure 6 (16), are primarily influenced by factors which are independent of company variation. These external factors induce a certain amount of random variation in the demand for such items. As a result, forecasts of demand of these items are typically projections of historical demand patterns. These forecasts estimate the average usage rate and the pattern of random variation.

The demand for the items in the manufacturing inventory shown in Figure 6, the raw materials and components, is directly influenced by internal factors that are well within the control of the firm. These internal factors include the assembly and fa ition production schedule. The demand for raw materials and component items is a derived demand which can be calculated exactly, once the assembly and fabrication production schedules are determined. Therefore, the demand for end-product items is referred to as independent demand, while the demand for items contained in manufacturing inventories is referred to as dependent demand.

Vollmann, Berry and Whybark show that the concepts of independent and dependent demand are important in selecting appropriate inventory management techniques. The inventory management techniques described in this section are best suited for independent demand items, while material

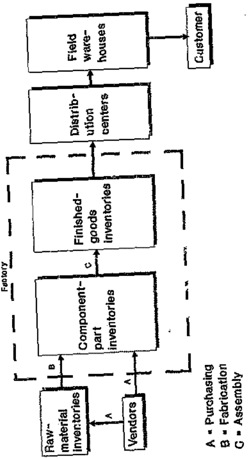


Figure 6: Materials Flow System

requirements planning techniques are best suited for the dependent demand items found in manufacturing.

3.2.1 Routine inventory decisions.

According to Vollmann, Berry and Whybark (17) two types of routine inventory decisions need to be made in managing inventories. These decisions are concerned with how much should be ordered (quantity) and when these orders should be placed (timing).

Routine decisions on the quantity and timing of replenishment orders for independent demand items can be made using any one of the four inventory control rules in Figure 7 (18). The decision rules shown in Figure 7 involve placing orders for either a fixed or a variable order quantity, with either a fixed or variable time period between successive orders.

- Order Quantity Decisions.

Order quantity decisions primarily affect the amount of inventory held in stock. Large order quantities enable orders to be placed infrequently and reduce the cost of preparing replenishment orders, but they also increase the cycle stock inventories and cost of carrying inventory.

Marvin R Smith (19) asserts that a general rule of inventory can be established from the relationship between order

ORDER FREQUENCE	ORDER QUANTITY	
	Fixed (Q)	Variable (S)
Variable (R)	Q,R	S,R
Fixed (T)	Q,T	S,T

Q = order a fixed quantity (Q)
S = order upto a fixed expected opening inventory quantity (S)
R = place an order when the balance drops to (R)
T = place an order every (T) periods

Figure 7: Inventory Decision Rules

quantity and inventory levels. In manufacturing, lot size is the major determinent of inventory levels and any increase or decrease in order quantity will have a major impact on inventory investment. It is, therefore, very importar': to regulate order quantities in manufacturing to balance the relationship of order quantity to inventory.

Smith continues by showing that the Economic Order Quar'ity (EOQ) provides a means of determining the lowest-cost order quantity directly. The EOQ model is an equation which describes the relationship between the cost of placing orders, the costs of carrying inventory and order quantity. Several simplifying assumptions are made by this model, these include: the demand rate is constant; costs remain fixed; and production and inventory capacity are unlimited. Marvin R Smith concluded that despite the fact that these assumptions seem restrictive, the EOQ model provides useful guilelines for ordering decisions. This is due to the fact that the EOQ model will assist the inventory planner in maintaining economic inventory levels provided demand is reasonably constant. In light of modern manufacturing techniques, as the setup times are reduced and tend to zero, the order quantity tends to one. This concept of having an economic order quantity of one is ideal.

- <u>Order Timing Decision.</u>

Vollmann, Berry and Whybark (20) believe that the timing of replenishment orders under the order point rule is determined by the use of a trigger level, that is the reorder point. The inventory level is assumed to be under continuous monitoring (review) and when the stock level reaches the reorder point, a replenishment order for a fixed or variable quantity is issued. The setting of the reorder point is influenced by five factors: the demand rate; the lead time required to obtain replenishment inventory; the amount of uncertainty in the demand rate; the replenishment lead time; and the management policy regarding the acceptable level of inventory shortages.

The assumption of a fixed demand rate and a constant replenishment lead time is rarely justified in actual operations. Random fluctuations in the demand for individual products occur because of variances in the timing of the purchase of the product by the customer. Therefore, if one is to provide protection against inventory shortages when there is uncertainty in demand, the reorder point needs to be increased beyond the average demand during the replenishment lead time. Some level of safety stock is also required.

3.2.2 Determining the safety stock level

Before the level of safety can be decided, a criterion must be established for determining how much protection against inventory shortage is warrented. One of two different criteria is often used: the probability of stocking out in any given replenishment order cycle; or the desired level of customer service in satisfying the product demand immediately out of inventory.

Once the routine inventory decisions have been decided on, the next step would be to develop an information system for inventory control.

3.2.3 <u>Information system for inventory control.</u>

The information system aspect of the decision rules are also critical in the effective management of inventories. Therefore, Vollmann, Berry and Whybark (21) direct attention towards the information requirments of an effective inventory control system. They obtain these information needs by *looking at a series of increasingly complex inventory control* systems.

1. <u>Two-Bin System</u>

The bin reserve system is one of the simplest inventory control systems in terms of its information requirements. In fact, no records are necessary for this system to function. In this system inventory is carried in two bins. Whenever the first bin is empty, a replenishment order is placed for additional materials. The second bin contains sufficient material to last during the replenishment lead time and serves as the reorder point quantity.

The disadvantages of this system are that the actual stock balance at any time is unknown, and there is little information available which can be used to estimate the current usage rate for a particular item.

2. <u>Perpetual System</u>

A perpetual inventory system maintains a record of the current stock balance for each inventory item. Receipt and disbursement transactions are routinely processed to update the inventory balance, as well as to obtain historical usage data.

The classic reorder point is a perpetual inventory system. This means that a reorder point is set, and every time an issue is made the stock on hand is checked to see whether it is down to the reorder point. If it is, an order is placed.

In the companies under study, the independent demand inventory management module is used to calculate the products that are required to be produced and the quantity of these products to produce. They are calculated with the aid of the reorder point models developed for each product in this module. The products that are required to be produced are determined by carrying out a manual comparison of the reorder point models of each product, with their respective stock status at the date of comparison. From this, it is determined which products are required to be produced.

The output of this module, is inputed into the production planning module.

3.3 The Production Planning Module

The inputs to the production planning module are from the independent demand inventory management module and from the marketing department. (see Figure 4)

The inputs from the independent demand inventory management module to the production planning module are the products that are required to be produced in order to bring the level of inventory of the finished goods to their required level. These are laid down by the reorder point models developed for each product.

The inputs from the marketing department to the production planning module are the products that are to be manufactured, to cover the requirements of special offers which are to be launched during the planning period.

The production planning module combines the information inputted from the two modules and generates the complete production plan for the period. Once the production plan has been determined, the planner would determine the validity of the plan, to ensure that all the products can be produced within the available capacity plan. The plan is then inputted into the capacity planning module, where "what if" analyses are carried out until such time as the production plan meets the requirements of the planner. The "what if" analyses allows the planner to produce a realistic production plan, which can be produced in the available capacity and production period. The final production plan generated is then inputted into the material requirements module (i.e. bill of materials module).

3.4 Capacity Planning M.

The activities carried out in the capacity planning module, involves converting the production plan into a capacity plan. This is carried out with the aid of time standards which are inputted into the module from the Industrial Engineering Module and are expressed in labour hours.

It is at this stage of the manufacturing planning system that the planner can perform "what if" analyses with the production plan, calculating the required capacity for the different plans until such time as the plan generated meets the requirements of the planner. In this way the planner can produce a realistic production plan, which is able to be produced within the available capacity.

3.5 Detailed Material And Capacity Planning

The next stage in designing a production planning and control system, is to examine the systems required to accomplish the detailed material and capacity planning. As a result of the company environment under consideration and the type of products made by these companies the material requirements module can be considered in two ways.

The first case occurs when product lead times are long (that is, greater than one day), product routings are complex, and bills of materials are time phased. *In this case*, a material requirements package becomes important for controlling the material *requirements* and time phasing the required components. The costs associated with purchasing a computer package of this nature are well worth it, when considering the time saved in generating the materials requirements plan.

In the second case, the products produced by the companies, have a short production lead time (that is, less than a day), and have a flat bill of materials, in which, the component parts are required at the same time and the bills of materials are not time phased during the manufacturing process. This greatly simplifies the material requirements planning. When a product is scheduled to be *produced*, all *components* are required to be available at that date. The only time phasing that *is necessary* is to account for the lead times when purchasing the component items.

In this case the company can input all the bills of materials into a micro computer. By entering the required production as laid down by the production plan into the computer, the required raw materials and component items would then be generated. From the computer all the components that are necessary to produce the products on the production plan would be calculated.

Within the business environment under study, the systems required to accomplish the detailed material and capacity planning can be seen in Figure 8

The module that would control these activities, is the material requirements, or bill-of-material module.

The production planning module inputs the products that are required to be produced and the quantities that are required of each product. The material requirements module then takes this plan, and with the aid of the bills of material, converts the production plan into a material requirements plan.

The next activity carried out by the material requirements module, is a comparison of the stock on hand with the material required. The inventory status of all the component items are inputted into the module from the inventory control module.

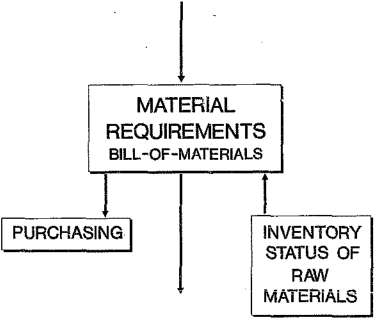


FIGURE 8: THE LINKS TO THE MATERIALS REQUIREMENTS MODULE

In the material requirements module a comparison of the materials required and their respective stock status is undertaken. From this comparison the quantity of each component item required to be purchased can be calculated. This information is then inputted into the purchasing module where the component items are purchased.

The final stage in designing a production planning and control system, is to examine the systems required for execution of the production plan.

3.6 Shop-Floor Control Module

The shop-floor control module is concerned with managing the detailed flow of material inside the plant. An effective shop-floor control system can lead to due date performance that ensures meeting the company's customer service goals.

The essential objective of the shop-floor control module is to execute the production plan, to build the right part at the right time. This would result in being able to satisfy customer service objectives.

R.W.Hall in his book Attaining Manufacturing Excellence, suggests some alternatives to shop-floor control:

Hall examines the different methods, to achieve visibility on the shop-floor. These methods are very good for large manufacturing concerns, where the top management and workforce do not communicate on a daily basis and other methods of communication are needed, to inform the workers of what is required of them. Also in large manufacturing organisations, where there are a large number of machine centers the design of a good factory layout would result in good visibility.

In a small company, there is continuous interaction and communication between the management and workers on a daily basis. The production scheduler would inform the workers of what is required to be produced during the day on the particular lines, and he would monitor the performance throughout the day, to ensure the schedules are met. Also if a problem should occur on a line, the factory manager would be notified immediately and the problem can be rectified straight away.

Bottom level workers have direct access to the factory manager on a daily basis, therefore, they are aware of what is going on around them and what is required of them.

In the business environment under consideration, where the companies produce to stock, the distribution center pulls materials through manufacturing or products out of manufacturing. The distribution center's stock levels serve as reorder points. When stock level reaches a predetermined level, the distribution center would inform the manufacturing manager what product to produce next and the quantity of that product that is required.

As a result of the assembly line manufacturing process in companies within this environment, pull systems (Kanban Squares) already exist between the different stages of manufacturing. This is due to the fact that the product is moved from one station to the next on the line, until such time as the product is completely manufactured. No work-in-process can build up between the work stations, due to the lack of storage space.

Due to the fact that the company'‹ demands for their products are low, and there are no dedicated production lines, the company has to utilise the concepts of product mix and people flexibility. This is due to the fact that a number of different products are produced on each production line and the workers are required to know how to manufacture each product.

3.6.1 The design of a shop-floor control module for the business environment under study.

There are two inputs into the shop-floor control module the first is from the mateial requirements module and the second is the final production schedule. The production plan is divided into the different product families according to the routings required when manufacturing the products. The factory manager or production planner would then schedule the production on the different production lines.

There are two cases to consider for the different companies under study. Firstly, there are the companies that produce products with complex routings, time phased bills of materials and with long production lead times. In this case good control has to be kept with regards to material flow and work center loading. A shop-floor control computer package can be of great assistance to the production planner.

In the other case, where the companies produce products with a line assembly and the product's bills-of-materials are flat and require no time phasing, and the production facilities and product routings are easy to control, production can be scheduled in the factory using manual methods, such as Gantt Charts.

It must be noted that when a company wants to implement a shop-floor control system, the company would have to adopt the system to it's particular requirements.

3.7 <u>Summary</u>

Vollmann, Berry and Whybark in their book Manufacturing Planning and Control Systems, suggest that for a company to implement a Manufacturing Planning and Control System, the company would have to adopt the system to its particular environment. Attempting to implement a complex manufacturing planning and control system as a first step to formalizing control can also be too great a leap for companies within the business environment under study. Most changes according to Vollmann, Berry and Whybark are made to the system inorder to simplify the system and also to enable some modules to be controlled in an informal manner.

The ability to adopt the system to the particular company environment is critical to the success of the system implementation.

4. PROPOSED MANUFACTURING PLANNING AND CONTROL SYSTEM FOR THE SMALL FAST GROWING BUSINESS ENVIRONMENT UNDER CONSIDERATION.

After studying the different methods proposed by the authors in Section 2, and having examined the comments made with respect to applying the system to the company environment under consideration, it was decided to propose a system for manufacturing planning and control which would apply to the business environment under consideration. (see Figure 9 for a diagram of the system).

It can be seen from Figure 9, that the system developed is a great simplification of the systems described in Section 2. The system has been designed in such a way as to simplify the control of each module and also to enable some of the modules to be controlled in an informal manner. This is essential for a small fast growing company, which does not have the required skills, technology and finance to purchase sophisticated computer packages to control the system modules.
The system proposed will be discussed briefly below:

Demand Forecasting Module

In this system, demand forecasts are used for setting up the control systems for the management of the independent demand inventory items. Thus the demand forecasts are inputted into the independent demand inventory module.

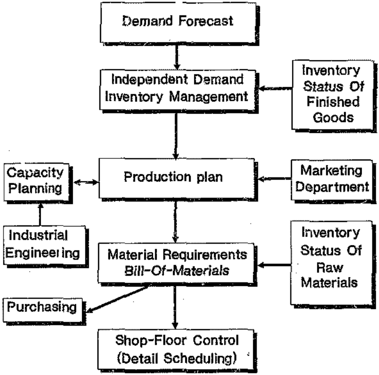


Figure 9: Manufacturing Planning And Control System For A Small Fast Growing Company

Independent Demand Inventory Module

This module is used to maintain and control the required levels of finished goods inventories in the warehouses. The module is also used to calculate the products that are required to be produced and the quantities of these products to produce.

The Production Planning Module

This module calculates the complete production plan for the period. The validity of the plan is also determined, to ensure that all the products can be produced within the available factory capacity.

Material Requirements (Bill-Of-Material) Module

This module is used to accomplish the detailed material and capacity planning.

Shop-Floor Control Module

This module is concerned with managing the detailed flow of material inside the factory and the execution of the production plan.

The system proposed above is merely a guide to implementing the manufacturing planning and control system. It is necessary for the different companies implementing the system, to adopt the system to its particular requirements to ensure the success of the implementation.

5. CASE STUDY OF THE IMPLEMENTATION OF THE PRODUCTION PLANNING AND CONTROL SYSTEM PROPOSED IN SECTION 4, AT AVROY SHLAIN COSMETICS, A SMALL FAST GROWING MANUFACTURING COMPANY.

This section of the project involved the designing and implementation of a production planning and scheduling system, to be implemented at Avroy Shlain Cosmetics.

The initial stage of this implementation process involved an investigation into the company's background, inorder to be able to adapt the system to the company's particular business environment. (See section 5.1)

The next step was the examination of the method used to plan and schedule the production prior to the study (see section 5.2). The problems associated with this method are then discussed in section 5.2.1.

With these problems in mind, the designing of the production planning and scheduling methods were undertaken and will be examined in section 6.

It was also necessary to develop the required infrastructure and tools in order to design and implement the new system.

The tools that were required to be developed (See section 6) were:

- demand forecasts
- the control of independent demand inventory items
- standard times
- the design of a computer model to aid with the scheduling task

It is crucial to realise that each stage of the project is inextricably linked, so that one part cannot be eliminated without having a detrimental effect on the entire system. It is because of these interactions that we were able to realise and achieve the results, imperative for the success of the project.

5.1 Company Background

The company was started in July 1973 by Avroy Shlain, to produce cosmetics.

In 1973, the idea of establishing a direct sales house was first conceived. Avroy Shlain's first premises were in Blairgowrie. Within five years the company out grew these premises and moved to Randburg. With the company's incredible growth of approximately 20-25% a year, these premises soon became inadequate and in 1984 they moved to their present home in Kramerville.

Avroy Shlain believes that the success of his company has been as a result of their unique order winning criteria, based on people and personal contact. By bringing a nationwide network of beauty advisors (sales women) to your home, they offer an alternative to the impersonal over-the-counter buying that is so often hasty and impulsive and leads to expensive mistakes.

The distribution of the company's products are solely by the use of beauty advisors, who are trained not only to sell cosmetics but to make sure that their customers meetings are beneficial, interesting and informative.

The beauty advisors are at the customers' beck and call, ready to replace a product the customer has run out of, or ready to give advice on some gift idea.

The company's first sales were made in and around Johannesburg, but they soon grew and it was not long before they had sales representatives in Durban, Pretoria, Vaal Triangle, Port Elizabeth, East London, Pietersburg, Bloemfontein, Cape Town and the Eastern Transvaal. Today sales are made throughout South Africa.

In 1973 the company started with 15 beauty advisors today they have over 5000. All the beauty advisors go through a highly specialised training programme. Every beauty advisor is her own boss, her time is flexible and she alone sets limits for her effort and income.

Throughout the year there are special offers, incentive programmes and exciting competitions to motivate the beauty advisors and encourage them to sell more products. The special offers are made up of: Mother's day packs, Father's day packs, Christmas gifts, and general special offers to boost sales.

In 1983 the company produced South Africa's first biological revitalising cream, the Nucelle product range. In 1985 Revitalin, used in the product range Nucelle developed by

Avroy Shlain, received an award from the Italian Society of Cosmetic Chemists.

In 1973 the company was launched with 14 products, today they have close to 200 products, and an annual sales amounting to approximately R25 million. The company's product range is reviewed, adjusted and expanded routinely to meet new trends and increasing demands.

The product range of 200 can be brocken down into six different product families, these are: lipstick, aerosole, nail, cream, liquid, and tube. Each product family is filled on a seperate production line, thus the assembly lines are dedicated to a particular product family.

The products that are manufactured by the company, have a flat singe level bill of materials, with none of the component items being time phased, this greatly reduces the complexity of the planning proceedure.

