THE DESIGN OF A MANAGEMENT INFORMATION SYSTEM FOR COOLANT HOSE PRODUCTION

by

JULIAN DAVID JAFFE

M.Phil.

A thesis submitted in fulfillment of the requirements for the degree of Master of Philosophy.

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SUMMARY

The Dunlop Group of Companies together with the University of Aston Interdisciplinary Higher Degrees Scheme have sponsored this research.

The problems of coolant hose within the Dunlop Autohose Group defined initial areas for research to be undertaken. After initial analysis it was decided that the most appropriate method of solving the stated problems was the provision of a Management Information System (M.I.S.). The development and design of a Management Information System have been based on the use of Cybernetic Management Principles. This research proposes an M.I.S. for the Dunlop Autohose Group (Coolant Hose) based on a Management Cybernetic Mode.

KEYWORDS: CYBERNETIC MANAGEMENT
MANAGEMENT INFORMATION SYSTEM

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INTRODUCTION

Introduction

The Dunlop Group of Companies has found that research projects within their existing factories provide effective training exercises for their trainee managers. In addition, they have found that these training exercises are an effective way of introducing new techniques into more well established parts of the company.

This research project was instigated as one of these exercises by the Dunlop Central Personnel Department to achieve the aims discussed above. Each project was chosen by the separate Dunlop Divisions (member companies) and in conjunction with the University of Aston Interdisciplinary Degrees Department allocated to graduate recruits.

The Interdisciplinary Higher Degrees Scheme has the aim of reversing the trend of traditional research from becoming the research into progressively more narrow and specialised subjects to the applications of appropriate disciplines to problem solving within industry. The application of these disciplines within industry has been termed as "Action Research".

This Action Research concerns the problems of inefficiency and un-profitability of coolant hose production within a Dunlop Group called the Autohose Group.

The Autohose Group (A.H.G.) forms one of two groups within the Polymer Engineering Division (P.E.D.) based in Leicester, the other being the Metalastik Group.

The Autohose Group is concerned with the production of a wide variety of rubber and synthetic rubber hoses for use mainly by the automotive industry but also by automotive spare parts suppliers. The factory has developed from the former John Bull Factory which previously also produced rubber accessories for the bicycle and motor bicycle market. Such an old established factory has many items of machinery that have been inherited from its predecessor as well as many well established business systems and procedures.

The Metalasik Group is the larger Group within the Polymer Engineering Division specialising in the production of rubber to metal bonded items for a very diverse market ranging from engine mountings for cars to mobile supports for bridges.

The Autohose Group shares with Metalastik the supply of rubber compound and also many administrative services including Accounts, Personnel, Management Services, and Costing Departments.

The initial aims of this Action Research were: to define the problem area within the Dunlop Polymer Engineering Division, and in parallel, to define and select the disciplines required to deal with the problems found.

The way in which the disciplines and problems were defined is discussed in detail in Chapters One and Two.

In Chapter One, the selection of the necessary disciplines and the way in which they have developed is discussed.

In Chapter Two, the way in which the broad problem areas were defined and the methods available to solve these problems are described.

An initial investigation of the existing systems within the Coolant Hose section of the Autohose Group, for the purpose of familiarisation, then forms the topic for Chapter Three.

In Chapter Four, the way in which the organisation was analysed for viability is discussed within a Management Cybernetic framework.

This analysis is then used, in Chapter Five, as the basis for the design of a Management Information System as the most appropriate solution to the problems revealed. The use of this design is then elaborated upon in Chapter Six in the form of a Case Study of two selected areas within the Coolant Hose factory.

The conclusions and recommendations drawn from these investigations are then presented in Chapter Seven.

CHAPTER ONE

THE ANALYTICAL TOOLS

1.0 Introduction

The initial aim of this Action Research was stated by a team of concerned managers within the Autohose Group (A.H.G.) as an investigation into the possibility of improving the efficiency of production of the production of coolant hose within the factory (Appendix A1).

The initial bias given was towards the disciplines of Production Engineering, but because of an emphasis towards an overall appreciation in the A.H.G. and the then probable need to use computer facilities for providing solutions to the stated problems, these disciplines appeared too narrow in their scope. Consequently a decision was made to study the use of Operations Research and Systems Analysis with a view to applying the methods and techniques that these disciplines offered to solving the problems stated.

This chapter describes some of the broad ideas and concepts within Operations Research and Systems Analysis which were used as the main tools for conducting this piece of Action Research.

1.1 The Development of Analysing Techniques

There are essentially two methods available to investigate a problem or series of problems; one based on a scientific, analytical approach and the other based on the Systems Approach (1, 2, 3).

The need during and after the Second World War to cope with increasingly more complex problems led to the use of more than one discipline in solving them. Thus the trend toward narrower and more specific disciplines was reversed in the direction of an inter-disciplinary approach to problem solving (2, 3). The functional basis for problem solving led to the concept of Systems Thinking. According to Schoderbek et al (1) it is based on the four principles of:

* Organisism - focussing on a particular organism or organisation.

* Holism - looking at the whole.

* Modelling - abstracting the relevant details.

* Understanding - the dynamic nature of the above principles.

A direct progression of the functional, inter-disciplinary movement was the formulation of General System Theory (G.S.T.) and Cybernetics. G.S.T. founded by Bertalanffy (4) is based on the principle that, in many situations, there are common characteristics of growth and evolution. Cybernetics initiated by Wiener (5) similarly makes comparisons between a wide range of phenomena but is based on the concepts of control and communication.

Out of these two areas of research the Systems Approach (the application of Systems Sciences to managerial problems) developed (1). Churchman (2) and Singleton (25) emphasise the importance in such an approach of extrapolating back to the thinking processes when analysing a set of problems. They say activities should be described by their function or purpose rather than by their most obvious characteristics. The basis for this is, according to Singleton, "...a matter of drawing the right set of (functional) block diagrams". So the use of block diagrams, keeping functional and physical blocks separate, together with maintenance of a consistent level of abstraction and complexity are pre-requisites for analysis.

From the Systems Approach arose five parallel, though not equivalent, channels of Management Research:

* Organisational Theory.
* Operations Research (and Management Science).
* Systems Analysis.
* Industrial Dynamics.
* Management Cybernetics.

These separate branches of Management Research are now discussed further.

1.1.1 Organisational Theory

Organisational Theory has been defined as, "The Study of the structure, functioning, and performance of organisations and the behaviour of groups and individuals within them" (13).

Handy (6) has identified the main considerations and the necessity for an overall appreciation of them in improving organisational effectiveness. They are:

* The Individuals.
* The Environment, and
* The Organisation (groups, structures, and systems).

To understand the individuals it is necessary to understand their motivation. There have been many theories proposed which have attempted to predict and thereby enable motivation of individuals, but as yet no one satisfactory method has been produced.

The environment has marked effects on all aspects of organisational effectiveness. It includes the geographical and societal environment which will determine the availability and type of workers, the economic and competitive environment (26), and the physical and technological environments.

Group formation and effectiveness are, according to Handy (6) determined by:

* The Givens - the group, the task and the environment.

* The Intervening Factors - leadership style, processes and procedures, and motivation.

* The Outcomes - productivity, member satisfaction.

These divisions may be further split and more considerations included, but the overall implication stated is one of being able to alter only the intervening factors in the short term when it is the givens that are more important.

History and ownership, size, goals and objectives, people and the environment all exert their influence on the organisational structure and systems. As such they are important considerations in the analysis of an organisation such as the Autohose Group.

1.1.2 Operations Research

Some authors (1) state that the current status of Operations Research is the application of a Systems Approach on a micro level and is more concerned with the use of indepth mathematical and simulation techniques for solving problems. However Beer (3) and Cook (15) both stress the wider considerations needed. There is perhaps a distinction to be made here between Operations Research Methodology and Operations Research Techniques. Operations Research Methodology is the analytical framework for understanding the context of more detailed problems which may be solved using the Operations Research Techniques.