Out of the 200 products that the company sells, 95% of them are manufactured inhouse. All component items required for production are purchased from suppliers, of which 90% are South African based and the remaining are sourced overseas. As a result of this the company's purchasing department has to be efficient, and ensure that all component items are purchased and delivered on time to meet the production schedules layed down.

The company's infrastructure, and especially its production planning department, did not grow in proportion to the overall growth of the product demands. A direct result of this was that the planning department was using methods and techniques which were inadequate for the company's needs.

A detrimental consequence of the methods used, was that approximately 15% of the company's product range was out of stock at any one particular time. This is highly unacceptable in a company like Avroy Shlain, were an out of stock product results in a back order having to be made, and also demotivates the beauty advisors. Backorders cost the company approximately R50,000 per month in 1987.

The company was also experiencing problems with its inventory control. Some finished goods were considerably overstocked, possibly up to 1,5 years normal supply and in other cases products were out of stock. As a result of this, it was very difficult to calculate the overall number of inventory turns for each product.

The company held approximately R1,5 million of stock per month in 1987. This large stock holding was as a direct result of the poor inventory management techniques in use. However, as a result of the company's order winning criteria of offering a high service level to its customers, it would require excess products having to be held in stock to reduce the possibilities of stockouts. This in turn results in a large amount of money invested in stock. It was felt by management that with proper management of the stock, this investment could be greatly reduced without effecting the service levels.

The company has two computer systems to aid in the manufacturing process. The first system runs on a IBM 36. This sytem controls the order processing and finished goods inventories. The second system runs on a IBM AT and it controls the material requirements, and the raw and packaging material inventories.

5.2 The Existing Methods Used To Plan And Schedule The Production Prior To The Study.

Production planning was carried out by a planner, who had no formal training in any scheduling techniques. The planner was a secretary who was promoted to production planning, as the company grew and required a full-time scheduler.

Taking into account the circumstances, the secretary performed the scheduling task adequately. She had the initiative to read up on different scheduling techniques, which helped her in the production planning. Her scheduling techniques were initially adequate, but as the company grew at approximately 20-25 % per year and the demand for each product increased, the techniques were not sufficient and numerouse problems arose in the production planning. These problems will be discussed later.

Production planning was initiated by a verbal message from the factory floor manager to the production planner when they were in need of more work. The production planner then examined the critical stock status report. This report gives an indication that an item is below the "minimum level" layed down. This, together with knowledge of the current demand situation, established the priority of production jobs on which to start next.

Once the planner determined which job to begin with, she would have to input the requirements into the computer, to determine whether all the required raw materials were in stock. If all the raw materials were not in stock, the job would have to wait approximately three to fo. weeks, as this is the time required for a material order to be fulfilled.

If all the raw materials were in stock, the planner would print out a job ticket, which states all the requirements and their quantities. The job ticket would then be given to the factory manager who would pass it on to the operator who mixes the product. Once the bulk was mixed it was moved from the mixing area to the filling line. The required packaging material for the product would also be transferred from the warehouse to the fill line. The filling process would then commence,

and would continue until either the packaging or bulk material was completed. All finished products would th e transferred to the finished goods warehouse, and .e remaining packaging material would be taken back to the packaging material warehouse.

The fact..ry manager would then inform the planner of the quantity of finished goods transferred to the warehouse. The planner then uses these quantities to update the stock records on the computer.

5.2.1 Problems with this existing method.

There was no formal "early warning" system (i.e. which items are likely to be manufactured in the immediate period ahead). The planner did not have the knowledge or experience needed to plan production for the period ahead. An indication of what product to produce next and the quantity required of that product, can be ascertained from a manual comparison between current stock levels, immediate past usage, and minimum levels set for each product.

"Minimum levels" (in effect Production Reorder Points - ROP's) were set for each product, in order to aid the planner in determining which product to produce next. It is unclear how these had been set, but there appear to be problems since some items have very large stocks and others are out of stock. These levels are critical because they are a prime way in which production "reactive" planning is initiated.

Since the planner did not use capacity planning, and there were no standards on which to base capacity planning, there was only a crude notion of what could actually be produced in the period ahead. The factory floor manager was the only person in the company who had the required knowledge, based on experience, to estimate the quantity of products that could be produced in a given period.

It was noted that within a period, there was either under capacity loading or over capacity loading of the factory. This resulted in the schedule having to be adjusted continuously, according to the capacity loading of the factory.

If the schedule was found to be 'undercapacity', this did not pose too much of a problem, as the planner would schedule some other product to utilise the excess capacity. If the schedule was found to be 'overcapacity' this resulted in some of the products not being produced within the period, and they would have to be moved to the next period's production schedule. The delay in production could result in products going out of stock which in turn results in poor customer service levels.

When the production planner issued a job ticket specifying what product to manufacture, the only information that was given to the factory manager was the product to be manufactured and the quantity of bulk material required. No information of how many products should be filled was given, and this was left up to the factory manager to determine.

The method that the factory manager adopted was to transfer all the packaging material that was required for the particular product from the warehouse to the fill line. The product would then be filled and packed. The filling process would continue until either the bulk material or any of the packaging material components were complete. At this stage the quantity of finished goods would be noted and then transferred to the finished goods warehouse. All remaining packaging materials would be transferred to the packaging warehouse. At no stage was the quantity of packaging material documented, either when leaving the warehouse or returning to the warehouse on completion of the job.

The method which was used to update the stock status of the packaging material was as follows. The factory manager would inform the planner of how many finished goods were transferred to the finished goods warehouse. The planner would then update the packaging material stock records on the computer from this information. The stock records were inaccurate as a result of the method used to update the records. The planner didn't take into account the fact that a large amount of the packaging material was defective. Approximately 10 % of all purchased goods were rejected on the line, these rejects were not noted earlier as a result of the poor quality control of incoming goods.

The inaccuracy of the stock data resulted in many problems which the planner had to deal with. In most cases the stock records showed more stock than there actually was on hand. A common occurrence that the planner faced was that she would specify a quantity of a product to be made, check on the computer to see that all the raw materials and packaging materials were on hand, and then issue the job ticket to the factory manager. Once the bulk material was manufactured, it would be moved to the fill line and all the required packaging material would be transported to the fill line. The filling and packaging of the product would then start. After a quantity of products were packed, the line would stop as one of the components of the packaging material was in short supply. This would delay the production, as more packaging material would have to be purchased, which could take approximately three to four weeks depending on the component.

The planner would be faced with the decision to either keep the line set up and to wait for the component or to end the fill and start filling another product on the line. The alternatives which the planner faced resulted in a large amount of wasted time and factory capacity. This in turn resulted in an increase in the production lead time.

Another problem arose when the Marketing Department decided to have a promotion on a certain product. There was no communication between the Marketing Department and the Production Planning Department. The planner only found out about the promotion item about a week before it was to be launched to the customers. This resulted in the planner having to stop production of other products and expedite the promotional item. Thus the production of the other items were moved to another date. This also resulted in products being out of stock and complicated the scheduling process for the planner.

In studying the growth of Avroy Shlain a number of points about the production planning methods used can be made at various stages of the growth process.

Initially, when the company was at the early stages of its growth there was no requirement for a full-time scheduler. Production planning was performed by the production manager. As the company grew, and the demand of products increased, scheduling activities became too involved and required too much of the production manager's time. At this stage it was decided to promote the secretary to production planner. The planner performed the scheduling task adequately for a period of time, but as the company grew and the demand for each product increased, the simple techniques which she used were not sufficient to perform the scheduling tasks in a satisfactory manner. The methods which she adopted resulted in a large number of problems in the production planning, which were discussed above.

It can easily be seen that if the company did not change it's methods of scheduling, the company could be in serious trouble.

It was at this stage of the growth of the company that it was decided to investigate the cause of the problems. One of the projects involved the study of the production planning and scheduling methods used by the company, and to design and implement new methods to aid the planner with planning and scheduling which would take the growth of the company into account.

6. CHANGES WHICH WERE MADE TO THE PRODUCTION PLANNING PROCESS AND DEPARTMENT

It was at this stage of the company's growth that the author was employed as a consultant, to implement changes to the existing production planning and control system in order to improve the system.

On close examination of the Production Planning Department, and it's affiliated departments, that is, marketing, purchasing, manufacturing, sales, etc, it was noted that the members of these departments did not have a clear understanding of what was required of them for the efficient running of the Production Planning Department

It is necessary for all staff members associated with the Planning Department to fully understand their role within their own department and also the links required between their department and the production planning department.

The first phase of the project involved a one day training seminar which all employees associated with the planning department attended. The different stages of the training programme are discussed below. (see Figure 10)

STAGE 1: The determination of what information should be covered during the training seminar

STAGE 2: One day seminar. During the seminar all the requirements of the production planning department will be discussed

STAGE 3: To determine whether the training programme was a sucsess and to see if any other areas need attention

STAGE 4: During this stage of the project,the production planning department and its related departments would be monitored, to ensure that the department is running smoothly.

Figure 10: The Different Stages Of The Training Programme

Stage 1:

Prior to the full-day session all workers involved were asked to fill out a questionaire. (see appendix A1)
The information obtained from the questionnaire was analysed, and from these results the areas to concentrate on during the one day session was determined. The major areas of concern were as follows:-

- In most cases the employees believed that the department in which they worked was the most important one in the company. They believed that each department was run on its own, and only communicated with the other departments when required. The employees did not see the company as one unit, which required the efficient and correct communication links between different departments, for the smooth running of the company.

- It was apparent that most of the employees did not have a clear understanding of their actual job description. They were unaware of the actual activities they had to perform and how their work related to other departments.

- Communication between the different departments was almost non-existent. Also some of the employees believed that these methods were correct (that is, it is not neccessary for departments to communicate frequently, unless a problem should arise). This type of thinking showed a clear misunderstanding of how the company should function. It was thus neccessary to explain to the employees what their roles within their departments were and also to discuss how the different departments were interelated with each another.

From this information the one day seminar was structured, and the relevent topics for discussion were determined.

Stage 2.

A one day seminar was developed and attended by all employees from the departments of purchasing, manufacturing, marketing, sales and production planning.

The following topics of interest were discussed during the seminar:

- Introduction to the planning department.
- Discussion of what role the planning department performs, and how these activities are to be accomplished.
- Detailed discussion of who performs the different activities within the planning department.
- Detailed discussion of how the different departments link to form one unit, concentrating in more detail on the interactions between the planning department and its related departments. (see Figure 11).

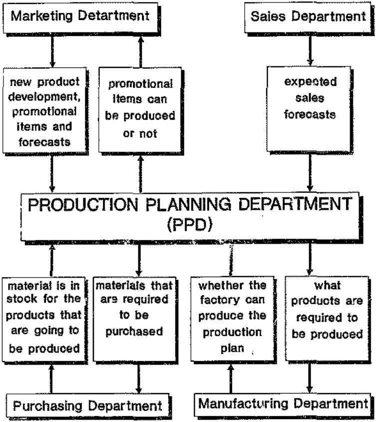


Figure 11: The Relationship Of The Planning Department And Its Related Departments

The training session was carried out in an informal manner. A lecture was given on a topic. Once all the major points were put forward, a discussion was initiated where all the employees were involved. From the topics of the discussion it was determined whether the employees understood the new concepts or not. A large number of interesting points came out from the discussions, and the employees began to understand their roles within the production planning cycle.

At the end of the training session the employees involved were asked once again to complete the initial questionaire.

The results obtained from the seminar will be discissed below.

Stage 3.

The questionnaires were then collected and once again analysed. A number of interesting points were noted from these questionnaires:

- The employees began to understand that if the company is to operate efficiently then it is necessary for the various departments to work in close co-operation. Furthermore, no department is more important than another and they are all interdependant.

- The employees of the different departments began to understand their roles within the production planning process and how the different departments are linked to the planning department.

From these results it was clear that the training session had a marked effect on the employees' understanding of the role of the production planning department.

Stage 4.

The final stage of the programme involved the monitoring of the departments and employees, who were related to the production planning department. The monitoring of the different activities was carried out while other changes to the production planning and scheduling methods were being performed. These changes will be discussed in Sections 6.1 to 6.3.

It became apparent that after the training programme, the different departments started to communicate with each other, and the employees within each department knew what their tasks and what their responsiblities were within the planning environment.

At this stage a production planning and control system was designed to be implemented at Avroy Shlain Cosmetics. It must be noted that when designing the system, the schematic proposed in Section 4 was used as a guideline. Each module of the system had to be modified and adopted to suite the company's particular business environment.

Figure 12 is a representation of the modules implemented and the interactions between the different modules.

What follows is an analysis of the modifications made to the different modules within the system, in order for them to be implemented in this particular company environment.

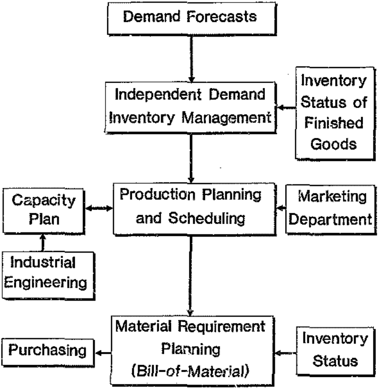


Figure 12: The Production Planning and Control Model Implemented at Avroy Shlain Cosmetics

6.1. Demand Forecasting

In section 5.2 the methods which were adopted by the planning department for scheduling the production in the factory were discussed. From the method used it is noted that the planner did not have any demand forecasts on which to base product demand. This made the scheduling task almost impossible, and the planner had to rely on her own experience and information given by the warehouse manager to determine the product demand. This method proved to be most unsatisfactory.

From Figure 12, it can be seen that the demand forecasting module is the first link in the production planning system proposed. The information generated in this module is the primary input to the Independent Demand Inventory Management module. Without demand forecasts the company has no information to aid in the planning of production for the period ahead. This resulted in errors occuring in the production plan. The company would thus experience large variances in stock levels, over stocked products in one month and out of stock products in other months.

As a result of these factors it was decided to determine demand forecasts for the different products in order to facilitate the production planning activities.

Since the company kept no historical product demand data which is required for demand forecasting, it was thus necessary to develop a method for determining the demand of each product.

<u>The method used to determine the demand forecasts.</u>

As the company had no historical demand data, it was required to study the historical information that the company did keep in order to attempt to determine what the product demands were in previous years or months.

After examining all the historical data which the company had collected, it was noted that sales re[illegible]s were printed at the end of every month and these reports gave [illegible]les to date of every product. It was felt that this [illegible] [illegible]ppropriate historical data available on which [illegible] feasible demand forecasts.

The method used to determine the percentage growth of sales per year, and the sales forecast per product, is discussed below. (see Appendix B1 for illustration of how the demand forecast were determined.)

<u>Step 1: The determination of the actual sales per month for each product.</u>

From the sales reports which dated back as far as January 1985 the actual sales figures for each product per month were determined. (see Appendix B1 step 1 for illustration of how the actual sales figures were calculated.)

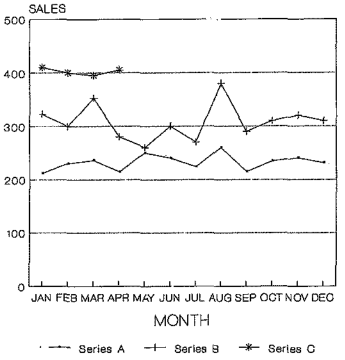
Step 2: The determination of the monthly sales trends during the year.

Once the actual sales for each product per month were determined (step 1), it was necessary to carefully investigate the trend of the sales, in order to determine some correlation between the monthly sales figures.

Graphs were plotted for sales figures for 1985, 1986, and 1987. (see Figure 13A for graphs plotted for product A). Similar graphs were plotted for all the company products.

From the graph it can be seen that there appears to be no trend that the sales figures were following. (It must be noted at this stage that all the products sales figures when plotted on a graph had very similar plots, that is, they did not follow any trend). The example in Appendix B.1 is a representation of all the products produced by the company. From the graph it can be seen that the demand is steady and not inherently seasonal, thus the simple mean may be suitable for representing the monthly sales.

SALES 1985-1987
Figure 13A



Series A = Sales 1985
Series B = Sales 1986
Series C = Sales 1987

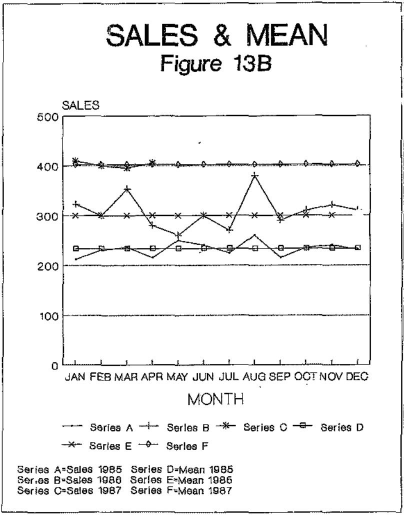
It was decided to take the mean of the monthly sales figures of each year to represent the sales per month, in order to help simplify the calculations of the percentage growth of sales from one year to the next. It was believed that this simplification was justified, as illustrated by the graph in Figure 13B, in which the plot can be represented as a straight line (the mean). Meaningful information can therefore be obtained from the monthly sales figures.

As can be seen in Appendix B.1 step 1, the mean was calculated for each set of data, and plotted on the graph.

Step 3: The calculation of the percentage growth of sales per year.

Once the monthly mean sales figures had been calculated for each year, that is, 1985, 1986, and 1987, sufficient information was available to calculate the percentage growth of sales per year. The method used can be seen in Appendix B.1.step 3.

This example shows how the percentage growth of sales from 1985 to 1986, and from 1986 to 1987 was calculated for the product A. It must be noted that the percentage growth of sales from one year to the next varied for the different products, but the variances were not very large, approximately 5% above and below the mean. As a result of the small variances it was decided to average the values calculated to


SALES & MEAN
Figure 13B
SALES
500
400
300
200
100
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
MONTH
Series A
Series B
Series C
Series D
Series E
Series F
Series A=Sales 1985
Series B=Sales 1986
Series C=Sales 1987
Series D=Mean 1985
Series E=Mean 1986
Series F=Mean 1987

determine an overall percentage sales growth for all the products.

The Sales and Marketing managers were then consulted and asked whether they believed the results calculated were accurate reflections of what actually occured during those periods. Both managers believed that the percentage growth calculated for period 1985 to 1985 was fairly accurate, but that calculated for period 1986 to 1987 was not very accurate. The two managers performed a manual comparison between the actual percentage growth for the period and the calculated one, when making their assessment.

One reason for the value calculated being inaccurate by approximately 5%, was as a result of only having data upto and including April 1987, thus the mean sales figures calculated for 1987 were based on four months as opposed to twelve months. Adjustments made to the percentage growth for the period, were based on the managers forecast of expected demand and expected growth of the company for the year (that is, not historical demand information, but rather projected demand). (see Appendix C.1 step 3)

Step 4: The determination of the sales forecast for 1987.

In Step 4, the mean monthly sales forecast for 1987 was calculated. (see how the calculation was performed for product A see Appendix B.1 step 4. This calculation was carried out for all products in order to determine the demand forecasts for 1987.)

Step 5: The determination of the forecasts for future years.