Operations Research Techniques fall into three main categories:

* Optimisation.
* Simulation, and
* Forecasting.

Of these it is the Forecasting Techniques that have been utilised in this Action Research (Chapter Five and Six).

1.1.3 Systems Analysis

Systems Analysis may be defined as, "The organised step by step study of the detailed procedures for the collection, manipulation and evaluation of data about an organisation for the purposes not only of determining what must be done, but also of ascertaining the best way to improve the functioning of the system" (1).

Daniels and Yeates (16) organise these steps into the following stages. Firstly, to obtain an overall impression of the environment around and activities within the company, taking into account the human aspects. Secondly, to conduct a Systems Investigation including fact finding (what systems already operate) and analysis (recording facts in a suitable manner). Thirdly, to conduct a Management Audit (if required) to show the efficiency of the existing systems. Fourthly, the objectives of management, they state, should be obtained before designing a new system, testing and implementing it.

The impression given by these authors and others (17, 18) is that of sets of rules, procedures and checklists for analysing and designing systems with the emphasis on computerisation.

1.1.4 Industrial Dynamics and Management Cybernetics

Forrester (19) initiated his study of Industrial Dynamics with the investigation of an inventory problem. This soon developed into problems of far greater complexity and wider implications. Using a Systems Approach he was able to identify the most important causes of oscillations recorded in the levels of performance of various activities. This enabled him to reduce the oscillations by altering factors that were far removed from the initial problem.

The method of attack on the problems in this instance was from the bottom upward, starting with the recording of continuous flows progressing to flow rates and decision functions.

Management Cybernetics has developed from both G.S.T. and Cybernetics in that it is the study of organisational viability (20) (a combination of communication and control, and growth and evolution).

The mutual importance of communication and control was emphasised by Wiener (5) in that if you can communicate you can control. Other authors outside the cybernetic field have also stressed this point (13).

Schoderbek et al (1) emphasise the two principles of Management Cybernetics:

* Enterprises are conceived as purposeful control systems that feed on the transmission of information, and

* Control is that function of the system via which a critical variable of systems behaviour is held at a desireable level by a self regulating (homeostatic) mechanism.

Implicit in the cybernetic meaning of control is the matching of complexity. The complexity of the situation may be measured by its variety (the number of possible states determined by the number of elements, their attributes, interactions between them, and their degree of organisation). Thus it is the variety that must be matched for an organisation to be effective (21). There are, however ways of engineering this variey using filters and amplifiers so that management may reduce incoming variety and in turn amplify its variety. Galbraith (11) although basing his assumptions on a different framework has shown examples of these as: Creation of self-contained tasks and slack resources (low productivity) which act as filters of variety, and Vertical Information Systems and Lateral Relations which act as amplifiers of variety.

All these characteristics of Management Cybernetics and many others have been incorporated into a model developed by Beer (22). It is built along the lines of General Systems Theory on the control processes in a viable organism - the human nervous system.

Beer has identified five functions of control between which control capacity is depicted as their links (Diagram 1.1).

These control levels are based on the objectives of a system. In brief they are:

* The Intelligence function - which identifies opportunities, alternatives, and strategies. It acts as a filter of variety in providing information for decisions by the next function.

* Policy - which takes the decisions.

* Operations Control - which is responsible for allocating resources and monitoring the Implementation function (below).

* Co-ordination - which acts to stabilise and induce synergy between all the functions.

* Implementation - the functions which actually take the action (22, 26, 27).

These five functional levels themselves constitute a recursive or management level which forms a part in a hierarchy of systems. Thus the same paradigm or model may be used in the analysis of the nesting of systems within systems when investigating the structure of an organisation.

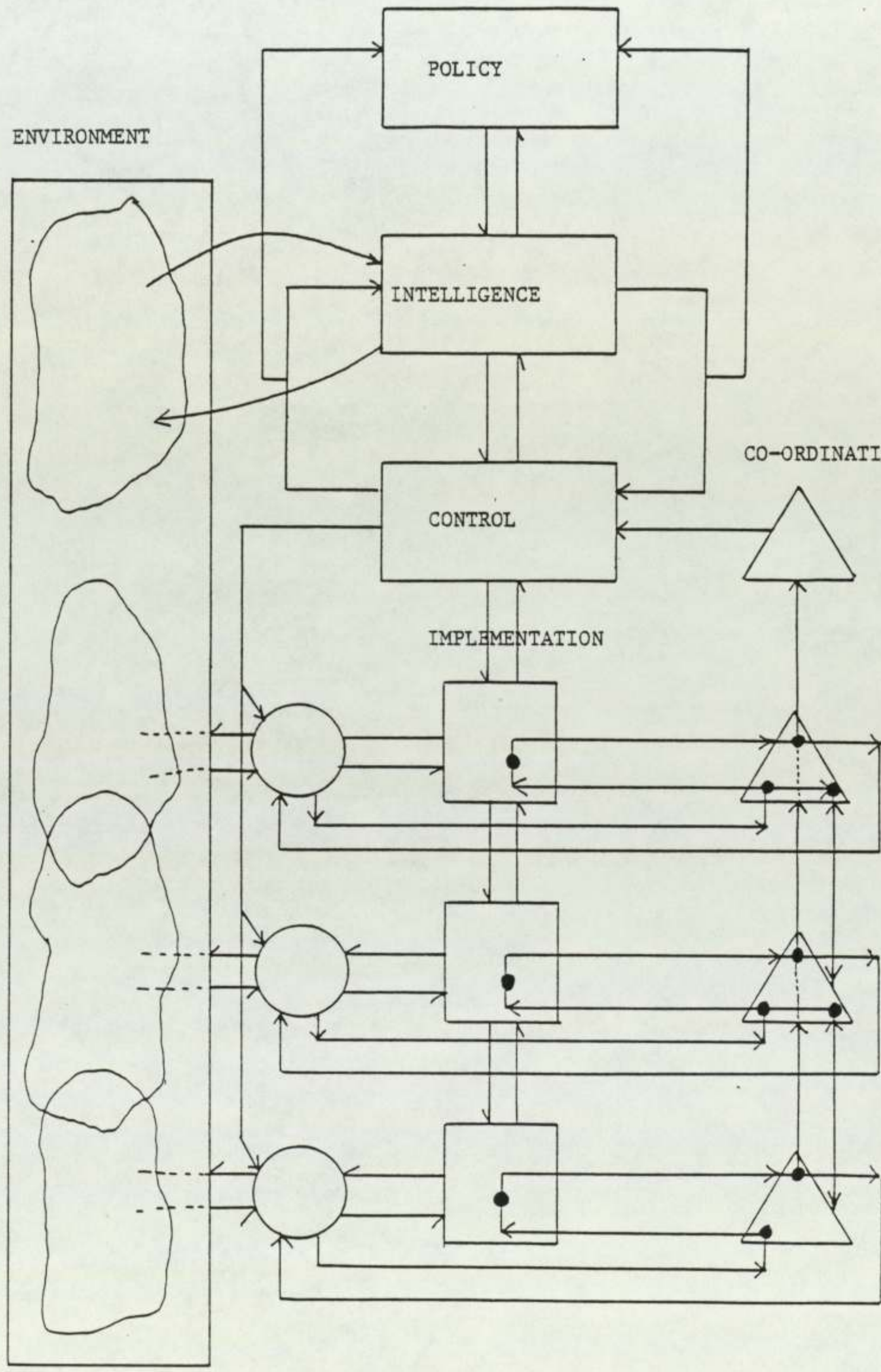
The theory behind the Model is that it represents a viable structure. That is any viable organisation must have such a structure if it is to remain viable. Because of this the Model may be used to analyse organisational structure and behaviour without the investigators having to have intimate knowledge of the organisation.