From the historical data, one is required to calculate the expected percentage growth in sales for the period from the present year to the next year, that is, 1987 to 1988 in this case (see Appendix B.1 step 5). Once the expected percentage growth of sales has been calculated it is necessary to consult the Sales and Marketing managers to determine whether they agree or disagree with the value calculated. If changes must be made to the value they must be made at this stage.

Once the percentage growth in sales has been decided on, the next stage is to determine the actual mean monthly sales figures for each product for the present period, that is, 1987. This value is calculated using the actual sales values, and not the forecasted values. Once the mean values have been calculated the forecast for the future period, that is, 1988, can be calculated. The forecast would be determined by multiplying the percentage growth of sales (1987 to 1988), by the mean monthly sales of each product for the present period. (see Appendix B.1 step 5).

This process would be carried out whenever a forecast is required.

The Demand Forecasts would be inputted into the Independent Demand Inventory Management Module. The way in which the forecasts will be used to achieve the inventory and production control required, will be discussed in section 6.2.

6.2. Independent Demand Inventory Management.

In section 5.2 the method which was adopted by the planning department to control the levels of the independent demand inventories in the distribution warehouse was described. From this it was apparent that the routine inventory decisions, that is, the order quantity decision and the order timing decision, were not very accurate.

As a result of the inaccuracy of the routine inventory decisions, it was required to study the different inventory management techniques. The next step is to implement changes to the methods used in order to improve the inventory management, and thus improve customer service, and control the amount of money invested in inventory.

Avroy Shlain Cosmetics is a company that has a order winning criteria of offering a high service level to its customers. To ensure this it is important for the company to have good control over it's finished goods inventory. As a result the company has to continually monitor the levels of inventory to ensure they remain within the allowable range set by the planning department. It was decided to implement an inventory control system that would trigger a reorder point when a predetermined inventory level is reached. Thus, an indication of what products are required to be manufactured, can be obtained when the reorder point is reached.

The information generated in this module would then be inputted into the production planning module.

It was decided to concerntrate the company's efforts on the management of independent demand inventories (the reason for this will be discussed later in this section). It must be noted that there are major differences between the methods for managing these inventories and manufacturing inventories. The differences occur mainly because of differences in the sources of demand for the items contained in independent demand inventories and those in manufacturing inventories. The demand for end-product items, such as those stocked in the warehouse, is primarily influenced by factors which are independent of company decisions. These external factors induce a certain amount of random variations in the demand for such items. As a result, forecasts of demand (see Section 6.1) for these items are typical projections of historical demand patterns.

The demand for the items in the manufacturing inventories, is directly influenced by internal factors that are well within the control of the firm.

It was decided to concentrate our efforts on the management of independent demand inventories, as these inventories are influenced by factors independent of the company decisions, such as, sales, which have the most effect on the customer service level. It was felt that it was important for the company to improve its management of these inventories. This would reduced the amount of money invested in stock and reduce the number of products going out of stock, thus, improving the customer service.

The reason for not concentrating on the dependent demand inventories was that their demands are derived demands which can be calculated precisely once the assembly and fabrication production schedules are determined. It was believed that once the demand for the independent demand items could be accurately managed, the accuracy would then cascade from one to the next, and therefore be maintained throughout. The determination of the dependent demand inventory items rely on indepentent demand items.

To increase service level requires a disproportionate increase in safety stock. If the reorder point is properly determined by taking into account the average lead time demand, one can only risk a stockout during that reorder point period. As a result safety stock does not need to be calculated on total demand variability, but rather only during the lead time period, since this is the period of risk.

The greater the lead time, the longer the risk period, the more often a reorder level is hit, the more lead time periods occur. Consequently one may want to minimize the number of lead time periods during the year and this results in increasing the order quantities substantially over the reorder level. A trade off has to be made between the order quantity and number of lead time periods.

It was decided with the inventory management that, as a result of the above mentioned problems, it was necessary to develop and implement an inventory control system that would:

- improve the stock status of all the products;
- does not require a large amount of data (historical), nor calculations to design the system (as the company did not have the required data on hand);
- be easy to implement, and require a short time period to implement; and
- the system should not be designed in such a way that it would be totally unfamiliar to the production planner, and the implementation should not require a large amount of training before the system could be implemented.

With these objectives in mind the system for monitoring the inventory was designed.

The first stage of the design of the system involved the determination of the routine inventory decisions, that is, how much should be ordered and when these orders should be placed. Because the company did not have any information required to perform the calculations necessary to determine the routine inventory decisions on hand, it was necessary to develop a method to determine these decisions.

After much discussion it was decided to design the inventory control model with a three months stock holding (this is the national consolidated stock) and base the routine decision rules on this stock holding.

Before a decision was made to base the inventory model on a three months stock holding, a number of simulations were performed, whereby the amount of money invested was calculated for different stock holdings. It was decided by the top management and the operations manager, after examining the different simulations and the probability of any product going out of stock, that the three months stock holding would be optimum for the company. If less than three months target stock level was chosen, the associated administrative costs would increase unfavorably due to more frequent ordering and production runs. Having to monitor inventories more closely and accurately would be too great a step of improvement for the existing control system, and a gradual improvement was decided on rather than one large optimization which may produce a nervous environment. It must be noted that the probability of stock out of any product for the different simulations could not be calculated, as the company did not have the required information on hand. It was thus left up to the experience of the operations manager to determine what the different probabilities would be.

Once the decision was made to design the inventory control system based on three months stock holding, it was time to determine which routine inventory decision model should be adopted.

From Section 3 Figure 7 the different inventory decision rules can be seen. It was decided to adopt an inventory control system where the order frequency was fixed and order quantity was variable, that is, the S, T system was adopted since it was felt that it would be the simplest system to implement. The training required by the production planner to implement the system would be less than that required to implement any of the other inventory control systems. Another reason for adopting these inventory decision rules was due to the fact that the company closed its books at the end of each month. As a result of this all product stock records were updated at the end of each month. It was thus decided that at the end of each month the planner would examine the product stock status report and determine what products have to be produced during the period ahead. This would be carried out at the end of each month, thus the fixed order frequency decision rule was adopted.

It was believed that if any other inventory control system was adopted whereby either the order frequency, or the order quantity were fixed, it would result in the planning operation being less flexible. The production planner would be forced either to produce a product in a particular quantity, or at a prescribed time, or both. These systems would require a large amount of training and discipline, and it was anticipated that a large number of errors would result in the inventory control during the implementation of the system.

The Routine Inventory Decisions

Once the inventory control system had been decided on, it was time to determine the routine inventory decisions, (the reorder point), and the order quantity decisions. As stated earlier in the section, these decision rules are not fixed, but are designed to aid the planner in determining when and in what quantity to order a particular product.

As a result of the lack of availability of data and information required to calculate these decision rules theoretically, an alternative method for calculating them had to be determined. The method that was used, was for the operations manager and the finance director to meet and pool their experience in their different fields of the business. The operation manager was experienced in production, purchasing and sales, and the finance director was experienced in the cost of holding inventory, the costs associated with placing orders and the general financial requirements.

After much discussion between the two managers, they devised the model with the following constraints :

- safety stock one month;
- trigger reorder point one month plus one month safety stock; and
- order quantity equals three months stock minus on-hand stock.

For illustration of the system see Figure 14.

The accuracy of the model may require refining in the future, since, at the time of analysis many of the variables consistant with modern manufacturing techniques were either new to the management or the information was unavailable.

Management has since become more aware of these variables used in developing the model and have devised methods for tracking information such as: order costs, setup costs, inventory holding costs, opportunity costs, stockout costs, service level costs and the like. This information will be built up in the future and used in refinement of the inventory model.

The information system

Once the routine inventory decision model was designed, the next stage was the determination of the information system for

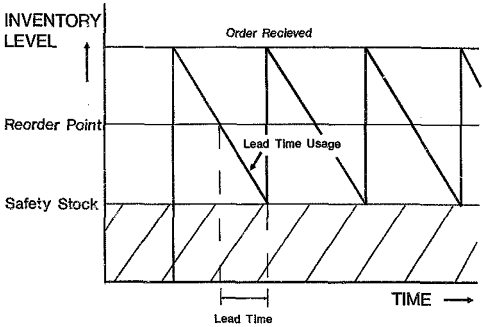


Figure 14: Routine Inventory Decision Model

inventory control. The information system aspect of the routine decision rules is critical in the effective management of inventories. It is necessary to develop a system for inventory control that would be effective, and produce accurate information.

The inventory control system adopted was a periodic (at month end) review information system. As a result of adopting the periodic review system, the interfacing transaction between the month end inventory status and the production planning model developed on the Lotus package (see Section 6.2.1) was downloaded in batch form at month end. This allowed for a month's production plan to be generated.

A monthly production schedule was chosen over a daily schedule due to the following factors:

(1) Downloading the stock status daily into the planning programme would have resulted in a highly dynamic production schedule, which would change daily.

(2) The daily stock status may not be accurate. This is due to: movement transactions on the computer being delayed due to system down time, stock returns, inaccurate on-hand quantities and delays in booking receipts.

Thus it was believed that the monthly review of the stock status, based on the financial accounting period ends, would satisfy the inventory requirements and allow a monthly production schedule to be determined with a fixed priority.

Once the routine inventory decision model has been designed, and the information system for the inventory control developed, the next stage was to implement the control system.

6.2.1 The implementation of the inventory control system

The implementation of the inventory control system was implemented in two stages.

Stage one was made up of a training program where the control and information systems were explained to the production planner. It was believed to be very important for the planner to fully understand how the systems are designed and also to know how they fit into the cycle of managerial control, as she would be in charge of monitoring the systems.

The following steps and guidlines were to be followed when setting up the system:

- take the monthly forecasts determined in section 6.1 for each product, these forecasts are used in the inventory control model;

- set the minimum stock level to equal one months forecast, therefore, each product would have a safety stock of one month;
- the reorder point equals one month safety stock plus one month stock; and
- the maximum stock holding equals three months.

For an example of how the inventory model was drawn up for each product refer to Appendix C.1

Once all the models had been developed, the next stage was to explain how the planner was going to use these models.

At this stage only the methods required by the planner to use the model, and the information that could be obtained from it was explained. How the inventory control system fits into the planning procedure, and how it will be used in that environment will be discussed in section 6.3

The method to be used by the production planner in determining the inventory status, and whether any of the products need to be produced is as follows:

- obtain a stock status report (from the computer department);

- compare the stock levels from the computer printout with the models developed above for each product, and determine the stock status, (Appendix C.2 shows how the comparison is to be performed);
- once the planner has compared the stock levels and determined the stock status, a decision is made as to whether it is required to produce the product, or, whether there are enough of the product in stock; and
- if the product is required to be produced, the planner then determines the quantity required. (See Appendix C.2)

This method was time consuming and a number of errors resulted in the caluclations as the procedure was performed manually.

As a result of these problems, it was decided to write a computer programme which would calculate the stock status of each product.

The programme was written with the following objectives :

- to reduce the time required for determining the stock status of each product; and
- to eliminate all errors when calculating the stock status.

See Appendix C.3 for the program , and operating instructions.

Once the production planner has entered all the required data into the programme, the stock status and production requirements for each product can be calculated as in Appendix C.3. From this information the planner can determine which product to produce and what quantity of the product to produce.

Figure 15 shows the priorities in which the different products are to be produced. As can be seen on the top of the list are the products with a "critical" stock status. These are the products with stock levels which are either in the safety stock, or are out of stock. In this case the planner would be required to produce the quantity of products required to bring the stock level from its present level to the maximum stock level laid down. The "make" stock status means that the products stock level is between the safety stock, and the reorder point. In this case the inventory level has not yet gone into the safety stock. The planner would be required to produce the product in a quantity that would bring the stock level up to the maximum stock level laid down. Finally, there are the products with the "OK" stock status. These products have stock levels which lie between the reorder point and the maximum stock level laid down. These are the only products that require no products to be produced, as the stock levels are within the allowable range.

CODE	DESCRIPTION	DATE 26/5/88		3-MONTH	STOCK	STATUS	PRODU
140171	ORGANIC COSMETIC SPO	126	1250	3750	951	CRIT	2799
120464	LIP- DESERT SAND	23	800	2400	605	CRIT	1795
210188	HOM.-AEROSOL DEORANT	156	730	2200	462	CRIT	1738
211052	SHO.-COLOGNE	161	830	2500	813	CRIT	1687
120472	LIP- BROWN BERRY	24	800	2400	768	CRIT	1632
104140	W/S.-FRAGRANT TALC	6	600	1800	211	CRIT	1589
210110	HOM.-AFTER SHAVE LOTION	155	480	1450	33	CRIT	1417
211095	SHO.-SOAP-ON-THE-ROPE	162	450	1350	274	CRIT	1076
210099	HOM.-AFTER SHAVE BALM	154	350	1050	198	CRIT	852
211001	SHO.-INVIGORATING LOTION	158	290	880	279	CRIT	601
121057	LIPLINER - CORAL	40	270	800	211	CRIT	589
211044	SHO.-MOIST BALM	160	215	650	66	CRIT	584
120561	LIP- RUBY ROSE	31	250	750	237	CRIT	513
210072	HOM.-SHAVE FOAM	153	160	500	38	CRIT	462
180157	TAH.-MOIST. FOR N/OILY	118	5000	15000	8846	MAKE	6154
180130	TAH.-MOIST. FOR DRY SKIN	117	2000	6000	2577	MAKE	3423
180254	TAH.-MASQUE	122	1930	5800	2459	MAKE	3341
200182	NUC.-NIGHT CREAM	144	2015	6050	2980	MAKE	3070
200018	NUC.-YOUTH GEL	135	1670	5000	2059	MAKE	2941
200115	NUC.-ULTRA RICH MOIST	141	2750	8250	5388	MAKE	2862
200166	NUC.-EYE STICK	143	1600	4800	2143	MAKE	2657
180599	TAH.-VERY GENTLE BUFFER C	125	2000	6000	3735	MAKE	2265
191450	B/C.-EMBRASING BODY SILK	132	1500	4500	2417	MAKE	2083
105058	COPP-BODY SILK	12	1600	4800	2770	MAKE	2030
180009	TAH.-SPE FACIAL CLEAN	110	1270	3800	2188	MAKE	1612
190101	TOTAL SUN BLOCK FACT	127	780	2350	953	MAKE	1397
211036	SHO.-ENRICHED SHOW/GEL	159	530	1600	613	MAKE	987
160342	PINK-GLIT	109	670	2000	1015	MAKE	985
172146	BURNISHED GARNET	104	530	1600	662	MAKE	938
150436	NAIL-BROWN BERRY	51	500	1500	584	MAKE	916
200050	NUC.-FACE CREAM-E	137	830	2500	1660	MAKE	840
120677	LIP- BURNT BRONZE	37	530	1600	813	MAKE	787
120480	LIP- PEACH	25	600	1800	1016	MAKE	784
150428	NAIL-DESERT SAND	50	500	1500	771	MAKE	729
172154	ROSE BLUSHER	[illegible]	500	1500	797	MAKE	703
160326	BRONZE-GLIT	[illegible]	600	1800	1103	MAKE	697
180270	TAH.-HAND AND BODY LOTION	123	370	1100	544	MAKE	556
150479	NAIL-CORAL FROST	55	450	1350	819	MAKE	531
171034	TRANS.POWD.COMP	[illegible]	400	1200	701	MAKE	499
161225	KHAKI HARMONY TRIO	[illegible]	330	1000	598	MAKE	402
130184	TOP BASE COAT	48	350	1050	693	MAKE	357
104035	W/S.-E.D.P 25 ML	2	280	850	526	MAKE	324
150517	NAIL-BURGUNDY WINE	59	250	750	429	MAKE	321
180203	TAH.-EYE CREAM	120	1780	5350	3586	OK	1764
191434	B/C.-ROLL ON ANTI-PERSP	133	1500	4500	3098	OK	1402
180092	TAH.-FRESHENER	115	3530	10600	9213	OK	1387
105155	COPP-MOIST BAR	14	1700	5000	3749	OK	1251
200131	NUC.-MASQUE	142	1085	3250	3009	OK	241
105015	COPP-E.D.P.50 ML	10	275	800	559	OK	241
120553	LIP- BLANC DE NOIR	30	550	1650	1412	OK	238
191418	B/C.-AEROSOL DEODORANT	131	300	900	678	OK	222

Figure 15: Priority In Which The Products Are To Be Produced

When the planner wants to determine which products to produce, he would examine the printout Figure 15 and produce the products with the "critical" stock status first, followed by those with the "make" stock status. The quantities in which these products would be produced can be obtained from the printout.

In this section the method used to implement the inventory control system has been described.

At this stage of the project the production planner was familiar with the methods needed to:

- determine the monthly demand forecasts for each product (Section 6.1);
- control the independent demand inventories (Section 6.2); and
- determine what product to produce, when to produce the product and in what quantity to produce the product. (Section 6.2.1).

The following stage was the determination of time standards to be used to calculate the factory capacity required when manufacturing the products identified by the production plan. This will be discussed in section 6.3.

Once the routine inventory decision model had been designed, and the information system for the inventory control developed, the next stage was to implement the inventory control system. A description of how the system was implemented and used in the production planning and control system is described in Section 7).

6.3 Production Planning And Scheduling Module

Once the products required to be manufactured have been determined in the Independent Demand Inventory Management module, the information is inputted into the Production Planning and Scheduling module, which is described in this section. In this module the planner would schedule the production and determine whether all the products required can be manufactured in the available production period.

With the aid of time standards, the planner is able to convert the production plan into a capacity requirements plan to ensure that all the products can be manufactured in the available factory capacity. In this way the planner can set realistic production schedules.

Prior to the study, the company had no time standards to aid the production planner with the scheduling of production in the factory. It was thus necessary to determine time standards.

6.3.1 Method used when carrying out the time study.

The study was divided into *different stages:*

Stage 1: Creating a spirit of Co-operation.

Although it is obviously necessary at all times for good relations to exist between the workers and *management*, the successful *application of time* study calls not only for the goodwill of the workers but also for their co-operation.

In order to gain the co-operation of the employees, group meetings were held with all the employees involved attending. At these meetings the reasons for *introducing* the time study, the *methods* which would be used, the contribution that the workers could make, and the benefits they could reasonably expect to gain were outlined. During the meetings all the questions the employees had, relating to the time study, were answered.

The workers were encouraged to suggest ideas any time during the study, this was believed would promote worker co-operation.

It was believed that successful completion *of the first* stage of the *study* would result in worker co-operation during the second stage of the study. The workers knew what the study entailed, and that it would not jeopardise their jobs in any way, but rather improve their working conditions.

Stage 2: Methods used to determine the time standards.

6.3.1A Method 1:

The first method for determining the standard time for a job can be shown as follows:

The different activities carried out within the factory were broken up into three groups, these were:

- Bulk manufacture.
- Filling.
- Packaging.

The filling activity was the bottleneck operation in the manufacturing process. It was thus believed that by starting the study in this area, the benefits gained for the production planning department would be greater than in the other two areas.

In the filling area, the bulk material was filled into the required containers, that is, bottles or tubes. Once the bulk was filled, the product would then be moved to the packaging area, where it would be packed into its required cartons.