Essential components of the Cybernetics Model are the control and communication channels of the requisite capacity and variety to meet the objectives of the functions described. These, Beer suggests, may be developed from measures of achievement. Historically the cost-accounting function using money as the common language has had this role. Beer suggests and elaborates on a more comprehensive measure, the use of pure numbers in the form of indices (23). These may then, using statistically defined limits and modelling techniques (20, 24) be matched to the requirements of management.

The application of the theories discussed in this chapter to the problems identified in the Autohose Group now form the basis for this Action Research as elaborated in the subsequent Chapters Two to Six.

Control Paths in Beer's Cybernetic Model

DIAGRAM 1.1



CHAPTER TWO

DEFINITION OF THE OBJECTIVES

2.0 Introduction

This Action Research started with a title, "Improvement of the Efficiency and Profitability of Coolant Hose", and a series of terms of reference (Appendix A1).

By a process of analysis at the factory and discussion with the clients (the AHG Managers) the true meaning of the clients requirements were progressively formulated.

This chapter describes the process by which more specific objectives and the methods of achieving them, were arrived at.

The chapter is divided into two main parts, a summary for the reader with a limited amount of time, and a more detailed discussion for the reader who is interested in the path followed in Defining the Objectives.

2.1 Summary

Five functional areas of concern were derived from the initial terms of reference:

* Customer Order Receipt and Processing.
* Conversion of Orders into Production Schedules.
* Transferring of Finished Goods for Storage.
* Stock levels and despatch to the customer.
* The Viability of Producing Small Quantity Orders.

Analysis of the factory situation linked these to four areas of constraint within the then existing information system:

* A slow and inflexible method of accepting and processing orders through to the planning of production.

* A cumbersome and time consuming method of allocating resources for Coolant Hose production.

* A lack of any form of stock control.

* No information on work in progress, and associated with these inaccurate information on lead times, costing and factory capacity.

As a result of these findings the title of the research was amended to, "The Provision of an Effective Management

Information System (M.I.S.)".

With this objective in mind suitable tools to provide such a system had to be found. Two alternative methods of analysis were available:

* To base the MIS on one in existence in the Metalastik Group.

* To develop an MIS using the Systems Approach incorporating the use of a Cybernetic Model of an effective organisation (as described briefly in Chapter One).

Of these options the latter was chosen because of the advantages it offered in terms of a model for comparison and a framework for analysis, and because of the need to provide a fresh look at problems within the Autohose Group rather than implementing an already designed system.

The use of this approach led to the formulation of five stages for the development of the M.I.S.

* The analysis and modelling of the AHG (Coolant Hose).

* Identification of the problem areas within the control aspects of the organisation.

* Development of suitable alternative strategies to overcome the problem areas.

* Detailed design of the mechanisms required.

* Presentation and Implementation of the mechansims developed.

A change in the management of the A.H.G. led to the last three of these stages being amended to:

* Design and produce indices of productivity.

* Design and provide mechanisms by which the indices could be converted to relevant exceptions information.

* Present and implement the findings.

These then formed the basis for the provision of a Production Control and Information System based on the use of indices of productivity.

2.2 Defining the Objectives

Within the broad objective of, "Improving profitability and Combating Inefficiency of Coolant Hose Production" a series of "Terms of Reference" outlining the symptoms of the problem areas were drawn up by a "management team" consisting of the AHG Manager, the Production Manager, and the Planning Manager.

The terms of reference provided the starting point for research, both in terms of defining the departments within the factory to be examined and pointing towards the types of solutions required by the management team.

Initial terms of reference (Appendix A1) highlighted five functional areas of concern.

* Customer order receipt and processing.
* Conversion of orders into production schedules.
* Transferring of finished goods for storage.
* Stock levels and despatch to the customer.
* The viability of producing small quantity orders.

These areas encompassed the Planning, Production, Warehousing and Financial Departments, each one with a separate management hierarchy and sub-objective.

Examination of these departments provided an understanding of the methods that each used, and helped to elaborate on the terms of reference.

It soon became apparent that the concern over inefficiency was linked to the predicted market for coolant hose being far greater than the then current factory output, and it was thought that much more profit could be reaped if production levels could be increased.

What management really lacked was information on where bottle-necks (areas of constraint) were from the start to the finish of coolant hose production. Linked to this was the lack of an accurate measure of the maximum production level possible and whether the order processing and warehouse functions could cope with such a level of production.

An almost entire lack of costing on the shop-floor was also highlighted by the Production Manager's concern over the profitability of small orders.

The symptoms given by the terms of reference pointed, in effect, to four areas of constraint in the existing information system:

* A slow and inflexible method of accepting and processing orders to the planning stage (The Kardex System - Appendix B).

* A cumbersome and time consuming method of allocating resources (raw materials and time) for Coolant Hose production.

* A lack of any reliable stock control system.

* No information on work-in-progress,

and associated with these, inaccurate information on lead-times, costing and factory capacity.

Discussion of the above findings with the management team led to the amendment of the initial terms of reference to the, "Provision of an Effective Management Information System (M.I.S.) for the Coolant Hose aspect of the Autohose Group" (Appendix A2).

The main aim of the M.I.S. would be to identify areas of likely problems before they occurred so as to enable managers to undertake suitable, preventive action.

Further analysis and interviews with personnel ranging from operatives to the managers themselves reinforced the nature of the overall problem of very bad and often complete lack of information transfer between departments which was widely blamed for major disruptions in, "the system". Other "scape-goats" frequently emerged as well, ranging from the effect of the Government Wages and Incomes policy to the, "poor standard of local labour".

2.3 Formulation of the Tools for Analysis

So far in this chapter the way in which the requirements of the management team have crystalised, have been discussed, from the basic symptoms of the problems to the specification for the provision of a Management Information System. Now the most appropriate methods of determining more precise details of the information requirements are considered.

There are two main options available at this stage of the Action Research:

* To base the M.I.S. on one already developed for the Metalastik Group (the other group within Dunlop P.E.D.), and

* To develop a system tailored to the provision of a useful form of information not necessarily realised by the management team at this stage, but which could be developed with management to meet their requirements. This would be based on the Systems Approach incorporating the Cybernetic Model.

2.3.1 The "Metalastik" Approach

Of the above options the first had the apparent advantage of having the computer systems already developed and in use by Metalastik, but this could also be interpreted as being a major disadvantage since any shortfalls in the Metalastik system would have been incorporated into the A.H.G. This option would also have been under the constraints of Management Services (the divisional computer centre) and therefore in contradiction with one of the original aims of the research, which was, "To provide a fresh look at the problems in the factory". In addition the A.H.G. Manager (Mr. Booth) was emphatic that an overall approach should be taken in relation to problems within the group, and not restricted to the improving of Order Processing only. The reason behind Mr. Booth's attitude was that he was concerned with improving the efficiency of the whole of Coolant Hose production and planning. He had stated that improving only one section would, in the long term, produce even more problems in terms of imbalances and additional costs (Appendix A2).

A certain amount of internal politics was also involved in the manager's decision not to use the Metalastik "system" because it was thought that it would both impose on the running of the Autohose Group and remove effective control from within the Group.

For these reasons it was decided that the provision of a Management Information System (M.I.S.) along the lines of that introduced into Metalastik should not be the concern of this Action Research.

The similarity between the Metalastik and Autohose Groups did however provide the opportunity to examine, and therefore avoid, some of the anomalies in the Metalastik M.I.S. The Metalastik system was therefore examined where relevant and is discussed in context in the next chapter.

2.3.2 The Systems Approach with the Cybernetic Model

Systems Analysis has evolved into the method of studying the detailed procedures for the collection and manipulation of data in order to determine what must be done and the best way to improve the functioning of a system (Chapter One). This would first of all entail the formation of an overall impression of the environment and the activities within the company. The next stage would be to find out how systems already operated and to record the facts in a suitable manner. Finally the objectives of the management would be incorporated into the design of a new system.

While these above stages form one method of attack on solving problems there were several factors which limited the usefulness of such an approach in relation to this Action Research. One of these factors was that no existing, effective organisation was available for direct comparison. For example, although the design of the Metalastik Order Processing and Stock Systems was based on, "...effective business procedures", they were not explicitly defined (30). In addition the method described above provided no set methodology or framework for analysis. Such a framework was provided by an Organisational Model developed by Beer (3) and then Davis et al (27) based on many years' experience in

Business Analysis.

The Organisational Model would provide the basis for assessing the effectiveness of an organisation as well as the framework for the provision of mechanisms to improve information and its supply to management. It would also enable the provision of management information in real time and on an exceptions basis, which was described in the Systems Development plan for the Metalastik Group (1971) (31) as being desireable when, "...the systems disciplines had considerably improved". This Organisational Model is described in greater detail in Chapter Four.

2.4 The Objectives and Strategies

In summary then, the Action Research had the aim of providing new ideas for an effective Management Information System as the method of alleviating problems within the Autohose Group.

The best option available to meet management objectives was the one based on the Systems Approach incorporating a suitable model for comparison and analysis (the Cybernetic Model).

Further discussions with the management-team led to the agreement of five stages for the development of the Management Information System:

* The analysis and modelling of the A.H.G. (Coolant Hose).

* Identification of problem areas within the control aspects of the organisation.

* Development of suitable alternative strategies to overcome the problem areas.

* Detailed design of the mechanisms required.

* Presentation and implementation of the mechanisms developed.

A subsequent change in the A.H.G. management (Mr. Bryans became A.H.G. Manager) brought about some changes in requirements. Mr. Bryans had previously been Works Manager for Metalastik and was used to the faster Order Processing System and the "Order Book" facilities provided by the Metalastik Order Processing System. He therefore considered the provision of a similar system in the A.H.G. as a matter of high priority and engaged the Management Services department to introduce such a system as soon as they could.

As a result the requirements for the Management Information System were altered to the provision of Information for Production Control purposes to be compatable with the Order Processing System to be introduced.

By this stage of the research the first of the five development stages had been partially completed and the main problem areas within Production Control had been broadly defined as:

* Absence of communications channels for planning purposes (as opposed to resource allocation).

* Low integrity of basic data.

* Lack of suitably summarised information on an exceptions basis (that is, information only when something or an event was unusual).

Discussion of these problem areas with the management team resulted in the decision to base the Production Control Information System on indices of productivity ranging from production levels to costs (these are further described in Chapters Five and Six).

The latter stages for the development of the M.I.S. were therefore amended to:

* Design and produce indices of productivity.

* Design and provide mechansims by which the indices could be converted to relevant information on an exceptions basis.

* Present and implement the findings.

2.5 Synopsis

In this chapter the real objectives of the clients (the management of A.H.G.) were established to provide the overall aim for this Action Research, and then the most suitable tools for achieving this aim were chosen.

In the next chapter familiarisation with the existing system, its problems and how they relate to the Metalastik system, are discussed in greater detail.

CHAPTER THREE

THE ORGANISATIONAL ENVIRONMENT

3.0 Introduction

The initial analysis conducted during the formulation of the client's objectives (discussed in the previous chapter) provided pointers to start more detailed examination of, and familiarisation with, the Auto-Hose Group. In this chapter the existing situation in the A.H.G. factory is discussed together with the problems found and how they relate to those already discovered within the Metalastik Group. Where the solutions applied to Metalastik problems proved inadequate they are also discussed.

3.1 Summary

The analysis discussed in this chapter provided both familiarisation with the factory and its environment, and pointers towards areas requiring more detailed analysis.

The problems identified during this stage are summarised below:

Order Receipt and Acceptance

* Lack of information relating to capacity for new orders.

* Little information on costs as the basis for fixing prices.

Order Planning

* Laborious and time consuming methods for recording customer requirements and allocating stock.

* Unreliable methods for order vetting.

* Unnecessary delays in communicating orders and changes to orders to programmers.

* No clear priority definition for stock allocation.

* Poor response to customer enquiries.

Order Programming

* Inaccurate information from production areas.

* Lack of advance information on the availability of raw materials.

* Late feedback of information of actual production levels of hoses.

* Confirmation of rubber compound provided was too late.

* No formal priority definition for orders.

Production Processes

* Lack of information on product scrap.

* Waste scrap poorly measured and not related to the production processes.

* Lack of cost consciousness by operatives and foremen.

* An inconsistent policy of autonomy for departments leading to problems of communication and transfer of products.

* The most important part of production was seen as the curing process and everything else was arranged around this process. This produced short term benefits but created planning problems in the longer term.

* Multiple part numbers produced problems of identification (for sorting and trimming).

* Lack of routing information on dockets.

* Transcription errors on dockets.

* Poor method of labelling bins and lack of priority definition between production processes.

* Little information on in-process stock.

Warehouse

* Duplicate filing systems and inconsistencies between these two systems.

* Lack of warehouse space.

* Poor stock control system.

* Dual stocking system: one stock system for spares and one for original equipment.

3.2 A Model of Coolant Hose (Fidelity)

The analysis provided here has produced a subjective interpretation or, in effect, a model of the true situation which could not be easily understood by any one person because of its size and complexity.

The value of such a model in this Action Research was fourfold. It provided:

* Familiarisation with the day to day running of the factory and its operating environment.

* Better definition of the boundaries for the Research.

* Pointers towards the existing problem areas requiring further, more detailed analysis to ascertain their causes.

* A platform for comparison with an effective organisational model at a later date (see Chapter Four).

The process of receiving orders through to production of finished hoses and their eventual despatch encompassed many departments and functional areas. These are summarised in Diagram 3.1 with the areas of major relevance to this Action Research contained inside the broken-lined box.

Analysis of these functions was conducted, for the sake of convenience, on a department by department basis.

The first department to be examined was the Planning Office which, despite its title, was actually concerned with all of the processing of customer orders. This processing was divided up into the following functional areas:

* Order Receipt and Acceptance.
* Order Planning and Stock Allocation.
* Order Programming.
* Invoicing and Sales Accounting.

They are discussed in further detail below, and the anomalies highlighted.

3.2.1 Order Receipt and Acceptance

Order receipt and acceptance covered not only the receipt of orders but also the initial order enquiries from a customer.

The Sales section of the Planning Office would ascertain whether a design requested by a customer was possible to produce, according to a set of specified technical criteria (Appendix C).

Once the order had been accepted on its technical merits it was classed as being one of either a Temporary, Fixed or Open Order. These classifications broadly specified the quantity and frequency of hose production required:

* Fixed Orders - Limited production quantity.

* Open Orders - No finite quantity specified.

* Temporary Orders - Low quantity of hoses ordered on a "once-off" or infrequent basis.

The method used for predicting whether the now technically acceptable hose could be produced in sufficient quantities was an informal liaison between the Sales Enquiry and Order Programming functions. It was generally of the form, "...these are the number of hoses that have been requested ...do you think you can fit them into the production schedule?" There was very little information available on spare production capacity other than this liaison. Such an arrangement worked very well in the case of small orders or when the Programmer was not too busy, but provided severe problems at other times due to the lack of other, formal information for use in planning in advance.

Communications between the separate functional areas (see Diagram 3.1) became more formal once production levels had been agreed with both the Programmers and the customer.