The filling process was broken up into elements (see Figure

NAIL FILL PROCESS

(1). Insert metal pellet
(2). Filling
(3). Insert brush
(4). Place lid on
(5). Label
(6). Packaging

Figure 16: The Different Activities For The Filling Process

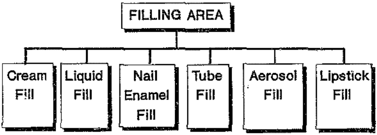


Figure 17: The Different Families Of Products In The Filling Area

the different elements of the job would be written down (see Appendix D1). From this information the time standards were calculated.

Problems with this method.

The product range was far too large to carry out a proper study. The products were not grouped according to their method of fill. Thus the fill of all the products could not be studied as this would have required more time than was available. The possible benefits were not considered worth the costs of such a time consuming study.

The workers did not feel part of the study, they felt as though they were being studied and were not helping or contributing to the study in any way. The accuracy of the standards calculated was not very good, as the ratings given to the workers were not accurately determined. This was due to a lack of the required experiance and knowledge required when performing a rating, and this resulted in errors occurring in the calculations

It can be seen from the problems associated with the first method used to determine the time standards, that it was necessary to develope a new method, which would alleviate some of these problems.

6.3.1B Method 2:

The second method used to determine the time standards, was to use informal techniques. It was believed that it would be more advantageous to the planning department, and the company as a whole to determine the standards accurately but as quickly as possible.

Before starting the study it was decided that it was necessary to consolidate the large product range (approximately 200 products), into families according to the method of fill required by the product. The method used to group the products was as follows:

The products were grouped into families according to the six different processes used to fill the bulk material, these are: lipstick, nail enamel, tube, liquid, aerosol, and cream fill (see Figure 17). The machinery required, and the time taken to fill the product differed from one group to the other, as a result of the different types of bulk materials required.

It was decided to involve the line workers, and allow them to help in determining the standards. A time standard form was developed, which was to be completed by the line workers. (see Figure 18). With the line workers collecting the required data it ensured that not only was data collected for all products being filled, but the time to calculate the standards would be greatly reduced.

Once the form was drawn up it was decided to appoint one worker on each line to be in charge of completing the form. These workers attended a meeting where they were explained the method used to complete the form, and how the information obtained from the form would be used to determine the standards.

Each production line was issued a standard time form. When any production was performed on a particular line, data was entered onto the form. Once all the data was entered onto the standard forms, it was possible to determine the time standards, the method which was used can be seen in Appendix E.1.

The time standards calculated for the different products filled on a particular line compared favourably to the actual times calculated. It was therefore concluded that the method used to calculate the standards was satisfactory.

One important point that was noted during the study with this method was the total co-operation and involvement of the workers. Once the workers were familiar with the standard form, and understood how the data was used to calculate the time standards, they were willing to help with the calculations. Some of the line workers used their iniative and discussed how they could change the standard form to aid with the calculations. After their discussions the workers

PRODUCTION RECORD

MACHINE PACKING LINE:-

DATE	PRODUCT	QUANTITY	BATCH NO.	QUANTITY REQUIRED	QUANTITY FILLED	HOURS TAKEN	WORKERS NUMBER	COMMENTS:

Figure 18: The First Time Standard Form

suggested a number of changes to be made to the existing form, these can be seen in Figure 19.

Comparing the two standard forms Figures 18 and 19 it can be seen that the original form was designed in such a way that the workers were only required to input data, and perform no calculations. The new form drawn up by the workers was of a different nature, it required the input of data, and the calculation of the standard time. This form showed that the workers wanted to become more involved in the actual calculation of the standards. From this it was concluded that the method used to carry out the time study was working well, as the workers co-operated and felt part of the study. It was believed that as a result, the accuracy of the standards calculated would be greater.

The determination of the time standards in the filling area continued for approximately one month. The standards were examined weekly to ensure that the line leaders were performing the calculations correctly. The standards compared favourably for the different production lines, and it was thus concluded that the method used for determining the time standards was successful.

Once the method used proved to be satisfactory in the filling area, and the results achieved were to the production planners satisfaction, it was decided that it was time to concentrate

PRODUCTION RECORD

Production Line: ____________

DATE	PRODUCT	QTY	TIME START	TIME END	HOURS TAKEN	ACTUAL HOURS TAKEN	NUMBER OF WORKERS	COMMENTS	QTY/ WORKER/ HOUR

Figure 19: The Time Standard Form Proposed By The Workers

on the other areas of the factory, that is, the bulk manufacture and packaging areas. The same method for determining the time standards was adopted for these two areas. Figure 20 shows the breakdown of processes in the bulk manufacturing area, and Figure 21 the breakdown of processes in the packaging area.

It took approximately three months from the start of the implementation of the second method, until it was felt that the standards calculated were accurate enough to be used in determining the capacity requirements in the factory when producing the products laid down in a production plan. The study did not end at this stage however, and it is still continuing today, where the standards are updated when changes are made to the processes.

The uses of standard times in the manufacturing planning and control system under study.

With the aid of time standards, the planner is able to convert the production plan into labour hour requirements, in order to determine the factory capacity required to produce the plan. This capacity requirement would then be compared with the available factory capacity, to ensure that it is within its limits. If not, the planner would adjust the production plan to ensure that it is within the capacity limits. In this way the planner is able to produce a realistic production plan, which is able to be produced within the available factory

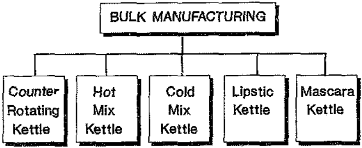


Figure 20: Breakdown Of Processes In The Bulk Manufacturing Area

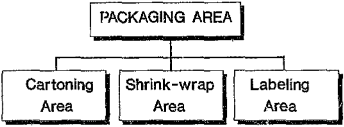


Figure 21: Breakdown Of Processes In The Packaging Area

The production planning and scheduling modules have been combined in the case under study. This was possible due to the nature of the products that are manufactured by the company. The entire product range can be broken up into six different families of products (that is, lipstick, aerosol, cream, liquid, nail and tube), and each family of products are filled on a particular production line. The product routings are simple, that is, the product would move from one station to the next on the fill line until the product is produced. All components have to be located at the *different* work stations at the start of the assembly of a product. This is due to the fact that the products have flat bills of materials and the component items are not time phased. These facts greatly reduce the complexity of the planning procedure. In this way the planner would only schedule the production of the products and not the components required. The method adopted by the planning department will be covered in Section 6.4

Once the production planner has given the purchasing department the production plan, it is up to the purchaser to ensure that all the components are purchased and delivered on time to be available for assembly at the time layed down on the production schedule.

6.3.2 The Method Used To Plan And Schedule The Production.

Prior to the design of the computer programme to aid the production planner in scheduling, the planner carried out the scheduling activities manually. The method adopted by the planner was as follows:

Earlier in this section time standards were determined for the different production fill lines in the factory (cream, liquid, nail, tube, aerosole, and lipstick lines). From these standards it is possible to calculate the maximum amount of products that can be filled per line, that is the capacity per line. Once the capacity of each line is calculated, the factory capacity can be determined by adding the different line capacities together.

The method used to calculate the line capacity was as follows: (Note, the standard time was calculated in units of labour hours, for example, 1000 units of lipstick per labour hour).

line capacity (in units of products) = number of hours worked per day x number of workers on line x standard

= number of units that can be produced.

This formula can be applied to all the production lines in order to calculate the factory capacity. (It must be noted, that the number of workers per *line is predetermined* and fixed)

In scheduling the production, the time standards were used to calculate the time required to produce a quantity of products on a particular line. The calculation was as follows:

Time required = (quantity to be produced / standard time for the line) x number of workers on the *line*.

Once the time required to produce a certain quantity of products on a *particular* line was calculated, the next stage was to schedule the production on the different production lines.

It is possible that more than one product would be filled on a particular production line each day. As a result of this the set-up time required to change from one product to the next had to be calculated for each line. The set-up time was made up of the time required to clean the fill machines, remove all packaging materials from the line, set up the new product on the fill machine, and bring all the required packaging material for the new product to the line.

It was decided to use the Gantt Chart to represent the production schedule for each line, because it:

- can be used to schedule a particular production line or machine centre;
- can be used in a manual scheduling system; and
- provides a graphical understanding of production scheduling in the factory.

The method used:

1. The production planner would take all the products that had to be filled (the products to be produced are determined as in section 6.2.1), and divide them into groups according to the different product fill lines.

2. The planner would then schedule the production of these products on the various fill lines, with the aid of the time standards. Set-up times would also be taken into account when changing from one product to another on a particular line.

Appendix F.1 contains an example of how the products are scheduled on the different fill li..s using the Gantt Chart technique.

Once the production planner had scheduled the products on the different lines using the Gantt Chart, a graphical representation of the utilisation of the available line capacity was provided.

This method has many advantages associated with it.

- When the production planner schedules the products to be filled on the production lines, he or she is able to set realistic schedules, that do not overload the lines. This is possible because the planner can see graphically how much capacity is required on a line to produce the products scheduled.
- If the planner sets a production plan and stipulates that all the products planned have to be manufactured, the required factory capacity to produce all the products would be determined using the above method. Once the capacity has been calculated the planner would determine whether the factory is over or under capacity. If it is over capacity then a fore-warning can be given to the factory workers that overtime has to be worked in order to produce all the required products. The overtime can then be scheduled, or the production plan altered.
- The production schedule provides a fore-warning of what products are going to be produced, in what quantity and when. This enables the production planner to:

  - produce the required bulk material only when it is required (that is only when the product is going to be filled) (see section 6.4 to see how the bulk manufacturing is scheduled);

- this also allows the factory manager to prepare for setting up the fill lines; and
- the factory manager can ensure that all the required packaging materials required for the product secheduled are in stock and move all the required packaging materials and bulk to the line prior to setting up the fill line so that the set-up can be reduced.

The factory manager can only carry out the activities listed above if he is fore-warned of what products are going to be produced and when. This information is obtained from the production schedule.

Although there are numerous advantages of this method of scheduling production, there are also some disadvantages, ie,

(i). It requires time for the planner to schedule the production on the different fill lines, as it requires detailed calculations.

(ii). When the planner has scheduled the products on the various fill lines, and then decides to change some of the products to be produced in the production time period. In this case the planner would have to recalculate the production schedule for each line. This would result in time being wasted, as the line schedules cannot be partially adjusted, they have to be totally recalculated.

(iii). Possible human error when the production planner performs the manual calculations required to determine the amount of time necessary to produce a quantity of a certain product on a fill line. Manual calculations result in incorrect schedules.

As a result of the above problems, it was decided to design a computer model, which would adopt the same methods as the manual method.

The programme was written with the following objectives:

- to aid the production planner with the scheduling tasks; and
- to reduce the time required to produce the production schedule to eliminate all errors when calculating the schedule.

See Appendix F.2 for programme details and operating instructions.

At this stage of the company's growth, a scheduling package could have been purchased, which would have been of equal or greater benefit to the company. However, was felt that too little was known about the scheduling requirements of the company. Instead an attempt would be made to develop a simple scheduling model with the information available. It is envisaged that experience will be gained from the model designed which would in time lead to more refined specifications of the scheduling requirements.

Once the production planner has entered all the required data into the computer, the production schedule for each line would be generated as in Appendix F.2. From the schedules generated the planner can see whether the lines are either under or over loaded. In either case if the planner wanted to change the product plan in any way, the new plan would be entered into the computer and a new schedule would be generated.

The time required to generate the line schedules is minimal, thus allowing the production planner to change the plan a number of times, until the schedule generated meets his or her requirements.

The computer programme has a number of advantages over the manual method of generating the schedule.

1. The number of errors resulting from the calculation of the time required to produce a quantity of products was greatly reduced. This results in more accurate schedules.
2. The time required to generate the schedule is greatly reduced with the aid of the computer programme. As a

result if changes are to be made to the production plan it does not take much time to generate a new schedule.

3. As a result of the short time required to generate the schedule, the programme allowed the production planner to perform "what if" analyses.

Once the production plan has been determined and the products scheduled to be manufactured, the planner then has to determine the material requirements for the particular plan.

The material requirements module can be greatly simplified for the company under study, due to the nature of the products that are produced (see Section 5.1). As a result of this the company would be able to achieve similar results as would be generated by an material requirements planning system if it adopted simple techniques for determining the material requirements.

In this case study the material requirements are calculated by using a simple bill of materials explosion of the products layed down in the production plan.

By now all the tools required to aid the planner with the production planning and scheduling had been designed and implemented (forecasting demand, controlling the inventory of independent demand items, the generation of time standards and the scheduling techniques)

In the next section, the method by which the different modules of the Production Planning and Control System have been linked and adopted to meet the requirements of Avroy Shlain Cosmeticss will be discussed. The new method that has been developed by the planning departmenc to plan and schedule the production is also covered in the next section. Special attention is given to the purchasing of raw and packaging materials.

6.4 The New Method Used For Planning And Scheduling Production

The method described below, is the new method designed and implemented for the planning and scheduling of production. This method takes into account the inventory control of raw materials, packaging materials and finished goods. The purchasing of raw materials and packaging materials is also discussed.

6.4.1 The Communication Required Between The Production Planner, The Marketing Department And The Purchasing Department.

At the beginning of each year the production planner and the representatives of the marketing department meet. At this meeting the marketing representatives state what the special offers are planned to be during the year. The planner is informed of the months in which the offers will be launched, and what the expected sales quantities are going to be.

With this information, it enables the planner to plan the production of these special offers prior to their dates of being launched. Provisions can also be made in advance to ensure that all the raw materials and packaging materials are on hand when production is scheduled to commence. (See Figure 22 for illustration of the layout of special offers.)

Apart from the meeting held at the beginning of the year, a meeting is held once a month. This meeting is attended by the production planner, the purchaser and the representative of the marketing department. At this meeting the special offers that are scheduled for the following month are discussed to ensure that they will be produced on the due date. If for any reason the offer cannot be produced on time, a decision is made during this meeting either to cancel the offer or to move it to a later date.

If the marketing department has made any changes to the due dates, or expected sales quantity of the special offers already planned, or added more offers to the plan, it is decided during this meeting whether these offers can be made or not. The reasons for not being able to manufacture these products could be because raw materials and packaging materials cannot ordered on time, or that the factory has insufficient capacity.

It is very important that these meetings are held every month to ensure that the plan for the special offer products is accurate and to ensure that the products are produced on their due dates.

ACCOUNTING MONTHS	JANUARY 5th (3 Weeks) 26th	FEBRUARY 27th (4 Weeks) 23rd	MARCH 24th (4 Weeks) 23rd	APRIL 24th (5 Weeks) 27th
MONTHLY SALES TARGET	1,238 200	961 300	1,087 200	1,691 200
ZODIAC THEME	Aquarius	Pisces	Aries	Taurus
CONFERENCES AND *BEAUTY DAYS*	National Conference - Durban 26 - 30 January '87		Regional Training Days for Group managers	6 - Founder's Day 24 - *Pesach* 17 - 20 Easter
IN-COMPANY COMMUNICATION	Consumer Offers & Special Special Letters	Consumer Offers & Special Special Letters	Consumer Offers & Special Special Letters Hostess Headliner	Consumer Offers & Special Special Letters Hostess Headliner
INCENTIVES	B.A.: Umbrella, Sling Bag and Kit Bag (1st Month)	Umbrella, Sling Bag and Kit Bag (2nd Month)	Umbrella, Sling Bag and Kit Bag (3rd Month)	New Silver Incentive for B.A.'s
	G.M.: Overseas trip	Overseas Trip and Group *Manager Bonus Scheme* (1st Month)	Overseas Trip and Group Manager Bonus Scheme (2nd Month)	Overseas Trip and Group Manager Bonus Scheme (3rd Month)
	A.M.: Overseas Trip	Overseas Trip "Dig for Diamonds" Sales	Overseas Trip Competition ----------	Overseas Trip ----------
HOSTESS GIFTS	White Satin Splash Cologne (For Champagne Day)	Slimline Pencils - Black Marble and Green Combo to be Hostess Gift for the first month	ONE MONTH SPECIAL: White Satin Body Silk (80ml) in a tube.	CREAMY PERFUMES: Coppelia & White Satin Musk Hombre Cologne & Shampoo
SPECIAL DAYS	Champagne Day - 14th Jan Cons. Offer - Eye Makeup *Remover* Offer	Valentines Day - 14 Feb (SPECIAL MEN'S PROMO)	Avroy's Birthday - 5th March Madness: Mad Hatter's Tea Party	April Fools - 1st
PRODUCT LAUNCHES		New Colour: Rhapsodies	New Pencils (2 as Hostess gifts. Coppelia Roll On	Femina Promo.
CONSUMER OFFERS	*Discounted Face Creams* : Less R15,00 (With Revitalin)	Reduced Moisturisers (Tahlita) to R10	Winter Night and Neck Packs: Tahlita & Nucelle (Double packs / Sachets)	Mothers Day Packs - MAY (Fragrance and Soaps)
	Residue of Xmas (If any)	Double Size Cleansers (*Tahlita & Nucelle*)	New Pencils	Tahlita Skin Care Trio (Cleanser, Freshener, Moisturiser)
	Champagne Day Offer: Eye make-up Removers	Valentine Day Special: - Hombre $1 Soap - Shogun Soap-on-a-Rope	MID MONTH: Launch new TAHLITA SKIN CARE TRIO	ONE DAY SPECIAL: Buy a foundation and get a set Sponge Wedges FREE !!!
SPECIAL SPECIAL	Combo pencils and Tahlita Normal Cleansers - 12th	Special on New Colour	New Pencils if they arrive Coppelia Roll-on	*Fragrant Talcs - 13th* New Foundations
RECRUITING DRIVES AND SALES COMPETIT.	B.A.: An Overnight Bag for every 2 BA's recruited G.M.: 1 star for each 2 (Personal)	B.A.: An Overnight for every 2 BA's recruited Personal Recruits A.M.: "Dig for Diamonds" -	G.M.: Double Stars Sales Sales Competition --------	Competition ----------

Figure 22: Calandar For Special Offers

6.4.2 The Role Of The Production Planner.

The production planner draws up two different types of reports. The first is a forecast of the expected production for a period of three months. This forecast is given to the purchasing department, and is used to plan the orders of the packaging materials and raw materials required to produce these products. The second report is an actual monthly production requirements schedule. This report is generated at the beginning of each month, and is the schedule for the production requirements of that month.

Due to the long lead times required to purchase the packaging materials(some packaging materials are imported), the production planner is required to give the purchasing department fore-warning of what materials are required to fulfill the production in the periods ahead. It was decided that the planner should give the purchasing department a forecast of expected production for three months ahead (this was done as the purchasing lead times varied from one week to three months). This must be done so that the purchaser can place the orders to ensure that the materials will be supplied on time.

The methods used by the purchasing department to purchase the raw materials and packaging materials are different due to differences in purchasing lead times. The methods used will be discussed later in this section.