A works Order Form (W.O.F. Appendix D) provided the basis for formal communications, with the noteable exception of small quantity orders which were not thought to justify the supposedly disproportionately high cost of the form.

At this stage in the proceedings the hose was assigned both a customer and internal (P.E.D.) identification number. The P.E.D. number being used mainly for accounting purposes and only for part identification if the hose was for the spare parts market rather than the original equipment market. Such duplicate (and often triplicate when two customers required the same hose) identification was a continual source of problems during order programming and hose manufacturing (these problems are discussed further, later on in this chapter).

3.2.2 Order Planning

Parts of the Works Order form described above provided a permanent record of data relating to production requirements and due dates, and formed the basis for the whole Order Planning procedure (the Kardex Filing System, Appendix B).

Order Planning consisted of laborious and time consuming manual searches through the Kardex records because the order status had to be established initially by cross-checking the despatches to date with the requirements specified by the customer order. Once this had been done, customer requirements that had not been fulfilled could be entered on the file card. The detection of any anomalies in the orders (particularly those orders that were too large) depended greatly on how alert the filing clerk happened to be at the time.

After entering all the customer orders into the Kardex file the clerk then had to make another search to ascertain customer requirements for the next three months ahead. This data was collated and then sent to the Order Programmers as a schedule. Frequent amendments to these schedules were communicated in a similar fashion (Appendix E).

Another function performed by the filing clerks was that of stock allocation. Once a quantity of hose had been produced and reached the warehouse, part of the identification label (present with each bin of hoses) was sent back to the filing clerks via a sorting clerk. Each of the labels specified the number of hoses of that particular type that had reached the warehouse, and from them a match was made between the number of hoses in stock and the customer's requirements. The despatch procedure was then initiated (Appendix F).

An important feedback of information for the Order Programmers was also performed by the analysis of the warehouse labels returned to the planning function. Data was collated on the quantities of each hose type in stock (and therefore a tangible production figure) and marked off against the quantity of each hose programmed, thus providing a measure of both goods in process (of production) and product scrap levels. This information was however, invariably far too late for effective action to be taken.

The laborious transcription of data conducted by the filing clerks frequently led to mistakes and delays in the passing of information to Order Programmers and in the despatch of goods to customers. Job satisfaction was also generally very low for filing clerks and led to the employment of low calibre personnel with concomitant effects on the efficiency of the functions described.

This combined with a lack of defined priorities for production and stock allocation led to a relatively poor level of customer satisfaction being achieved. Some measure of this dissatisfaction was available from customer complaints, although no clear indication of the number of orders met on time existed.

3.2.3 Sales Accounting and Invoicing

This function was concerned with determining the price for a particular hose. The price was calculated from available information on the cost of production, past prices and generally what the Sales Manager thought he could charge for the product. It was realised, however that this was not a particularly satisfactory practice. For example the cost information was known to be inaccurate, as stressed by the managers' concern with the profitability of small quantity orders. Such small orders were given relatively high prices and it was thought that with such prices the A.H.G. must have made a profit on them, however there was no information available to substantiate this supposition.

3.2.4 Order Programming

The schedules provided by the Order Planning function enabled weekly programmes to be drawn up specifying where, when, and how many hoses were required for each curing pan (the curing pans fixed the hose shape by curing at high temperature and pressure). Daily requirements duplicated from the weekly programmes then provided the basic instructions to manufacture for the shop floor operatives, and the programmes themselves provided the details for both materials and tooling requirements.

The main problems identified here were:

* Inaccurate information on the available capacity of each production area (due to staff shortages or machine failure).

* Lack of information on the availability of raw materials (whether rubber compound had been prepared or not).

* Erroneous or late information on the number and type of hoses actually produced (due to transcription errors on part numbers, multi-numbered parts and delays in collating the data).

* Late ordering of rubber compounds and unusable rubber compound.

The problems with the A.H.G. Order Processing system highlighted so far were not unique in the factory. According to a previous study on "Systems Requirements" within the Division as a whole similar problems were found in the Metalastik Order Processing system in 1968 (30). This same study, however had dismissed any problems within the then equivalent of the A.H.G. saying that the, "...simplicity of planning" didn't warrant intervention.

In 1971 when action was taken on the preliminary study of the Metalastik Group, among the more detailed problems with the Order Processing System were:

* Impossible delivery date requests.
* Non-economic batch quantities.
* Poor record maintenance.
* Poor liaison between functions and bad information links.

These were attributed to:

* Multiple recording.
* Transcription errors.
* Excessive information processing times.
* Lack of information feedback on production.
* Multiple reference points for information retrieval.

The similarities between the problems in Metalastik in 1971 and those in A.H.G. in 1978 were great indeed. It was not suprising therefore that a manager previously conversant with a "computerised" system such as that introduced into Metalastik to combat the above problems, would expect a similar facility in the A.H.G., irrespective of its shortfalls. Discussions with the Metalastik Order Processing Manager brought to light some of these shortfalls.

One major bone of contention was that although the computer system gave great detail on parts and their progress through the factory the information was not always reliable. Furthermore the computer printouts provided only basic data for management use rather than information in a form from which management decisions could be made (Appendix A4).

3.2.5 Production Processes

At this stage of the analysis the distinction between Coolant Hose and Brake Hose became important. Coolant Hose accounted for approximately 60% of A.H.G. turnover in 1977 and Brake Hose approximately 30% (compounds supply accounting for the remaining 10% of turnover). The larger turnover of Coolant Hose together with the relatively better control of Brake Hose production emphasised the concern of the management-team to concentrate on the Coolant Hose side of production.

Further distinctions were made within coolant hose manufacture between "Fidelity" and "Built" hoses:

"Fidelity" or knitted hoses (so named because the knitting process was conducted on Fidelity knitting machines) accounted for 87% of Coolant Hose volume and 78% of its turnover. In other words, approximately 47% of the total turnover for A.H.G. in 1977 was accounted for by the production of Fidelity type hoses. The Quantitative Flowchart in Diagram 3.6 illustrates the approximate relative proportions of each process in Coolant Hose, and their approximate productivities (the shaded part of each box). In recognition of the large turnover value of Fidelity hoses, it was decided to focus on the provision of effective control procedures for Fidelity hoses but at the same time to take into account the peculiarities of other types of hose manufacture.

A breakdown of the types of hose produced by A.H.G. is given in Diagrams 3.3 and 3.4.

The manufacturing processes leading to the production of a finished hose were split into three broad areas (Diagram 3.2).

* Rawhose - basic hose construction.

* Transformation - cutting and moulding of the rawhose into a large variety of individual hose types (Diagram 3.5).

* Finishing - trimming, checking and stamping hoses.

Rawhose Production

This category contains all production processes from the initial extrusion of the rubber (or compound) hose up to, but not including, the cutting to length prior to moulding.

In this area there was considerable difference between the manufacture of Fidelity and Built hoses, the latter in general, being far more labour intensive. As a result the Built Hoses required more detailed specification for manufacture and more skilled operatives.

Rawhose production for Fidelity hose comprised three sequential processes:

* Lining Extrusion.
* Knitting.
* Covering Extrusion.

Lining extrusion was the formation of a hollow rubber tube of specified diameter, annulus and compound type (the length was determined by the size of the drum that the tube was extruded onto). Accuracy of extrusion during this process was very important because most rubber could be reclaimed before, but not after the next (knitting) process.

The knitting process had to wait for a minimum of eight hours after lining extrusion to allow time for the rubber compound to harden. After this period an "air mandril" was formed (by sealing both ends of the tube and inflating it until the rubber was taught) to provide shape to the hose. The knitted "sock" was one of several yarn types and was applied to the hose on different machines according to the bore size of the hose.