The second report that is generated by the production planner is the month's production plan. This plan starts at the beginning of the second week of the month and ends at the end of the first week of the next month. The reasons for having the start and ending dates of the month's production plan are:

- The company closes its accounts at the end of each month, (that is the month end for the company)
- At month end all transfers in and out of the warehouse are balanced, and thus the stock levels are adjusted to obtain accurate stock balances.
- On the first working day of the month the production planner requests a finished goods stock report to be generated by the computer department. This report is used to determine what products are required to be produced. (See section 6.2.1)
- Once the planner knows what products are required to be produced, and the quantity required of each product to produce, the next stage would be for the planner to schedule the production in the factory. (See section 6.3) The time required by the production planner to generate the production schedule for the factory is approximately one day. This means that at the end of the first working day of the month, the production schedule would be completed.

- On the morning of the second working day of the month, a meeting is held between the production planner and the purchasing department. At this meeting the planner discusses the production schedule with the purchaser to ensure that all the required raw materials and packaging materials that are required to manufacture the schedule are in stock. If for some reason some of the materials are not in stock, the purchaser would inform the planner when the materials are going to be delivered. If it is necessary for the product to be scheduled at a later date, the planner would have to adjust the production plan and generate a new production schedule to accomodate the late deliveries.
- Once the production schedule has been finalised, the production planner and the factory manager determines what bulk material has to be produced during the next three days of the month, to ensure that the bulk is manufactured in time for it to be filled, as laid down by the production schedules.

Appendix G.1 illustrates the method used to determine what bulk materials are required to be produced and when they are required.

As can be seen from the points listed above, it is necessary for the production planner to start scheduling the production for the second week of the month at the beginning of the month. *This allows sufficient time for the planner* to adjust the schedule if required, and also to allow for the factory manager to produce the required bulk materials during the first week, to ensure that it would be ready to be filled at the start of the second week.

Before the factory manager starts to fill a product on a line, he draws up a production ticket for the product (See Figure 23). At the start of each day the factory manager issues the line supervisors with the production tickets required for the products that are going to be produced that day. The line supervisor then uses these tickets to prepare tr ines. If a product is being filled, the supervisor would examine the tickets and determine what product is going to be filled next. He would then st. to prepare for the set-up of the line, by bringing all the required packaging materials and bulk, for the next product to be filled to the line. This *greatly* reduces the set-up time when changing from one product to the next on a particular line, as the external set-ups where now performed when the line was still running.

PRODUCTION TICKET

LINE : ____________________

DATE : ____________________

PRODUCT : ____________________

QUANTITY REQUIRED : ________

QUANTITY FILLED : __________

TIME START : ______________

TIME END : _______________

ANY REJECTED MATERIAL

	Part Number	Quantity Defective
1.		
2.		
3.		
4.		
5.		

Figure 23: Production Ticket

The production tickets follow the products from the filling area to the cartoning area, at which stage the balance of the information required on the ticket is completed.

The finished product is then moved to the warehouse, and the production ticket is given to the production planner.

The production planner then uses the information on the ticket, that is, the total quantity of products produced is noted, and if some packaging materials are found to be of poor quality, the quantity of each product rejected is taken into account.

The stock records of the raw materials and packaging materials are updated on the IBM AS, and those of the finished goods are updated on the IBM 36. In this way the accuracy of all the stock records is maintained, and continuously updated.

In this section we have illustrated the new methods used by the production planner to plan and schedule the monthly production requirements. Also discussed was the method used by the factory manager to follow the schedule to ensure that all products are produced on time. Next, in this section the methods used by the purchasing department to purchase the packaging and raw materials will be discussed.

6.4.3 The Role Of The Purchasing Department

6.4.3.1 Purchasing of the packaging materials

At the beginning of the month the production planner issues the purchasing department a production forecast for three months, as mentioned earlier.

When the purchaser receives the forecast, he enters all the products listed on the forecast and their required quantities into the computer (IBM AT). He then requests that the computer generates a printout of the stock status of all the packaging material required. (See Figure 24 for printout of packaging material required).

As can be seen from the printout in Figure 24 considerable information is given on the printout, that is, all the packaging materials required, giving the forecast requirements, the stock holding, quantity on order, and the quantity of each material that has to be ordered to fulfill the three months demand.

When determining the quantity of products to purchase the purchaser is faced with three senarios.

1. In the first case, the on-hand stock covers the requirements for the three months forecast. In this case no products are required to be purchased.

2. In the second case, the on-hand stock covers only part of the requirement for the three months forecast, (for example, two months out of three). In this case the purchaser has to purchase some products to produce the required forecasted demand.

The quantity that can be purchased may be governed by the minimum allowable purchase quantity, which is laid down by the suppliers. In this case the purchaser would order the minimum quantity.

The suppliers often produce their products in greater quantities than is actually required to fulfill the three month demand. In this case the purchasing department makes arangements with the suppliers that they would split the deliveries of the order. They would supply enough products to fulfill the requirements of the three months forecast (one months requirements). The supplier would then hold the remainder of the order until the product is required at a

TUE 28 JUN 88

PAGE : 2

** B.O.M. ENQUIRY AT LOWEST LEVEL **

LV	STOCK CD.	DESCRIPTION	CAT	SUP	LOC	REQ. Q.	AVAIL.	%	ON ORDER	DUE DATE	DESCRIPT:
0	3253-C598	CLASSICS LIPSTICK DUSKY PINK	FNG	......	....	-5620	5620		0	11/09/87	
0	PLC-1-517	BULK-LIPSTICK PINK SPICE	BULK	......	....	0	2,478		0	/ /	
1	001062	CUTINA LM	RMAT	HENKEL	JHB	14.891	23.84	100	20	27/06/88	1
1	001248	MYRITOL 318	RMAT	HENKEL	JHB	3.428	41,708	100	0	/ /	2
1	001379	TIMIRON MP 45	RMAT	MERCK	RAND	2.068	.971	100	25	23/06/88	3
1	001228	L.P. WHITE 25324	RMAT	EDENCH	EDEN	2.586	9.729	100	10	22/06/88	4
1	001229	L.P. YELLOW 25976	RMAT	EDENCH	EDEN	.657	12.538	100	0	/ /	5
1	001230	L.P. RED 259[illegible]4	RMAT	EDENCH	EDEN	.362	-1.569	0	10	22/06/88	6
1	001232	L.P. RED 29267	RMAT	EDENCH	EDEN	1.194	3.547	100	10	22/06/88	7
1	001233	L.P. BLACK 26041	RMAT	ASCOSH	KRAM	.194	-.239	0	0	../../..	8
1	001236	L.P.ORANGE 25595	RMAT	EDENCH	EDEN	.421	4.787	100	0	/ /	9
1	001444	PERFUME 111/5	RMAT	GIVAUD	ISAN	.052	.641	100	0	/ /	10
0	008010	CONTAINER LIPS.SQU.NAVY BLUE	PMAT	A.C.S.	TAIW	5732.4	-15728.4	0	25000	15/05/88	
0	008051	CARTON WOOLWORTHS LIPSTICKS	PMAT	PRINTP	C.T.	5732.4	-9732.82	0	20000	18/07/88	
0	008173	CARTON INNER W/W LIPSTICK	PMAT	PRINTP	C.T.	5732.4	-15728.4	0	20000	18/07/88	
0	008175	LABEL SQ.CTN.BASE DUSKY PINK	PMAT	ROTALA	C.T.	5732.4	-3838.32	42	0	/ /	
0	008178	LABEL LIPS DUSKY PINK	PMAT	ROTALA	C.T.	5732.4	-2532.4	56	600	03/06/88	
0	008017	FUJI 8SLF 1000O N/E & LIPS	PMAT	PRINTP	C.T.	5732.4	-14232.8	0	26000	27/06/88	
0	008048	LABEL W.WORTHS RETAIL LABEL	PMAT	METO..	JHB.	5732.4	83032.4	100	151200	22/05/88	
0	008068	STRAIGHT ON STD LIPS/NAILS	PMAT	EMPRO	C.T.	236.04	-229.464	5	1300	07/07/88	
0	008071	SHIP A8M13 LIPSTICK/NAIL ENAM.	PMAT	NAMPAK	JHB	236.04	-67.464	71	600	15/07/88	
0	008136	LABEL BOXEND LIPSTICKS T78	PMAT	AVERY	PARO	236.04	-466.072	0	700	04/07/88	
0	O/HEAD	OVERHEAD ALLOCATION	ALLC	......	....	2135.6	-38004	0	0	../../..	
0	LAB	DIRECT LABOUR	ALLC	......	....	640.68	-9088.39	0	0	../../..	
0	3253-C59D	CLASSICS LIPSTICK CHAMPAGNE	FNG			-5000	5000			/ /	
0	WIL-1-801	BULK-LIPSTICK CHAMPAGNE	BULK			0	0			/ /	
1	001062	CUTINA LM	RMAT	HENKEL	JHB	13.8	10.04	100	20	27/06/88	1
1	001248	MYRITOL 318	RMAT	HENKEL	JHB	1.203	40.505	100	0	/ /	2
1	001228	L.P. WHITE 25324	RMAT	EDENCH	EDEN	2.939	6.79	100	10	22/06/88	3
1	001229	L.P. YELLOW 25976	RMAT	EDENCH	EDEN	1.948	10.59	100	0	/ /	4
1	001232	L.P. RED 29267	RMAT	EDENCH	EDEN	.886	2.661	100	10	22/06/88	5
1	001233	L.P. BLACK 26041	RMAT	ASCOSH	KRAM	.338	-.577	0	0	../../..	6
1	001379	TIMIRON MP 45	RMAT	MERCK	RAND	1.84	-.869	83	25	23/06/88	7
1	001444	PERFUME 111/5	RMAT	GIVAUD	ISAN	.046	.595	100	0	/ /	8
0	008010	CONTAINER LIPS.SQU.NAVY BLUE	PMAT	A.C.S.	TAIW	5100	-20828.4	0	25000	15/05/88	
0	008051	CARTON WOOLWORTHS LIPSTICKS	PMAT	PRINTP	C.T.	5100	-14832.3	0	20000	18/07/88	
0	008173	CARTON INNER W/W LIPSTICK	PMAT	PRINTP	C.T.	5100	-20828.4	0	20000	18/07/88	
0	008291	LABEL LIPS CHAMPAGNE	PMAT	ROTOLA		5100	-5100	0	5500	14/06/88	
0	008293	LABEL SQ.CTN.BASE CHAMPAGNE	PMAT	ROTOLA		5100	-5100	0	8000	14/06/88	
0	008017	FUJI 8SLF 1000O N/E & LIPS	PMAT	PRINTP	C.T.	5100	-19332.8	0	26000	27/06/88	
0	008048	LABEL W.WORTHS RETAIL LABEL	PMAT	METO..	JHB.	5100	77592.4	100	151200	22/06/88	
0	008068	STRAIGHT ON STD LIPS/NAILS	PMAT	EMPRO	C.T.	210	-433.464	0	1300	07/07/88	
0	008071	SHIP A8M13 LIPSTICK/NAIL ENAM.	PMAT	NAMPAK	JHB	210	-277.464	0	600	15/07/88	
0	008136	LABEL BOXEND LIPSTICKS T78	PMAT	AVERY	PARO	210	-678.072	0	700	04/07/88	
0	O/HEAD	OVERHEAD ALLOCATION	ALLC	......	....	1900	-39904	0	0	../../..	

Figure 24: Raw and Packaging Material Requirements

later date which would be laid down by the purchaser. If the suppliers do not hold the excess product, the whole order is delivered at once and the balance of produce is held in inventory.

Appendix G.2 illustrates the method used by the purchaser when determining how much of each packaging material to purchase.

This method of purchasing is in line with modern manufacturing systems, since the supplier is aware of the company's production schedule at least three months in advance. The implication is that the supplier can optimise his own operations and thus meet the re- quirements more effectively.

6.4.3.2 Purchasing of the raw materials

All raw materials are purchased from local suppliers. These sup ...s hold stocks of all the materials required by the com. . As a result the lead times of these raw materials is approximately three days.

At present the company policy in relation to the stock of raw materials is to hold two to three weeks requirements on hand as a safety stock. This ensured all raw materials to be on hand when required. It was believed that as the company gained confidence in the purchasing procedure and the control of inventory the safety stock would be reduced

The raw material stock records are kept on the IBM AT computer. This is to enable the purchaser to examine the stock holdings of any raw material and determine its status at any given time.

The method used by the purchasing department to purchase raw materials is the same as that used for the packaging materials, except the monthly production schedule was used rather than the three month forecast. (See Appendix G.3)

The above are the methods now used by the purchasing department to purchase both the raw materials and packaging materials.

At the time of writing this report, the new methods used for planning and scheduling the production in the factory had been implemented for approximately seven months. The results achieved by the implementation will be discussed in Section 7.

7 RESULTS

The changes made to the original methods used (see Section 6.4), proved to be most advantageous as the company benefitted greatly from them. Some of the results achieved by the implementation of the new method will be discussed below.

1. The new method implemented encouraged the continuous interaction between the production planner and the marketing department.

This resulted in the marketing department issuing the production planner with a forecast of the year's special offers, listing the dates these offers are to be launched and the expected sales quantites of each offer. This forecast is also updated every month to ensure that it is as accurate as possible. As a result of these schedules, the planner has ample notice of what offers are going to be launched, and when they are going to be launched. Thus the planner can plan for the production of these offers in advance, to ensure that they will be manufactured prior to the date of being launched.

With this method it was found that most of the special offers were produced prior to their due date and thus when the offer was launched, products were in stock ready to be supplied.

This had the following results:

- when the offer was launched, and the sales women sold the offer, they could be supplied with the goods, out of the stock on hand immediately;
- with the old method used, the offers were not produced before their due date, thus when the sales women placed an order for these products, the company would not be able to supply the goods, and they would have to be placed on backorder and supplied at a later date. This method resulted in the sales women loosing motivation, and customers being dissatisfied. This is a highly undersirable outcome for the company.

With the new method, however, the offer is produced prior to the launch date and waits in stock, so that it can be delivered immediately. It has been noted that the sales women have changed their attitudes from one of anticipating late deliveries of special offers, to one of knowing when orders are placed for offers, they will be carried through.

These improvements have also saved the company money. In 1987 the cost of backorders amounted to R50,000 per month, and in 1988 with the new system implemented the cost of backorders had reduced to R20,000 per month.

2. The production planner gave the purchasing department a three month forecast of expected sales. From this forecast the purchasing department can determine what raw materials and packaging materials are required to be purchased, to meet the forecast demand. This method ensures that all the required materials are in stock prior to the product being manufactured. The new methods adopted by the purchasing department laid down in Section 6.4 resulted in most of the materials being in stock in the required quantity, when needed for production. The number of products being out of stock was greatly reduced. (The number of component items out of stock was reduced from approximately 20% to between 5 and 10% at any one time.)

The purchasing department only purchasing the required amount of material as laid down by the forecast, this resulted in:

- the amount of money invested in stock being reduced, (see quantities below);
- the inventory levels kept at a acceptable level, (finished goods at three months nationally, raw and packaging materials at their desired level as layed down by the purchasing department); and
- the possibility of any product going old and becomming obsolete was reduced.

Better control of inventory of both the raw materials and packaging materials, as the stock levels are reviewed on a regular basis.

The amount of money invested in inventory was also greatly reduced:

INVENTORY	1987 (Rand)	1988 (Rand)
Raw & Packaging Materials	1.4 Mill	900,000
Finished Goods	1.6 Mill	1.1 Mill
Stock Turns	4-8 times/year	7-8 times/year

These figures are approximations of the value of inventory on hand at one particular time. The relative stock levels were reduced greatly from 1987 to 1988, when you take into consideration the growth in sales and increase in product demand. To maintain this decrease in stock levels, the stock was required to turn around approximately 7-8 times a year.

3. With the new method the production planner was able to determine what products were required to be produced each

month, with the aid of the computer programme designed in section 6.2.1. The programme was designed in such a way that it would maintain the inventory levels laid down by the inventory control models designed in section 6.2.

This method of controlling the inventory of the independent demand items proved to be most successful. At the time this report was written, the finished goods inventory levels in the warehouse had levelled out to the desired three months stock holding. The amount of money invested in stock reduced from R1.6mill in 1987 to R1.1 mill in 1988. The company was experiencing a reduction in stock outs of all products (finished goods from 15% in 1987 to 5% in 1988, purchased components 20% in 1987 to between 5 and 10% in 1988).

4. Once the planner has determined what products to produce, the information is then entered into the computer programme designed in section 6.3. The programme then schedules the production in the factory for the month. The programme allows the planner to calculate the factory capacity required to produce the products. As is mentioned in section 6.3 the planner can perform "what if" analyses, with the production schedule in order to produce a schedule that is realistic, and can be produced in the allotted time period. Section 6.3 also lists a number of advantages of using this new method of scheduling the production in the factory.

5. When the production planner issued the month's production plan to the factory manager, the plan informed the factory manager what products to produce, the "bulk" batch size required for each product, when to produce both the bulk material and the product, and what quantity are required. The factory manager was instructed not to produce any more or less of the particular product than was stated on the schedule. This ensured that the inventory control of the raw materials, packaging materials and finished goods were maintained.

It can be concluded from viewing the numerous benefits gained by the company due to the implementation of the new system used to plan and schedule the production in the factory, that the production planning and control system was an undoubted success.

8. FUTURE IMPROVEMENTS

It is highly undesirable for the company to stop implementing changes to the methods used in the system. By reviewing the systems continuously, the company could improve the system, and thereby improve the results obtained.

Some suggested changes that could be made to the present system are:

1. Avroy Shlain Cosmetics should move towards the just in time (JIT) scheduling techniques which implies producing to market rate of demand in the very short term, and inparticular avoiding overproducing. According to Bicheno (22), the cardinal sin under JIT is overproducing. In other words you must avoid making anything, including components and final products that cannot be sold in the very short term. The scheduling rule is to produce an ever greater proportion of items Just-In-Time to be shipped. JIT tries to achieve continuous flow which minimises lead time.

To implement JIT is to move towards producing a set of products across the range, with quantities and products to the current sales mix, in a shorter and shorter time bucket. Scheduling aims at sending through a set of products which will meet the market demand for that time bucket, whilst not overproducing. Ultimately, as the lot size reduces, a complete market place range would be produced perhaps every day or even every hour. Regular schedules, comprising the complete proportional range, would be repeated with increasing frequency, but decreased number of items. This would result in the inventory levels being reduced.

Bicheno (22), believes that it is dangerous to move towards JIT scheduling unless there is good control over *inventories*. It is believed that the system proposed and implemented at Avroy *Shlain*, *for the* management of production and scheduling would serve as a good base from which to build.

2. A production pull system can be implemented to simplify the planning procedure. The inventory levels in the warehouse can serve as pull signals. When they reach a predetermined level, the warehouse manager would issue a production ticket to the factory manager. The ticket would have information with regards to the product and the quant of the product to produce. In this way products would be pulled from the factory to the warehouse when required.

The "Pull System" is an important JIT tool for scheduling. John *Bicheno* says that when the pull system is combined with regular batch sizes it becomes a prime tool to control inventory levels and prevent overproducing.