The final part of rawhose production was the covering extrusion in which a layer of rubber compound (which could be the same or different from the lining) was extruded over the knitted lining in such a way as to maximise the bonding between the rubber and that of the covering.

This analysis of rawhose manufacture highlighted several problem areas. The first of these was the artificial lowering of product scrap (the rawhose scrap) by programmers utilising undersize, oversize or poor quality products for other types of hose production. This served to reduce product scrap levels very effectively but provided little information for management on the true efficiency of the processes.

Secondly, the waste scrap levels (from trimmings) were not accurately measured in relation to the process producing it and so there was little feedback to operatives on their own scrap levels.

Thirdly, the factory layout meant a great deal of transportation between processes and the lack of storage space allowed an in-process stock level sufficient only for one day's production.

Fourthly, there was no cost consciousness by the operatives, and little incentive to produce high quality products since their wages were related to Standard Minutes of production and not quality.

Another problem with the method of production, related to the destinations of the rawhoses. Within the A.H.G. two so called "autonomous" departments had been set up to produce fidelity hoses, but in practice neither one produced the rawhose to supply itself only (the A4 and B6 departments). The effect of this was to further add to the problems of communications both in the data concerning the hose numbers and in the supply of hoses.

Transformation

Transformation constituted the cutting-to-length of the rawhose and its subsequent curing (shaping in a steam oven). Once a rawhose had been cut to length the type of hose that could eventually be produced became very limited, the final hose type being dictated by the shaping process.

Cutting to length for coolant hose was mainly conducted with the use of automatic guillotines set to the required hose length and fitted with the correct size guide for the particular hose diameter. Additionally some cutting-to-length was done manually, in particular by the B6-Coolant

Hose department and by the A4 (Fidelity) department for the supply of lengths to the Built Hose section.

Again the aim of having two autonomous departments for coolant hose production was contradictory since many automatically cut lengths were sent from one department (B6) to the other (A4). Problems of communication and supply surfaced again in this area.

Cut-lengths of hoses were formed into the final hose product by pushing the lengths onto forming mandrils, arranged in racks for curing, in several pressurised steam ovens. It was this curing process which was seen as the limiting factor in hose production and around which all other processes were arranged irrespective of the communications and supply difficulties that such a policy imposed.

Finishing

The finishing function comprised of various different processes depending on the particular finish required. Included in this category were:

* Washing / Sorting / Counting.
* Trimming.
* Spouting.
* Checking and Re-counting (Diagrams 3.2 and 3.6).

Washing, Sorting and Counting

It was after the washing process that the management-team was most concerned about "bottle-necks" because of the large, unsorted pile of hoses that usually collected on the floor. Hoses from not only the A4 department (where the washing machines were located) but from all other departments (except B6) were washed in three separate machines. The results at the end of the washing process were barely sorted piles of hoses and several big problems. One of these problems was the sorting process which relied on sorters to physically identify each hose and collect them in separate bins. With some hoses having several part numbers, recognising which was for which customer became very difficult even when checking off the hoses against the production programmes (several days' production of hoses would often build up on the floor adding further to this problem).

After a bin of hoses were sorted they were labelled with a multi-part docket (Appendix G).

On each docket the sorter had to fill out three separate sections, each with the customer name, part number and the quantity in each bin. This proved to be a very time consuming and error prone task. The importance of transcription errors at this stage can be seen in context if it is realised that the docket was used to identify hoses which required additional finishing processes, for storage, and for acknowledgement of storage.

The lack of any routing information on the docket did little to help routing of hoses for further processing.

Trimming

After the washing process the majority of hoses produced in the Coolant Hose section had to be trimmed to length by hand (because of their awkward shapes) although some could be machine (lathe) trimmed. Each hose type required a specific trimming jig into which it was fitted before trimming. Several problems were apparent with this process.

The first was that bins of sorted hoses were usually piled one on top of the other. This meant that the bins on the top of the piles were usually the last ones to have been sorted, and because the identifying dockets were inside the bins progress chasing was made extremely difficult.

Secondly, the operatives were paid according to their standard minutes of performance. As a result the more generously timed (in terms of standard minutes) hoses were naturally selected irrespective of any customer demand.

Thirdly, trimming jigs and hose part numbers frequently didn't match because of different part numbers in use at the same time.

Once the hoses had been trimmed they were returned to their bins and transported (on an overhead conveyor system) to the Stamping, Inspection and Counting areas or alternatively were routed to the spouting area prior to inspection.

Stamping, Inspection and Counting

On reaching the Inspection area hoses known to require stamping were removed from the conveyor and passed to the stamping section where they were manually stamped according to customer specification.

All the hoses were then inspected for quality and tolerances (again as specified by the customer) before counting and eventual transfer to the warehouse via a vertical conveyor.

Spouting

If a particular hose type required spouting (the attachment of a side-spout) it was first drilled, buffed and a spout moulded on prior to the stamping, inspection and counting procedures.

A major problem with the above processes was a lack of any form of routing information on the identification docket. This meant that operatives had to have intimate knowledge of each hose type if the hoses were not to be sent to the wrong area.

The process of stamping the hoses also caused problems of inflexibility of stock because once stamped the hoses concerned could be sold to one customer only, even if there were several markets for that hose type.

Some problems similar to those found in the A.H.G. production processes, above, had previously been identified in the Metalastik Group, particularly the need for a new docket system and the poor process control. The major concern, however, had been due to the more complex manufacturing processes in Metalastik which required better stock control for metal parts used in the production processes.

The systems introduced to alleviate the problems of stock control and process control in Metalastik were, according to staff interviewed, satisfactory but not entirely reliable. For example little accurate information was available on in-process stock until the products reached one of several sections within the factory, and there were invariably delays prior to the products reaching these sections.

Factory loading information was also cited as being inaccurate and Standard Minute Values biased towards a wages rather than a production (or process) control system.

3.2.6 Warehousing

When a bin of hoses was received by the Warehouse the multi-part docket was split into three parts. One remained with the bin, another was used in the Warehouse files to identify the bin the Planning Office as confirmation of production and receipt by the warehouse.

Once an order despatch document had been generated by the Order-Planning filing clerks, hoses corresponding to the order were located using the warehouse file. Location slips were then used to select the required hoses prior to packaging and despatch.

One copy of the despatch form confirmed despatch, another formed the basis for invoicing the customer, one went with the goods, another by post to the customer, and the fifth to P.E.D. Group Enquiries (Diagram 3.7). Problems noted in the Warehouse were:

Firstly a severe lack of space exacerbated by a large proprotion of stationary stock (items that had been in stock for longer than four weeks). Hoses were also divided into two types of stock, those for supply as original equipment and those for supply as spare parts (the so called "John Bull" hoses). The dual stocking system brought to light a policy of increasing production of John Bull hoses when demand for original equipment hoses was low, even though there was no formal structure or form or trend analysis to assist with any management decisions in this area.