3. The company should modify the two computers (IBM AT and IBM 36), to enable them to communicate with each other. This would reduce the amount of manual data input required. The information flow would be as follows:

Data Flow	Information Transferred
IBM 36 – IBM AT Lotus	Stock level of finished goods
IBM AT lotus – IBM AT, Purchasing and bill of materials program	Production schedule and forecasts

4. Avroy Shlain Cosmetics is dependent on its suppliers' delivery performance. This is due to the fact that all component items are purchased and late deliveries can lead to production schedules not being met. To ensure that the component items are delivered on their due dates, and in the required quantities, it is required of the company to improve it's vendor relationships. In this way the suppliers could become a definite link within the production planning system. The vendors could be given fore-warning of what products are required, and this would allow them to plan for their production in advance.

As lot sizes are reduced it is desirable to have parts delivered in smaller lots just-in-time for assembly or processing. The buyers must begin the tasks of working with suppliers to ensure delivery in small lot sizes and with perfect quality. This is a task that may take years. Importantly, there are rewards for both parties. John Bicheno believes that the supplier can move towards JIT even faster, can produce in smaller regular lots, avoid finished goods inventories and enjoy an increasingly secure market.

John Bicheno (22), believes that under JIT, procurement *is* a new art. Procurement should play the central role between supplier on the one hand and *design, quality* and manufacturing on the other. The buyer becomes a facilitator of communication, spending a major amount of time in suppliers' plants and with his own engineers and operations managers.

It must be noted that these suggested changes for the production planning and scheduling methods, are not necessarily the only ones that should be taken into account. As changes are made to the system, it would highlight other areas where attention is needed. This project is a continuous one, where the system is continuously updated to improve its effectiveness and efficiency.

9. CONCLUSION

This report was divided into eight sections. Sections one to three are devoted to theoretical aspects of production planning and control. In these sections different models proposed by different authors were examined, and applied to a small fast growing manufacturing business environment.

In section four a system was designed for the Production Planning and Control within the business environment under study. The system represents an overall system objective. The model presents a useful way to divide the overall system objectives into subsystem projects. The critical implementation question is which project to take on, and in what order. As mentioned in Section 10 this depends on the company under study.

In the next three sections the proposed model is applied and tested. These sections offer an effective method of implementing the system at Avroy Shlain Cosmetics. The company is a small fast growing company which is engaged in line assembly, and producess a wide variety of products to stock.

Section 7 examines the results achieved by the implementation of system, while section 8 suggestes some future changes that can be made to the system to improve it.

The system proposed in Section 4 is merely a guide for companies in the business environment under study, to implement a Production Planning and Control System.

The model to which a company should be moving to, is the general Production Planning and Control Schematic, presented in Figure 9. A first step in establishing the current position of the company is to determine how well each of these modules is performed. The first test is one of completeness. Are there any gaps in the current production planning and control system or is performance so poor in any activity that it might as well not exist ?

When implementing the production planning and control system, it does not matter which module one starts implementing first. The key is to critically assess where the company is and where it should be.

Vollmann, Berry and Whybark (5), believe that to some extent, all companies tend to consider themselves unique, often to the detriment of the system implementation. However, there are indeed aspects of each company's situation that make some system modules more appropriate than others for implementation emphasis. It is thus necessary for the company to determine it's particular business environment, before determining the modules to implement first. In so doing the company would be able to adopt the system to it's particular environment and requirements to ensure the success of the implementation.

The total Production Planning and Control system implementation efforts should be divided into manageable subtasks, so that each task yields concrete benefits. In this way the people involved in the implementation would see the results and benefits of each module once implemented, much quicker than if the entire system was implemented as a whole. One should start with a subsystem that can be implemented quickly and that will be of recognized use to some readily identified user group. As a result of this, the project team would be encouraged, motivated and eager to carry on with the next stage of the implementation process. The entire system could be implemented in this way.

It is almost impossible to over emphasize the role of education in achieving an effective system implementation. Training should be given to all people involved in the project at all stages, and they should be aware of what changes are occuring around them. This would ensure their support throughout the implementation stages, which is essential for the success of the project.

No matter how a company may adopt the system to it's particular business environment, the system must be continuously monitored and changes made when necessary.

APPENDIX A:1

QUESTIONNAIRE

1. WHAT DEPARTMENT DO YOU BELIEVE IS THE MOST IMPORTANT WITHIN THE ORGANIZATION ?

2. WHAT DEPARTMENT DO YOU BELONG TO ?

3. WHAT IS YOUR ROLE WITHIN YOUR DEPARTMENT ?

4. WHAT LINKS EXIST, OR DO YOU BELIEVE SHOULD EXIST BETWEEN YOUR DEPARTMENT AND THE PRODUCTION PLANNING DEPARTMENT ?

APPENDIX B:1

This example illustrates how the forecasts were calculated for each product. In this example the forecasts are calculated for Product A.

Step 1 : The determination of the actual sales per month for Product A.

From the sales reports it was possible to determine the actual sales figures for Product A, for the period January 1985 to April 1987.

Table of sales for Product A:

	1985	1986	1987
January	212	323	410
February	230	300	400
March	236	353	395
April	215	280	405
May	250	260	
June	240	300	
July	224	270	
August	260	290	
September	215	290	
October	235	310	
November	240	320	
December	231	310	

APPENDIX B:1 (Cont)

Step 2 : The determination of the monthly sales trends during the year.

Figure B1 shows the graphs plotted for product A of the Sales figures v..se the Months for 1985 to 1987.

Figure B2 shoes the same graphs plotted for product A as shown in Figure B1 except the mean sales per year is also plotted.

Step 3 : Th. calculation of the percentage growth of sales from one year to the next for Product A.

From Step 2, we have determined the mean monthly sales figures for each year for Product A.

	Mean monthly sales
1985	232
1986	300
1987	402

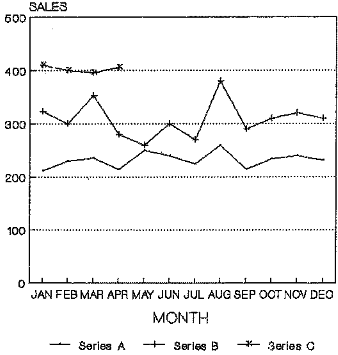
The percentage growth of sales for the period 1985 - 1986.

$$(\frac{300}{233} - 1) * 100 = 29\%$$

The percentage growth of sales for the period 1986 - 1987.

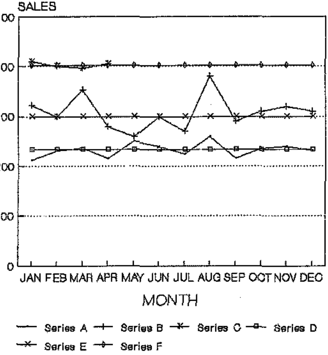
$$(\frac{402}{300} - 1) * 100 = 34\%$$

SALES 1985-1987
Figure B1



Series A - Sales 1985
Series B - Sales 1986
Series C - Sales 1987

SALES & MEAN
Figure B2



Series A-Sales 1985 Series D-Mean 1985
Series B-Sales 1986 Series E-Mean 1986
Series C-Sales 1987 Series F-Mean 1987

APPENDIX B:1 (Contd)

The percentage growth of sales was calculated for all the products, using the same method as was used for Product A above.

The next stage was to add all the percentage growths of the different products together and determine the average growth. This could be done, as the variances in growth from one product to the next was found to be small, approximately 5% deviation from the mean.

The average percentage growth for all the products was found to be:

1985 - to - 1986 was 25%

1896 - to - 1987 was 30%

After consulting the Sales and Marketing managers, the percentage growth of sales were then changed to.

1985 - to - 1986 was 25%

1986 - to - 1987 was 35%

Step 4 : The determination of the sales forecast for product A *for the period 1987.*

In step 2, the mean monthly sales figures were calculated for product A. It was found that the mean monthly sales figure for 1986 was 300 unitss. In step 3, the average percentage growth of sales for 1986 - to - 1987 was calculated and found to be 35%

APPENDIX B:1 (Cont)

Therefore, the mean monthly sales forecast for product A for

1987 = 300 * (1 + 0,35)

= 405 units

Step 5 : The determination of the monthly sales forecast for future years. In our case for the period 1988.

The avarage percentage growthg of sales for period 1985 - 1986 and 1986 - 1987, was calculated in step 3.

1985 - to - 1986 = 25%

1986 - to - 1987 = 35%

Increase in percentage growth between these two periods = 10%
Therefore, the expected percentage growth for the period 1987 - to - 1988 = 45%

Once the expected percentage growth has been calculated, it is necessary to consult the Marketing and Sales managers to determine wheather they agree or disagree with the values calculated. If changes are to be made to this value, they must be made at this stage.

The next stage would be to calculate the mean monthly sales figures for the products for 1988. You first calculate the actual mean monthly sales figures for each product for the period 1987. Then the mean monthly forecast for each product for 1988 = Actual mean monthly sales figure for the product * the expected percentage growth in sales for 1987 - 1988, as calculated above.

APPENDIX C:1

In appendix B1 step 4 the mean monthly forecast for product A, for 1987 was determined.

Product A = 405 units for 1987

The inventory control model can be drawn up with the aid of this forecasted value.

Minimum Stock	= 1 month = 405 units
Safety Stock	= 1 month = 405 units
Reorder point	= 2 months = 810 units
Order (maximum stock)	= 3 months = 1215 units

Figure C1 represents the model stock holding for product A.

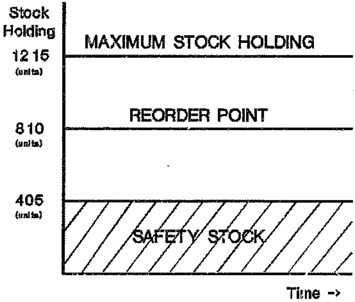


Figure C1 : Model Stock Holding For Product A.

APPENDIX C:2

In this section an example will illustrate how the production planner would compare the stock status of product A to it's model stock holding determined in Appendix C:1. This example will illustrate three senarios.

Comparisons will be made between the stock status, and the model determined in Appendix C:1 for product A.

1. From the stock status report, it is found that the stock holding for product A = 900 units.

When comparing this figure to the stock model, it can be seen that it lies between the 2 month and 3 month stock holding. Therefore, no products have to be produced and the stock status is " OK ".

2. From the stock status report, it is found that the stock holding for product A = 500 units.

When comparing this figure to the stock model, it can be seen that it lies betwee the 1 month and 2 month stock holding. Therefore, products have to be produced, and the stock status is " MAKE ".

In this case the production planner would schedule products to be produced.

Number of products to produce = 1215 - 500

= 715 units

APPENDIX C:2 (Cont)

3. From the stock status report, it is found that the stock holding for product A = 300 units.

When comparing this figure to the stock model, it can be seen that it lies between the 0 stock holding, and one month. Therefore, it is within the safety stock, and products have to be produced. In this case the product stock status is "critical".

The production planner would have to schedule production.

The number of products to produce = 1215 − 300

= 915 units.

APPENDIX C:3

The programme was written utilising the Lotus 123 spreadsheet programme. The programme was designed and written in such a way as to aid the production planner in determining the stock status for each product. The programme is based on the inventory control model designed in Section 6.2 for each product.

The programme was written in such a way that the stock status for each product would be calculated. The programme compares the actual stock holding with the inventory model for each product, to determine the stock status.

If the product stock holding is:

- greater then 2 m[illegible]n the status is " OK "
- less then 2 mon[illegible]er then 1 month, then stock status is " MAKE
- less then 1 month, then stock status is " CRITICAL ".

Besides calculating the *stock status of each product*, the programme also calculates how much of each product is required to be produced. The methods adopted when designing the programme, follows the same procedure as illustrated in Appendix C:2.

The method to be used by the planner when using the programme:

1. As can be see from Figure C2, the monthly and 3 monthly demands for each product are entered into the programme. These figures can be changed at anytime, when the monthly

CODE	DESCRIPTION	DATE	26/5/88	3-MONTH	STOCK	STATUS	PRODUC
104[illegible] 7	W/S.-E.D.P.50 ML	1	570	1700			
1040[illegible]5	W/S.-E.D.P 25 ML	2	280	850			
104043	W/S.-CR.BATH CONCENTRATE	3	233	700			
104078	W/S.-BODY SILK 250 ML	4	430	1300			
104124	W/S.-PURFUME DEODORANT	5	470	1450			
104140	W/S.-FRAGRANT TALC	6	600	1800			
104183	W/S.-MOISTURISING BARS	7	670	2000			
104175	W/S.-REFILL	8	100	300			
104280	W/S.-E.D.P.35 ML	9	200	500			
105015	COPP-E.D.P.50 ML	10	275	800			
105023	COPP-E.D.P.25 ML	11	300	900			
105058	COP[illegible] -BODY SILK	12	1600	4800			
105147	COPP-FRAGRANT TALC	13	600	1800			
105155	COPP-MOIST BAR	14	1700	5000			
105163	COPP-ROL-ON ANT-PERSPIRAN	15	1600	48[illegible]			
106003	LA BALLE-EDP 25ML	16	0				
110019	B/C- SHAMPOO N/D	17	730	2200			
110027	B/C- SHAMPOO OILY	18	500	1500			
110043	B/C- CONDITIONER	19	600	1800			
110078	B/C- ANTIDANDR. SH. N/D	20	330	1000			
110094	B/C- ANTIDANDR SH. OILY	21	250	750			
110221	B/C- STYLING GEL	22	400	1200			
120464	LIP- DESERT SAND	23	800	2400			
120472	LIP- BROWN BERRY	24	800	2400			
120480	LIP- PEACH	25	600	1800			
120499	LIP- SOFT PINK	26	600	1800			
120502	LIP- MANDARIN	27	600	1800			
120510	LIP- CORAL FROST	28	600	1800			
120545	LIP- PINK CHAMPAGNE	29	380	1150			
120553	LIP- BLANC DE NOIR	30	550	1650			
120561	LIP- RUBY ROSE	31	250	750			
120588	LIP- BURGUNDY WINE	32	680	2050			
120596	LIP- PINK SPICE	33	950	2850			
120618	LIP- RED VALENTINE	34	300	900			
120634	LIP- SAHARA RED	35	180	550			
120669	LIP- WARM CORAL	36	670	2000			
120677	LIP- BURNT BRONZE	37	530	1600			
120685	LIP- HOT PURPLE	38	930	2800			
121029	LIPLINER - ROSE	39	500	1500			
121037	LIPLINER - CORAL	40	270	800			
121045	LIP SHINE	41	200	600			
130036	INSTANT NAIL DRY	42	250	750			
130052	ORANGE STICKS	43	100	300			
130079	NAIL ENAMEL REMOVER	44	200	600			
130095	CUTICAL MASSAGE CREA	45	270	800			
130133	CUTICALE REMOVER	46	130	400			
130168	EMERY BOARDS	47	115	350			
130184	TOP BASE COAT	4[illegible]	350	1050			
130230	NAIL ESSENTIALS	49	700	2100			
150428	NAIL-DESERT SAND	50	500	1500			
150436	NAIL-BROWN BERRY	51	500	1500			
150444	NAIL-PEACH	52	450	1350			
150452	NAIL-SOFT PINK	53	450	1350			

APPENDIX C:3 (Cont).

forecasts are updated to ensure that the programme is accurate, and using the correct data.

2. When the planner " BOOTS " the system up, the programme would be as in Figure C2.

3. The planner would then enter the current date and then the stock levels for each product, see Figure C3.

4. The production planner would then instruct the programme to calculate the product stock status, and the requirements for production, see Figure C4.

5. Once the products stock status have been calculated, the planner would then sort the products in order of most "CRITICAL" products down to products that do not have to be produced.

6. From the printout in Figure C5, the planner can determine what products to plan for production, and the quantity that is required to be produced.

CODE	DESCRIPTION | DATE 26/5/98			3-MONTH	STOCK	STATUS	PRODUC
104027	W/S.-E.D.P.50 ML	1	570	1700	2029		
104035	W/S.-E.D.P 25 ML	2	280	850	526		
104043	W/S.-CR.BATH CONCENTRATE	3	233	700	2492		
104078	W/S.-BODY SILK 250 ML	4	430	1300	1185		
104124	W/S.-PURFUME DEODORANT	5	470	1450	1269		
104140	W/S.-FRAGRANT TALC	6	600	1800	211		
104183	W/S.-MOISTURISING BARS	7	670	2000	2391		
104175	W/S.-REFILL	8	100	300	1737		
104280	W/S.-E.D.P.35 ML	9	200	500	494		
105015	COPP-E.D.P.50 ML	10	275	800	559		
105023	COPP-E.D.P.25 ML	11	300	900	1563		
105058	COPP-BODY SILK	12	1600	4800	2770		
105147	COPP-FRAGRANT TALC	13	600	1800	1250		
105155	COPP-MOIST BAR	14	1700	5000	3749		
105163	COPP-ROL-ON ANT-PERSPIRAN	15	1600	4800	5882		
106003	LA BALLE-EDP 25ML	16	0		6000		
110019	B/C- SHAMPOO N/D	17	730	2200	1762		
110027	B/C- SHAMPOO OILY	18	500	1500	1639		
110043	B/C- CONDITIONER	19	600	1800	1849		
110078	B/C- ANTIDANDR. SH. N/D	20	330	1000	1630		
110094	B/C- ANTIDANDR SH. OILY	21	250	750	1571		
110221	B/C- STYLING GEL	22	400	1200	2066		
120464	LIP- DESERT SAND	23	800	2400	605		
120472	LIP- BROWN BERRY	24	800	2400	768		
120480	LIP- PEACH	25	600	1800	1016		
120499	LIP- SOFT PINK	26	600	1800	1471		
120502	LIP- MANDARIN	27	600	1800	2018		
120510	LIP- CORAL FROST	28	600	1800	1839		
120545	LIP- PINK CHAMPAGNE	29	380	1150	974		
120553	LIP- BLANC DE NOIR	30	550	1650	1412		
120561	LIP- RUBY ROSE	31	250	750	237		
120588	LIP- BURGUNDY WINE	32	680	2050	2022		
120596	LIP- PINK SPICE	33	950	2850	2556		
120618	LIP- RED VALENTINE	34	300	900	779		
120634	LIP- SAHARA RED	35	180	550	496		
120669	LIP- WARM CORAL	36	670	2000	2528		
120677	LIP- BURNT BRONZE	37	530	1600	813		
120685	LIP- HOT PURPLE	38	930	2800	1927		
121029	LIPLINER - ROSE	39	500	1500	2585		
121037	LIPLINER - CORAL	40	270	800	211		
121045	LIP SHINE	41	200	600	3649		
130036	INSTANT NAIL DRY	42	250	750	737		
130052	ORANGE STICKS	43	100	300	1057		
130079	NAIL ENAMEL REMOVER	44	200	600	543		
130095	CUTICAL MASSAGE CREA	45	270	800	4856		
130133	CUTICALE REMOVER	46	130	400	744		
130168	EMERY BOARDS	47	115	350	446		
130184	TOP BASE COAT	48	350	1050	693		
130230	NAIL ESSENTIALS	49	700	2100	3547		
150428	NAIL-DESERT SAND	50	500	1500	771		
150436	NAIL-BROWN BERRY	51	500	1500	584		
150444	NAIL-PEACH	52	450	1350	3782		
150452	NAIL-SOFT PINK	53	450	1350	2809		