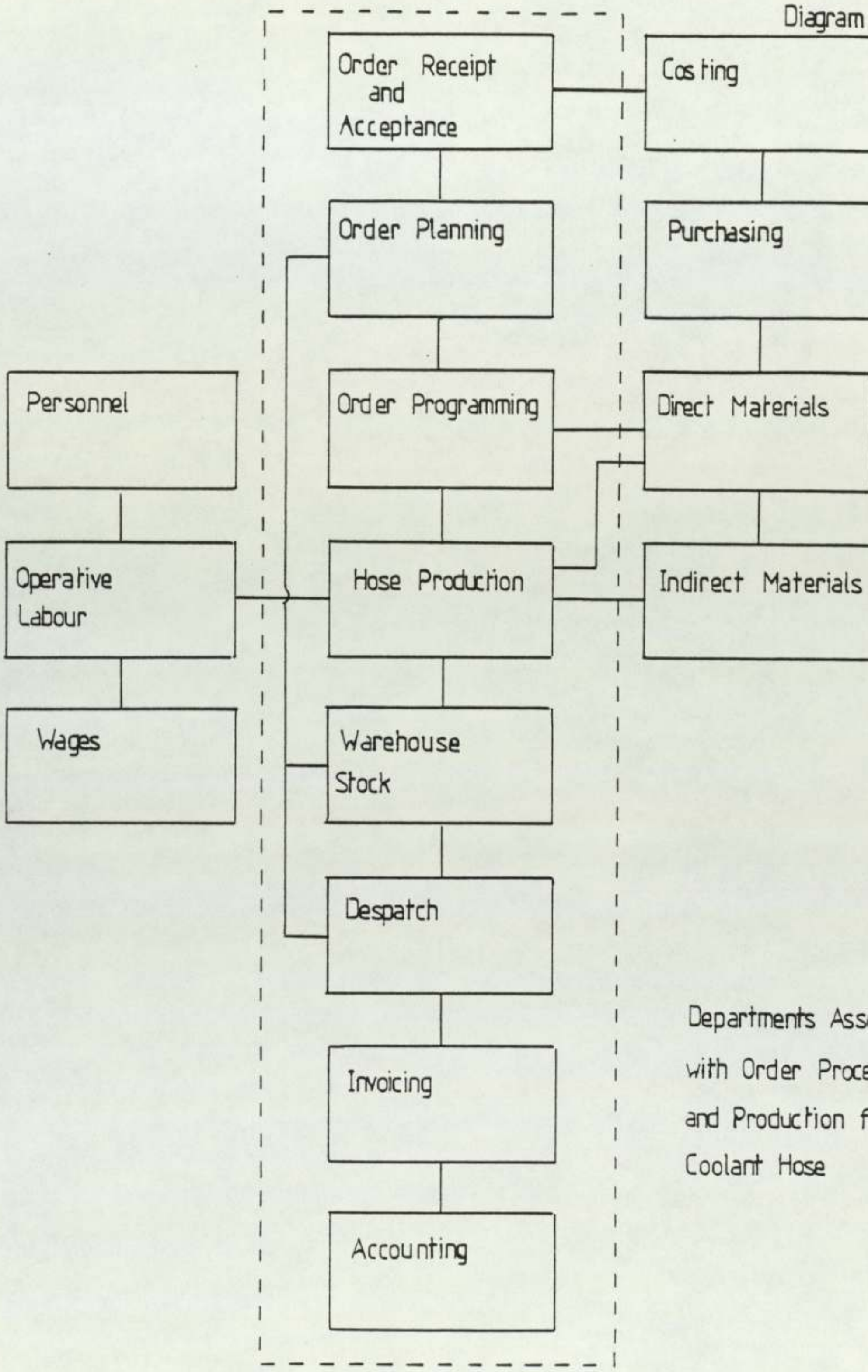
The duplication of stock records was another source of errors since they were often contradictory. A problem probably brought about by the illegible dockets due to transcription errors.

3.3 Synopsis

The problems discussed in this chapter contributed to an overall inefficiency in coolant hose production, which can best be described as the consistent failure to satisfy the customers in terms of the quantity of hoses produced and meeting delivery dates. This unsatisfactory service to customers was further exacerbated by the poor response to customer enquiries mainly due to the tremendous difficulty that was encountered by anyone trying to trace any particular batch of hoses through the factory.

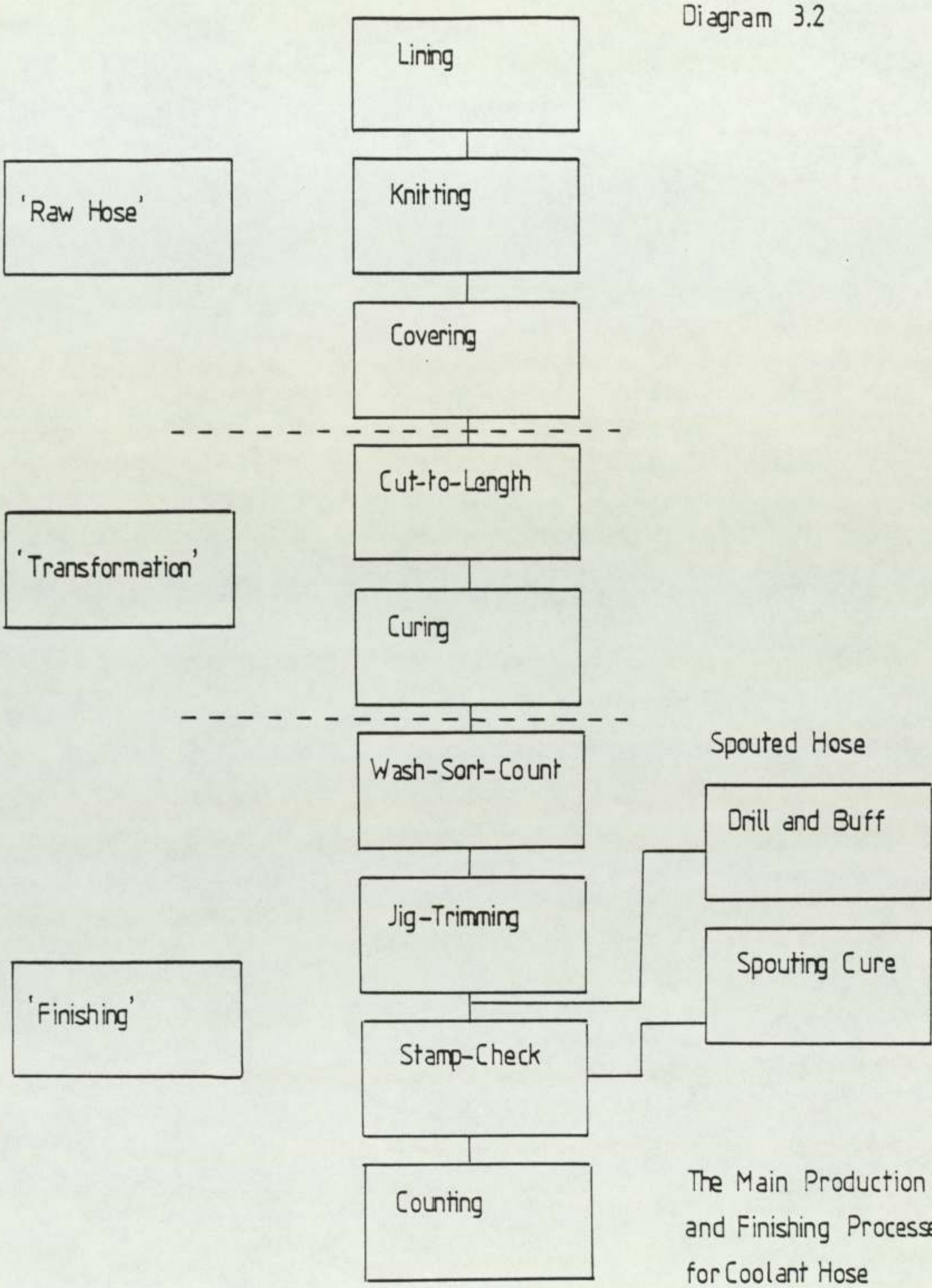
While this analysis has not been comprehensive in locating every problem in the A.H.G. it has provided a means of identifying the major problems. These problems are further analysed in terms of an effective Organisational Model in the next chapter. The methods by which these problems may be alleviated are then formulated in terms of this Organisational Model.