150460	NAIL-MANDARIN	54	450	1350	1135		
150479	NAIL-CORAL FROST	55	450	1350	8[illegible]		
150487	*NAIL-PINK CHAMPAGNE*	*56*	*330*	*1000*	*1894*		
1504[illegible]	NAIL-BLANC DE NOIR	57	615	1850	1294		
150509	NAIL-RUBY ROSE	58	370	1100	974		
150517	NAIL-BURGUNDY WINE	59	250	750	429		
150525	NAIL-PINK SPICE	60	670	2000	1861		
150533	NAIL-RED VALENTINE	61	150	450	554		
150568	NAIL-SAHARA RED	62	230	700	677		
150592	NAIL-WARM CORAL	63	300	900	746		
150606	NAIL-BURNT BRONZE	64	250	750	976		
150614	NAIL-OPALESCENT	65	370	1100	891		
150630	NAIL-HOT PURPLE	66	680	2050	1656		
161225	*KHAKI HARMONY TRIO*	*67*	*330*	*1000*	*598*		
161306	WINTER RHAPSODY	68	500	1500	1165		
161314	SUMMER RHAPSODY	69	330	1000	1473		
161322	AUTUMN RHAPSODY	70	230	700	1124		
161330	SPRING RHAPSODY	71	600	1800	2539		
161349	FOREST	72	600	1800	1522		
161357	NOSTALGIA	73	700	2100	3144		
161365	HI - LIFE	74	800	2400	3120		
160288	REARL HIGHLIGHTER	75	380	1150	10000		
160296	IVORY HIGHLIGHTER	76	260	[illegible]	10000		
162019	BLACK MASCARA	77	1600	[illegible]	10000		
162027	*BROWN MASCARA*	*78*	*300*	*900*	*10000*		
162043	BLUE MASCARA	79	430	1300	10000		
162124	TEAL MASCARA	80	870	2600	10000		
1[illegible]2132	COBALT MASCARA	81	1470	4400	3333		
162140	PURPLE MASCARA	82	1330	4000	10000		
163015	EYE MAKE-UP REMOVER	83	2500	7500	10000		
165085	TEAL DEFINNING PENCI	84	430	1300	10000		
165093	BLUE DEFINNING PENCI	85	770	2300	10000		
165107	VIOLET DEFINNING PEN	86	570	1700	10000		
165115	BLACK DEFINNING PENC	87	400	1200	10000		
170038	LIGHT COVERSTICK	88	500	1500	10000		
170046	*SILKY RADIANCE*	*89*	*800*	*2400*	*10000*		
170054	LIGHT BEIGE	90	2030	6100	10000		
170097	GOLDEN BEIGE FOUND	91	615	1850	10000		
170119	WARM BEIGE FOUNDATIO	92	315	950	10000		
170356	NATURAL BEIGE FOUND	93	280	850	10000		
170151	IVORY FOUNDATION	94	630	1900	10000		
170364	NEUTRAL FOUNDATION	95	170	500	10000		
170372	COOL BEIGE FOUNDATIO	97	530	1600	1301		
170380	MAKE - UP SPONGES	98	500	1500	10000		
171018	TRANS. POWDER	99	1200	3600	10000		
171034	TRANS.POWD.COMP	100	400	1200	701		
172022	*AMBER BLUSHER*	*101*	*300*	*900*	*728*		
172049	BRONZE BLUSHER	102	470	1400	10000		
172138	IN THE PINK	103	530	1600	10000		
172146	BURNISHED GARNET	104	530	1600	662		
172154	ROSE BLUSHER	105	500	1500	797		
160318	SILVER BLUE	106	800	2400	1716		
160326	BRONZE-GLIT	107	600	1800	1103		
160334	SUNGOLD-GLIT	108	515	1550	10000		
160342	PINK-GLIT	109	670	2000	1015		
180009	TAH.-SPE FACIAL CLEAN	110	1270	3800	2188		

CODE	DESCRIPTION	DATE 26/5/88		3-MONTH	STOCK	STATUS	PRODUC
							0
104027	W/S.-E.D.P.50 ML	1	570	1700	2029	OK	-329
104035	W/S.-E.D.P 25 ML	2	280	850	526	MAKE	324
104043	W/S.-CR.BATH CONCENTRATE	3	233	700	2492	OK	-1792
104078	W/S.-BODY SILK 250 ML	4	430	1300	1185	OK	115
104124	*W/S.-PURFUME DEODORANT*	*5*	*470*	1450	1269	OK	181
104140	W/S.-FRAGRANT TALC	6	600	1800	211	CRIT	1569
104183	W/S.-MOISTURISING BARS	7	670	2000	2391	OK	-391
104175	W/S.-REFILL	8	100	300	1737	OK	-1437
104280	W/S.-E.D.P.35 ML	9	200	500	494	OK	6
105015	COPP-E.D.P.50 ML	10	275	800	559	OK	241
105023	COPP-E.D.P.25 ML	11	300	900	1563	OK	-663
105058	COPP-BODY SILK	12	1600	4800	2770	MAKE	2030
105147	COPP-FRAGRANT TALC	13	600	1800	1250	OK	550
105155	COPP-MOIST BAR	14	1700	5000	3749	OK	1251
105163	COPP-ROL-ON ANT-PERSPIRAN	15	1600	4800	5882	OK	-1082
106003	*LA BALLE-EDP 25ML*	*16*	*0*		6000	OK	-6000
110019	B/C- SHAMPOO N/D	17	730	2200	1762	OK	438
110027	B/C- SHAMPOO OILY	18	500	1500	1639	OK	-139
110043	B/C- CONDITIONER	19	600	1800	1849	OK	-49
110078	B/C- ANTIDANDR. SH. N/D	20	330	1000	1630	OK	-630
110094	B/C- ANTIDANDR SH. OILY	21	250	750	1571	OK	-821
110221	B/C- STYLING GEL	22	400	1200	2066	OK	-866
120464	LIP- DESERT SAND	23	800	2400	605	CRIT	1795
120472	LIP- BROWN BERRY	24	800	2400	768	CRIT	1632
120480	LIP- PEACH	25	600	1800	1016	MAKE	784
120499	LIP- SOFT PINK	26	600	1800	1471	OK	329
120502	LIP- *MANDARIN*	*27*	*600*	*1800*	*2018*	OK	-218
120510	LIP- CORAL FROST	28	600	1800	1839	OK	-39
120545	LIP- PINK CHAMPAGNE	29	380	1150	974	OK	176
120553	LIP- BLANC DE NOIR	30	550	1650	1412	OK	238
120561	LIP- RUBY ROSE	31	250	750	237	CRIT	513
120588	LIP- BURGUNDY WINE	32	680	2050	2022	OK	28
120596	LIP- PINK SPICE	33	950	2850	2556	OK	294
120618	LIP- RED VALENTINE	34	300	900	779	OK	121
120634	LIP- SAHARA RED	35	180	550	496	OK	54
120669	LIP- WARM CORAL	36	670	2000	2528	OK	-528
120677	LIP- BURNT BRONZE	37	530	1600	813	MAKE	787
120685	LIP- HOT PURPLE	*38*	*930*	*2800*	1927	OK	873
121029	LIPLINER - ROSE	39	500	1500	2585	OK	-1085
121037	LIPLINER - CORAL	40	270	800	211	CRIT	589
121045	LIP SHINE	41	200	600	3649	OK	-3049
130036	INSTANT NAIL DRY	42	250	750	737	OK	13
130052	ORANGE STICKS	43	100	300	1057	OK	-757
130079	NAIL ENAMEL REMOVER	44	200	600	543	OK	57
130095	CUTICAL MASSAGE CREA	45	270	800	4856	OK	-4056
130133	CUTICALE REMOVER	46	130	400	744	OK	-344
130168	EMERY BOARDS	47	115	350	446	OK	-96
130184	TOP BASE COAT	48	350	1050	693	MAKE	357
130230	*NAIL ESSENTIALS*	*49*	*700*	*2100*	*3547*	OK	-1447
150428	NAIL-DESERT SAND	50	500	1500	771	MAKE	729
150436	NAIL-BROWN BERRY	51	500	1500	584	MAKE	916
150444	NAIL-PEACH	52	450	1350	3782	OK	-2432
150452	NAIL-SOFT PINK	53	450	1350	2809	OK	-1459

150460	NAIL-MANDARIN	54	450	1350	1135	OK	215
150479	NAIL-CORAL FROST	55	450	1350	819	MAKE	531
150487	NAIL-PINK CHAMPAGNE	56	330	1000	1894	OK	-894
150495	NAIL-BLANC DE NOIR	57	615	1850	1294	OK	556
150509	NAIL-RUBY ROSE	58	370	1100	974	OK	126
150517	NAIL-BURGUNDY WINE	59	250	750	429	MAKE	321
150525	NAIL-PINK SPICE	60	670	2000	1861	OK	139
150533	NAIL-RED VALENTINE	61	150	450	554	OK	-104
150568	NAIL-SAHARA RED	62	230	700	677	OK	23
150592	NAIL-WARM CORAL	63	300	900	746	OK	154
150606	NAIL-BURNT BRONZE	64	250	750	976	OK	-226
150614	NAIL-OPALESCENT	65	370	1100	891	OK	209
150630	NAIL-HOT PURPLE	66	680	2050	1656	OK	394
161225	KHAKI HARMONY TRIO	67	330	1000	598	MAKE	402
161306	WINTER RHAPSODY	68	500	1500	1165	OK	335
161314	SUMMER RHAPSODY	69	330	1000	1473	OK	-473
161322	AUTUMN RHAPSODY	70	230	700	1124	OK	-424
161330	SPRING RHAPSODY	71	600	1800	2539	OK	-739
161349	FOREST	72	600	1800	1522	OK	278
161357	NOSTALGIA	73	700	2100	3144	OK	-1044
161365	HI - LIFE	74	600	2400	3120	OK	-720
160288	REARL HIGHLIGHTER	75	380	1150	10000	OK	-8850
160296	IVORY HIGHLIGHTER	76	260	800	10000	OK	-9200
162019	BLACK MASCARA	77	1600	4800	10000	OK	-5200
162027	BROWN MASCARA	78	300	900	10000	OK	-9100
162043	BLUE MASCARA	79	430	1300	10000	OK	-8700
162124	TEAL MASCARA	80	870	2600	10000	OK	-7400
162132	COBALT MASCARA	81	1470	4400	3333	OK	1067
162140	PURPLE MASCARA	82	1330	4000	10000	OK	-6000
163015	EYE MAKE-UP REMOVER	83	2500	7500	10000	OK	-2500
165085	TEAL DEFINNING PENCI	84	430	1300	10000	OK	-8700
165093	BLUE DEFINNING PENCI	85	770	2300	10000	OK	-7700
165107	VIOLET DEFINNING PEN	86	570	1700	10000	OK	-8300
165115	BLACK DEFINNING PENC	87	400	1200	10000	OK	-8800
170038	LIGHT COVERSTICK	88	500	1500	10000	OK	-8500
170046	SILKY RADIANCE	89	800	2400	10000	OK	-7600
170054	LIGHT BEIGE	90	2030	6100	10000	OK	-3900
170097	GOLDEN BEIGE FOUND	91	615	1850	10000	OK	-8150
170119	WARM BEIGE FOUNDATIO	92	315	950	10000	OK	-9050
170356	NATURAL BEIGE FOUND	93	280	850	10000	OK	-9150
170151	IVORY FOUNDATION	94	630	1900	10000	OK	-8100
170364	NEUTRAL FOUNDATION	95	170	500	10000	OK	-9500
170372	COOL BEIGE FOUNDATIO	97	530	1600	1301	OK	299
170380	MAKE - UP SPONGES	98	500	1500	10000	OK	-8500
171018	TRANS. POWDER	99	1200	3600	10000	OK	-6400
171034	TRANS.POWD.COMP	100	400	1200	701	MAKE	499
172022	AMBER BLUSHER	101	300	900	728	OK	172
172049	BRONZE BLUSHER	102	470	1400	10000	OK	-8600
172138	IN THE PINK	103	530	1600	10000	OK	-8400
172146	BURNISHED GARNET	104	530	1600	662	MAKE	938
172154	ROSE BLUSHER	105	500	1500	797	MAKE	703
160318	SILVER BLUE	106	800	2400	1716	OK	684
160326	BRONZE-GLIT	107	600	1800	1103	MAKE	697
160334	SUNGOLD-GLIT	108	515	1550	10000	OK	-8450
160342	PINK-GLIT	109	670	2000	1015	MAKE	985
180009	TAH.-SPE FACIAL CLEAN	110	1270	3800	2188	MAKE	1612

CODE	DESCRIPTION	DATE 26/5/88		3-MONTH	STOCK	STATUS	PRODUC
							0
140171	ORGANIC COSMETIC SPO	126	1250	3750	951	CRIT	2799
120464	LIP- DESERT SAND	23	800	2400	605	CRIT	1795
210188	HOM.-AEROSOL DEORANT	156	730	2200	462	CRIT	1738
211052	SHO.-COLOGNE	161	830	2500	813	CRIT	1687
120472	LIP- BROWN BERRY	24	800	2400	768	CRIT	1632
104140	W/S.-FRAGRANT TALC	6	600	1800	211	CRIT	1589
210110	HOM.-AFTER SHAVE LOTION	155	480	1450	33	CRIT	1417
211095	SHO.-SOAP-ON-THE-ROPE	162	450	1350	274	CRIT	1076
210099	HOM.-AFTER SHAVE BALM	154	350	1050	198	CRIT	852
211001	SHO.-INVIGORATING LOTION	158	290	880	279	CRIT	601
121037	LIPLINER - CORAL	40	270	800	211	CRIT	589
211044	SHO.-MOIST BALM	160	215	650	66	CRIT	584
120561	LIP- RUBY ROSE	31	250	750	237	CRIT	513
210072	HOM.-SHAVE FOAM	153	160	500	38	CRIT	462
180157	TAH.-MOIST. FOR N/OILY	118	5000	15000	8846	MAKE	6154
180130	TAH.-MOIST. FOR DRY SKIN	117	2000	6000	2577	MAKE	3423
180254	TAH.-MASQUE	122	1930	5800	2459	MAKE	3341
200182	NUC.-NIGHT CREAM	144	2015	6050	2980	MAKE	3070
200018	NUC.-YOUTH GEL	135	1670	5000	2059	MAKE	2941
200115	NUC.-ULTRA RICH MOIST	141	2750	8250	5388	MAKE	2862
200166	NUC.-EYE STICK	143	1600	4800	2143	MAKE	2657
180599	TAH.-VERY GENTLE BUFFER C	125	2000	6000	3735	MAKE	2265
191450	B/C.-EMBRASING BODY SILK	132	1500	4500	2417	MAKE	2083
105058	COPP-BODY SILK	12	1600	4800	2770	MAKE	2030
180009	TAH.-SPE FACIAL CLEAN	110	1270	3800	2188	MAKE	1612
190101	TOTAL SUN BLOCK FACT	127	760	2350	953	MAKE	1397
211036	SHO.-ENRICHED SHOW/GEL	159	530	1600	613	MAKE	987
160342	PINK-GLIT	109	670	2000	1015	MAKE	985
172146	BURNISHED GARNET	104	530	1600	662	MAKE	938
150436	NAIL-BROWN BERRY	51	500	1500	584	MAKE	916
200050	NUC.-FACE CREAM-E	137	830	2500	1660	MAKE	840
120677	LIP- BURNT BRONZE	37	530	1600	813	MAKE	787
120480	LIP- PEACH	25	600	1800	1016	MAKE	784
150428	NAIL-DESERT SAND	50	500	1500	771	MAKE	729
172154	ROSE BLUSHER	105	500	1500	797	MAKE	703
160326	BRONZE-GLIT	107	600	1800	1103	MAKE	697
180270	TAH.-HAND AND BODY LOTION	123	370	1100	544	MAKE	556
150479	NAIL-CORAL FROST	55	450	1350	819	MAKE	531
171034	TRANS.POWD.COMP	100	400	1200	701	MAKE	499
161225	KHAKI HARMONY TRIO	67	330	1000	598	MAKE	402
130184	TOP BASE COAT	48	350	1050	693	MAKE	357
104035	W/S.-E.D.P 25 ML	2	280	850	526	MAKE	324
150517	NAIL-BURGUNDY WINE	59	250	750	429	MAKE	321
180203	TAH.-EYE CREAM	120	1780	5350	3586	OK	1764
191434	B/C.-ROLL ON ANTI-PERSP	133	1500	4500	3098	OK	1402
180092	TAH.-FRESHENER	115	3530	10600	9213	OK	1387
105155	COPP-MOIST BAR	14	1700	5000	3749	OK	1251
180025	TAH.-CLEANSER NORMAL	111	3070	9200	8044	OK	1156
180011	TAH.-CLEANSER FOR OILY	112	1400	4200	3108	OK	1092
162132	COBALT MASCARA	81	1470	4400	3033	OK	1067
200093	NUC.-FRESHENER	140	2170	6500	5452	OK	1048
180076	TAH.-CLEANSER FOR DRY	113	1180	3550	2518	OK	1032
120685	LIP- HOT PURPLE	38	930	2800	1927	OK	873

200034	NUC.-FACE CREAM-A	136	980	2950	2244	OK	706
200204	NUC.-NECK CREAM	145	1050	3150	2464	OK	686
160318	SILVER BLUE	105	800	2400	1716	OK	684
150495	NAIL-BLANC DE NOIR	57	615	1850	1294	OK	556
105147	COPP-FRAGRANT TALC	13	600	1800	1250	OK	550
110019	B/C- SHAMPOO N/D	17	730	2200	1762	OK	438
150630	NAIL-HOT PURPLE	66	680	2050	1656	OK	394
200271	NUC.-BUFFER CREAM	147	1000	3000	2633	OK	367
161306	WINTER RHAPSODY	68	500	1500	1165	OK	335
120499	LIP- SOFT PINK	26	600	1800	1471	OK	329
200735	NUC.-BODY CONDI LOTION	151	570	1700	1381	OK	319
170372	COOL BEIGE FOUNDATIO	97	530	1600	1301	OK	299
120596	LIP- PINK SPICE	33	950	2850	2556	OK	294
161349	FOREST	72	600	1800	1522	OK	278
180327	TAH.-HAND TREATMENT CR.	124	470	1400	1131	OK	269
200131	NUC.-MASQUE	142	1085	3250	3009	OK	241
105015	COPP-E.D.P.50 ML	10	275	800	559	OK	241
120553	LIP- BLANC DE NOIR	30	550	1650	1412	OK	238
191416	B/C.-AEROSOL DEODORANT	131	300	900	678	OK	222
200743	NUC.-TONING BUST TREATMEN	152	500	1500	1279	OK	221
150460	NAIL-MANDARIN	54	450	1350	1135	OK	215
150614	NAIL-OPALESCENT	65	370	1100	891	OK	209
104124	W/S.-PURFUME DEODORANT	5	470	1450	1269	OK	181
120545	LIP- PINK CHAMPAGNE	29	380	1150	974	OK	176
172022	AMBER BLUSHER	101	300	900	728	OK	172
150592	NAIL-WARM CORAL	63	300	900	746	OK	154
150525	NAIL-PINK SPICE	60	670	2000	1861	OK	139
150509	NAIL-RUBY ROSE	58	370	1100	974	OK	126
120618	LIP- RED VALENTINE	34	300	900	779	OK	121
104078	W/S.-BODY SILK 250 ML	4	430	1300	1185	OK	115
130079	NAIL ENAMEL REMOVER	44	200	600	543	OK	57
120634	LIP- SAHARA RED	35	180	550	496	OK	54
120588	LIP- BURGUNDY WINE	32	680	2050	2022	OK	28
150568	NAIL-SAHARA RED	62	230	700	677	OK	23
130036	INSTANT NAIL DRY	42	250	750	737	OK	13
104280	W/S.-E.D.P.35 ML	9	200	500	494	OK	6
120510	LIP- CORAL FROST	28	600	1800	1839	OK	-39
110043	B/C- CONDITIONER	19	600	1800	1849	OK	-49
130168	EMERY BOARDS	47	115	350	446	OK	-96
150533	NAIL-RED VALENTINE	61	150	450	554	OK	-104
110027	B/C- SHAMPOO OILY	18	500	1500	1639	OK	-139
120502	LIP- MANDARIN	27	600	1800	2018	OK	-218
150606	NAIL-BURNT BRONZE	64	250	750	976	OK	-226
104027	W/S.-E.D.P.50 ML	1	570	1700	2029	OK	-329
130133	CUTICALE REMOVER	46	130	400	744	OK	-344
104183	W/S.-MOISTURISING BARS	7	670	2000	2391	OK	-391
161322	AUTUMN RHAPSODY	70	230	700	1124	OK	-424
161314	SUMMER RHAPSODY	69	330	1000	1473	OK	-473
120669	LIP- WARM CORAL	36	670	2000	2528	OK	-528
110078	B/C- ANTIDANDR. SH. N/D	20	330	1000	1630	OK	-630
105023	COPP-E.D.P.25 ML	11	300	900	1563	OK	-663
161365	HI - LIFE	74	800	2400	3120	OK	-720
161330	SPRING RHAPSODY	71	600	1800	2539	OK	-739
130052	ORANGE STICKS	43	100	300	1057	OK	-757
110094	B/C- ANTIDANDR SH. OILY	21	250	750	1571	OK	-821
110221	B/C- STYLING GEL	22	400	1200	2066	OK	-866

APPENDIX D:1

Figure D1: Table drawn up to calculate the time standards.

MACHINE : Nail Filler

PRODUCT : Nail Polish

QUANTITY :

CONTAINER :

ELEMENTS : 1. Insert metal pellets
2. Filling
3. Brush
4. Lid
5. Sticker
6. Packaging

ELEMENTS	AMOUNT	TIME	TIME / UNIT	AVERAGE
1.Insert metal Pellets	10	14	1.4	
	10	16	1.6	
	10	27	2.7	
	10	14	1.4	
	20	24	1.2	1.66
2.Filling	5	22	4.4	
	5	18	3.6	
	5	21	4.2	
	5	18	3.6	
	5	18	3.6	3.88
3.Brush	Keeps up with the filling process			
4.Lid	5	25	5	
	5	29	5.8	
	5	33	6.6	
	5	32	6.4	
	5	29	5.8	5.97
5.Sticker and Packaging	13	72	5.54	
	11	57	5.18	
	10	60	6	
	12	63	5.25	
	13	78	6	5.78

APPENDIX E:1

The method used to calculate the standard time is as follows: Time end - Time start = Time taken before deductions - Time for tea or lunch - Time taken for stoppages as per comments = TOTAL TIME.

Note: when writing down the time start and end, this means the actual times of the day. The workers do not take off time for breakes for tea and lunch. For example:

Time start = 8.30 am Time end = 3.30 pm

Time taken before deductions = 3.30 pm -8.30 am

= 7 hours

Total time taken = 7 - 0.25(tea) - 0.5(lunch) - time taken for stoppages as per comments.

= 6.25 hours - time taken for stoppages

Once the total time is calculated the quantity of products filled per hour was calculated

$$= \frac{\text{Total Quantity Filled}}{\text{Total Time}}$$

= Total Quantity Filled Per Hour

From this the quantity filled per hour per worker was calculated (each fill line has a predetermined number of workers on the line):

$$= \frac{\text{Total Quantity Filled Per Hour}}{\text{No of workers on line}}$$

APPENDIX F:1

From the printout, Figure C5, Appendix C3, the planner can determine what products are required to be produced, and what quantity of each product is required to be produced, during the month ahead.

The planner than has a look at the products that are required to be produced, and breakes them up into their different fill processes, that is, cream, liquid, tube, etc.

Line 1 = cream fill
Line 2 = tube fill
Line 3 = liquid fill
Line 4 = aerosole fill
Line 5 = nail fill
Line 6 = lipstick fill
P = purchased finished goods

Figure F1 shows how the products are seperated into their different fill processes, according to the different lines they are filled on. One the products have been grouped together, the next stage would be for the planner to schedule the production on the fill lines.

In this example the production of the products on Line 1 will be scheduled, that is, the cream fill line. From Figure F1, the products to be filled can be seen in Figure F2.

The time standards and the set up time calculated for the cream line, that is, Line 1, in the previous section was found to be:

Quantity filled per hour = 460 units, with 5 workers on the line.
Set up time = 45 min or .75 of an hour.

CODE	DESCRIPTION	DATE 26/5/88	GROUP	QUANTITY
140171	ORGANIC COSMETIC SPO	126	P	2799
120464	LIP- DESERT SAND	23	7	1795
210188	HOM.-AEROSOL DEORANT	156	5	1738
211052	SHO.-COLOGNE	161	1	1687
120472	LIP- BROWN BERRY	24	7	1632
104140	W/S.-FRAGRANT TALC	6		1589
210110	HOM.-AFTER SHAVE LOTION	155	4	1417
211095	SHO.-SOAP-ON-THE-ROPE	162	P	1076
210099	HOM.-AFTER SHAVE BALM	154	1	852
211001	SHO.-INVIGORATING LOTION	158	1	601
121037	LIPLI[illegible] - CORAL	40	4	589
211044	SHO.-MOIST [illegible]M	160	4	584
120561	LIP- RUBY [illegible]	31	7	513
210072	HOM.-SHAVE FOAM	153	5	462
180157	TAH.-MOIST. FOR N/OILY	118	4	6154
180130	TAH.-MOIST. FOR DRY SKIN	117	4	3423
180254	TAH.-MASQUE	122	1	3341
200182	NUC.-NIGHT CREAM	144	1	3070
200018	NUC.-YOUTH GEL	135	1	2941
200115	NUC.-ULTRA RICH MOIST	141	1	2862
200166	NUC.-EYE STICK	143	7	2657
180599	TAH.-VERY GENTLE BUFFER C	125	1	2265
191450	B/C.-EMBRASING BODY SILK	132	4	2083
105058	COPP-BODY SILK	12	4	2030
180009	TAH.-SPE FACIAL CLEAN	110	4	1612
190101	TOTAL SUN BLOCK FACT	127	4	1397
211036	SHO.-ENRICHED SHOW/GEL	159	1	987
160342	PINK-GLIT	109		985
172146	BURNISHED GARNET	104		938
150436	NAIL-BROWN BERRY	51	6	916
200050	NUC.-FACE CREAM-E	137	1	840
120677	LIP- BURNT BRONZE	37	7	787
120480	LIP- PEACH	25	7	784
150428	NAIL-DESERT SAND	50	6	729
172154	ROSE BLUSHER	105		703
160326	BRONZE-GLIT	107		697
180270	TAH.-HAND AND BODY LOTION	123	4	556
150479	NAIL-CORAL FROST	55	6	531
171034	TRANS.POWD.COMP	100		499
161225	KHAKI HARMONY TRIO	67		402
130184	TOP BASE COAT	48	6	357
104035	W/S.-E.D.P 25 ML	2	5	324
150517	NAIL-BURGUNDY WINE	59	6	321
180203	TAH.-EYE CREAM	120	1	1764
191434	B/C.-ROLL ON ANTI-PERSP	133	4	1402
180092	TAH.-FRESHENER	115	4	1387
105155	COPP-MOIST BAR	14	P	1251
180025	TAH.-CLEANSER NORMAL	111	4	1156
180041	TAH.-CLEANSER FOR OILY	112	4	1092
162132	COBALT MASCARA	81	1	1067
200093	NUC.-FRESHENER	140	4	1048
180076	TAH.-CLEANSER FOR DRY	113	4	1032
120685	LIP- HOT PURPLE	38	7	873
200034	NUC.-FACE CREAM-A	136	1	706

CODE	DESCRIPTION	DATE 26/5/88		GROUP	QUANTITY
211052	SHO.-COLOGNE	161		1	1687
210099	HOM.-AFTER SHAVE BALM	154		1	852
211001	SHO.-INVIGORATING LOTION	158		1	601
180254	TAH.-MASQUE	122		1	3341
200182	NUC.-NIGHT CREAM	144		1	3070
200018	NUC.-YOUTH GEL	135		1	2941
200115	NUC.-ULTRA RICH MOIST	141		1	2862
180599	TAH.-VERY GENTLE BUFFER C	125		1	2265
211036	SHO.-ENRICHED SHOW/GEL	159		1	987
200050	NUC.-FACE CREAM-E	137		1	840
180203	TAH.-EYE CREAM	120		1	1764
162132	COBALT MASCARA	81		1	1067
200034	NUC.-FACE CREAM-A	136		1	706
200204	NUC.-NECK CREAM	145		1	686

APPENDIX F:1 (Cont)

The production planner would than calculate the time required on the line to fill the different products.

If we consider (1) Sho-Cologne form Figure F2, it is required to produce 1687 units. The time required to produce these units is calculated as follows:

$$\text{Time required} = \frac{\text{units}}{\text{units / hour}}$$

$$= \frac{1687}{460}$$

$$= 3,67 \text{ hours}$$

The production planner would than calculate the time required to produce each product, as shown above.

(2) 1.85 hr
(3) 1.31 hr
(4) 7.26 hr
(5) 6.67 hr
(6) 6.39 hr
(7) 6.22 hr
(8) 4.92 hr
(9) 2.15 hr
(10) 1.83 hr
(11) 3.83 hr
(12) 1.53 hr
(13) 1.49 hr

The next stage would be for the planner to schedule the production for the line, using the Gantt Chart. Figure F3, illustrates the products scheduled on the chart. This method for scheduling the production one Line 1, will be used for all the different production lines.

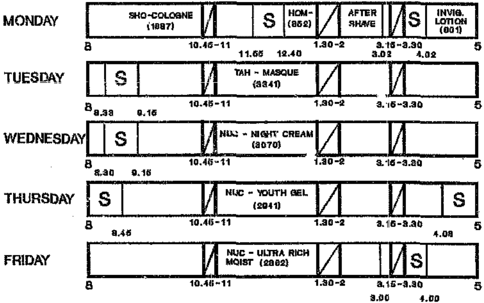


FIGURE F3 : SCHEDULED GANTT CHART

PRODUCTION LINE: 1
DATE START:
DATE END:

APPENDIX F2

The programme was written utilizing the Lotus 123 spreadsheet programme. It was written in such a way as to aid the planner with the scheduling of the production on the different fill lines.

The programme adopts the same method used by the planner to schedule the production in the factory, as was described in Appendix F1.

The method adopted when using the programme:

- The planner would enter all the products and their required quantities, and what line they are filled on, into the programme.
- The planner would then instruct the computer to generate the schedules for the different production lines.
- Once the schedules have been generated, the planner would decide wheather he is satisfied with the them, if he is the schedules would be given to the factory manager. If however, the planner is not satisfied with the schedule, he would make changes to the plan and regenerate the schedule once again. This would continue until such time as the planner is satisfied with the schedules generated.

Figure F4 shows a printout generated by the computer model, of the production schedule for Line 1.

DATE 25/04/88 LINE 1 PRODUCTION PLAN DATE 02/05/88

WEEK 1

QUANTITY	PRODUCT	DAY
		MONDAY
19000.00	COPP-M/DAY	40.38
		8.00
		TUESDAY
		32.38
		8.00
		WEDNESDAY
		24.38
		8.00
		THURSDAY
		16.38
		8.00
		FRIDAY
		8.38
		8.00

WEEK 2

QUANTITY	PRODUCT	DAY
		MONDAY
		0.38
6000.00	BODY TREATMENT	19.90
		8.00
		TUESDAY
		5.90
1200.00	MASC.NAVY	9.20
		8.00
		WEDNESDAY
		1.20
1152.00	MASC.BLACK	4.40
770.00	MASC.B/BLUE	6.79
3000.00	MASQUE	13.92
		8.00
		THURSDAY
		5.92
3000.00	ADVANCED MOIST	12.63
		8.00
		FRIDAY
		4.63
8000.00	W/S-M/DAY	22.11

OVER SCHEDULED

APPENDIX G:1

In this section the method used by the factory manager to ensure that all the bulk materials are produced on time, to be filled as laid down by the production schedulde, is discussed.

The production schedule is finalized on the third working day of the month, by the production planner. The production schedule starts to plan the production at the begining of the second week of the month. Thus there are three working days to plan the bulk production for those products scheduled at the start of the second week.

The reason for allowing three days, is as it takes up to two days to produce some of the bulk materials, thus time has to be allocated to ensure that the bulk material is going to be produced on time.

The method for scheduling the bulk material production will now be looked at:
From the production schedule for the different fill lines (see Figure G1), the bulk production for all the bulk required on the first day of the schedule is planned.

The bulk materials that are required by the schedule, would then be manufactured on the third working day of the week.

In this example, the factory manager would schedule the production of the bulks: A, B, C, F and H to be manufactured

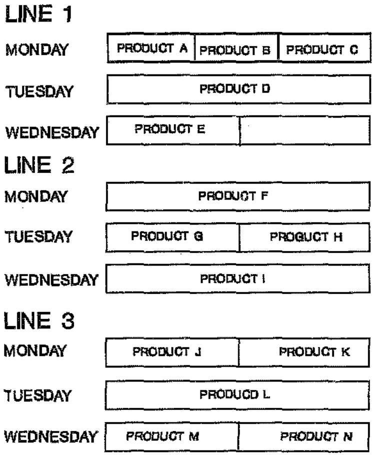


FIGURE G1: PRODUCTION SCHEDULE

APPENDIX G:1 (Cont)

on the Third working day of the month and bulks: D, G, H, and K on the fourth working day of the week, and so on. This would ensure that the bulk materials are manufactured and ready to be filled as laid down by the production schedule.

APPENDIX G:2

It must be noted that on the three month forecast, which is issued to the purchasing department, is listed the monthly forecasted demands for each product, when there is a special offer for a product, this is also listed on the forecast, showing which month the offer is going to be launched, and it's expected sales.

In the example below, the forecast, and purchasing requirements for product A will be illustrated. In this example the forecast is issued at the beginning of January.

Two different cases will be discussed in this section:

Case 1 : In the first case product A is not offered as a special offer during the three month period.

Product A demand forecast:

March	April	MAY
900	1000	1100

Case 2 : The second case, illustrates the case when product A has a three months forecast, and the product will be offered as a special offer in April, and the expected sales for the offer is 1000 units.

Product A demand forecast:

March	April	May
900	1000 1000	1100

APPENDIX G:2 (Cont)

The three senarios that the purchaser is faced with when placing an order with the product *having no special offer*, that is Case 1, will be illustrated first.

In this example it is found that the minimum order quantity for product A, as laid down by the suppliers is 5000 units.

1. In the first case, adding the three month forecasts, we get a total requirement of 3000 units.

When the purchaser enters the product requirements into the computer and requests that a product status report is generated, the information obtainned is as follows:

	On-hand	Required	order
Product A	4000	3000	-1000

In this case the purchaser would not have to place an order, as the on-hand stock covers the product requirements.

2. In this case, when the product stock status is generated, the information is as follows:

	On-hand	Required	Order
Product A	2000	3000	1000

In this case a order of 1000 units must be made. The order would be made in January, to be delivered at the end of April, so that the product can be produced in May. The reason for the delivery only being required at the end of April, is as the on-hand stock covers the requirements for March and April.

APPENDIX G:2 (Cont)

In this example, the product can only be purchased in a minimum lot size of 5000 units. Thus a order would be made for 5000 units. The purchasing department has made arrangements with their suppliers to hold stock and supply orders in part deliveries. In this case the supplier would supply 1000 units at the end of April, and hold the remaining 4000 units until required at a later date.

3. In this case, when the product stock status report is generated, the information obtained is as follows:

	On-hand	Required	Order
Product A	0	3000	3000

In this case a order of 3000 units must be made in January. If the minimum allowable order quantity is 5000 units, then the purchaser would aranga with the supplier to deliver the product as follows:

31 Febuary	900
31 March	1000
31 April	1100
	3000 units

The remaining 2000 units will be held by the supplier until it is required at a later date.

In case 2, were we have a special offer on product A during the three month forecasted period, the purchaser would order the product as follows:

APPENDIX G:2 (Cont)

The purchaser knows what the three month forecast is for product A, this is obtained from the report. Also listed on the report is the month inwhich the special offer is going to be launched, and the expected sales of the offer.

In this example, the three month forecast = 3000 units, special offer in April = 1000 units, therefore, total requirements for the three month period = 4000 units.

The stock status generated on the computer:

	On-hand	Required	Order
Product A	1000	4000	3000

In this case a order is placed in January for 5000 units, to be delivered as follows:

31 Febuary	1000 units	to cover the production requirements for the special offer
31 March	1000 units	
31 April	1100 units.	

In this case, the special offer is going to be launched in April, therefore, the products required have to be purchased a month before, and produced during that month, that is, March, to ensure that the offer can be supplied during April when sales are made. The remaining 2000 units would be held by the supplier until a later date.

APPENDIX G:3

The different senarios that the purchaser is faced with when purchasing the raw materials will be discussed below:

As was mentioned in Section 7 it was decided to hold one months stock on hand of raw materials, in case of late deliveries and problems with suppliers.

In this example the purchasing requirements for product A will be considered. The stock holding for product A = 90 kg. This is made up of the monthly forecasted value, and some safety stock, to allow for variances in demand.

Two senarios will be considered:

Case 1

From the production schedule the requirements of product A is 50 kg, and the stock holding is 150 kg.

After comparing the requirements with the stock holding, and taking into account the safety stock allowances, that is, 90 kg, the purchaser does not have to purchase any more product as the requirements can be taken out of the on hand stock, leaving 100 kg of product which is still larger than the required safety stock.

Case 2

From the production schedule the requirements of product A is 110 kg, and the stock holding is 150 kg.

APPENDIX G:3 (Cont)

In this case the purchaser has to order 50 kg of product A to maintain the safety stock level. The purchaser may not be able to order a quantity of 50 kg do to the minimum allowable order quantities laid down by the supplier. In this case the purchaser would order the minimum lot size and hold the remainder of the product in stock for a later date. If however, the purchaser can order the product in any quantity required, then he would order 50 kg in order to fulfill the requirements of the monthly production schedule, and thus maintain the 90 kg safety stock level.

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