Diagram 3.1



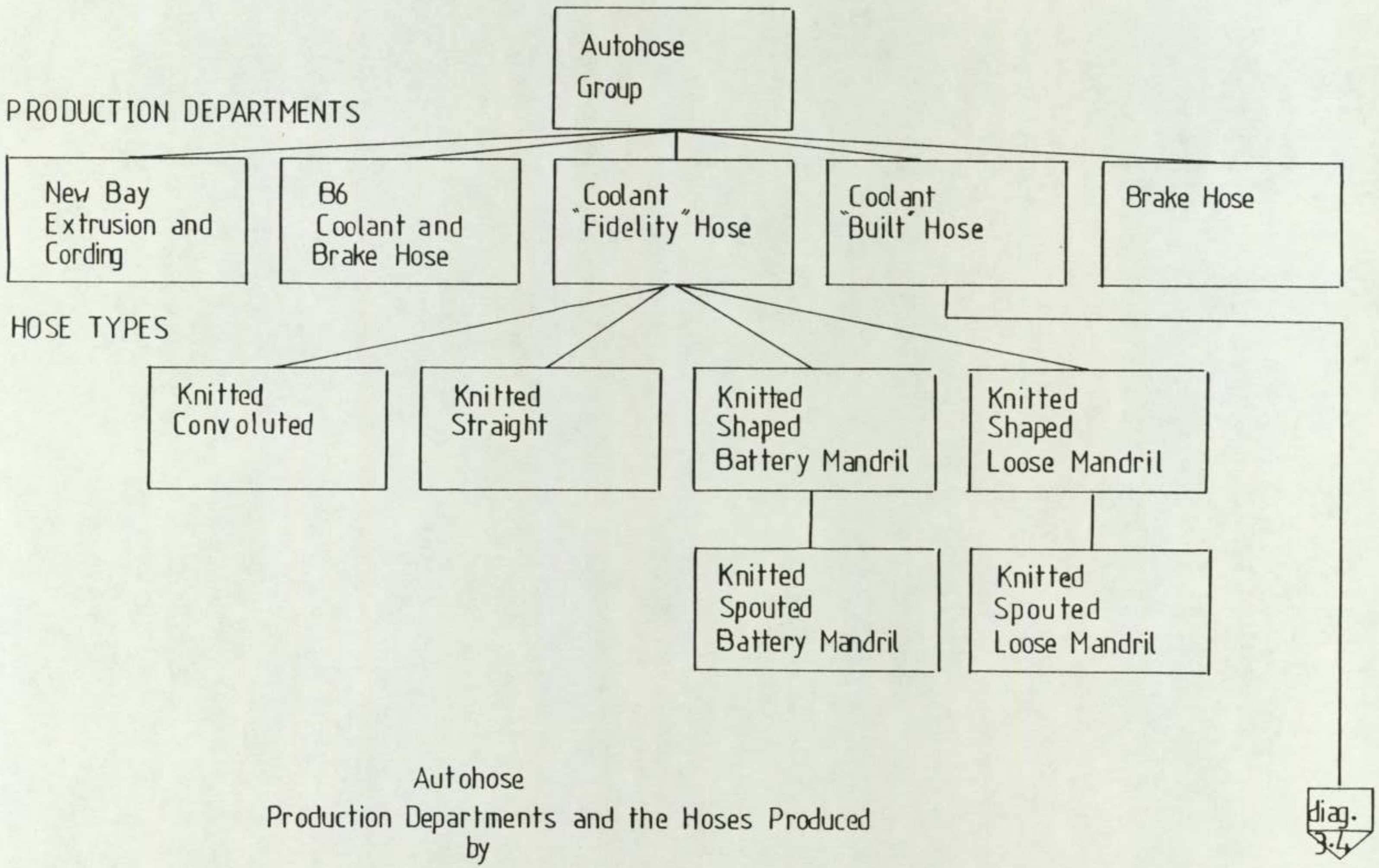
Departments Associated with Order Processing and Production for Coolant Hose

Diagram 3.2



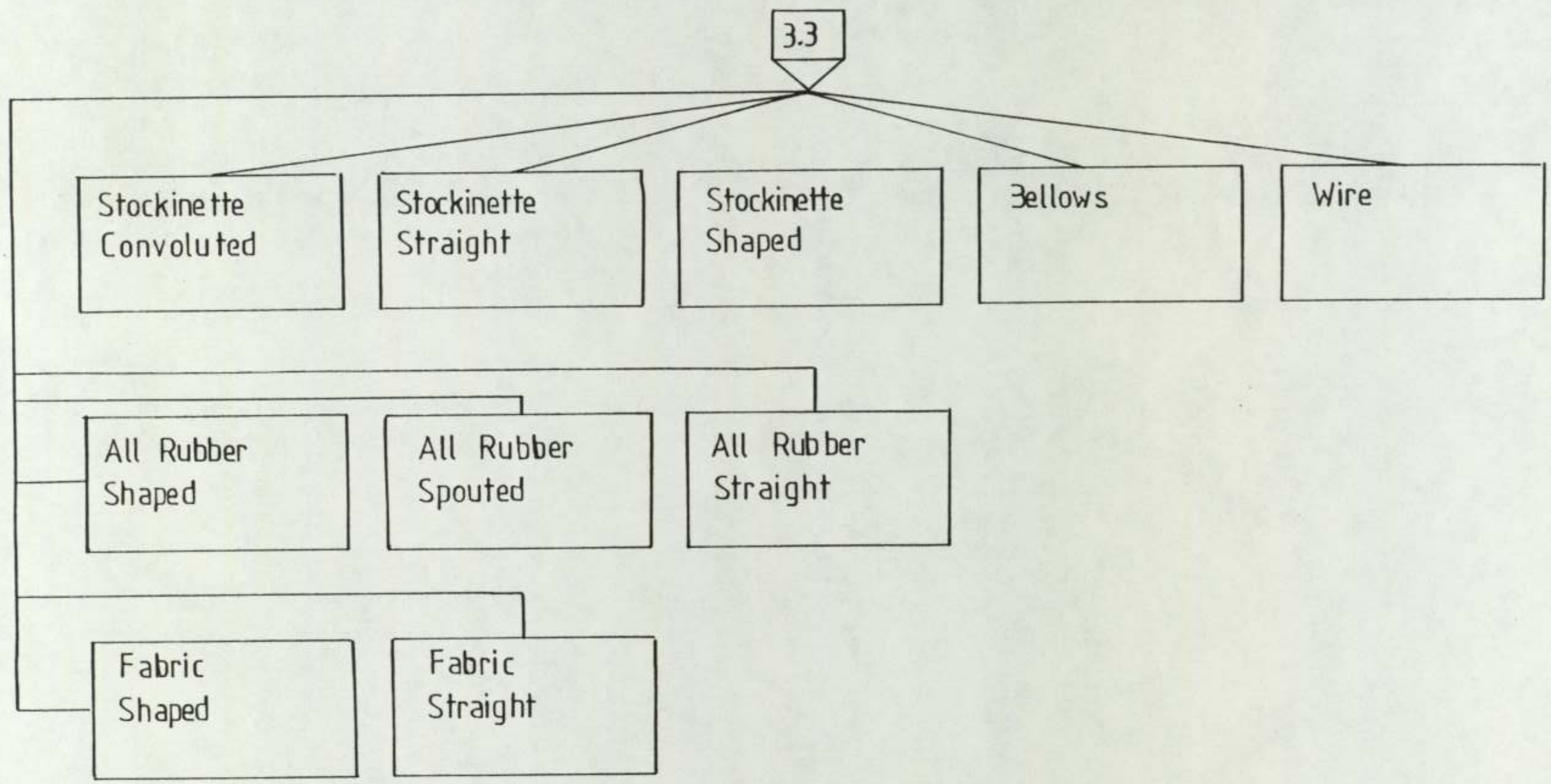
The Main Production and Finishing Processes for Coolant Hose (Fidelity) Production

Diagram 3.3



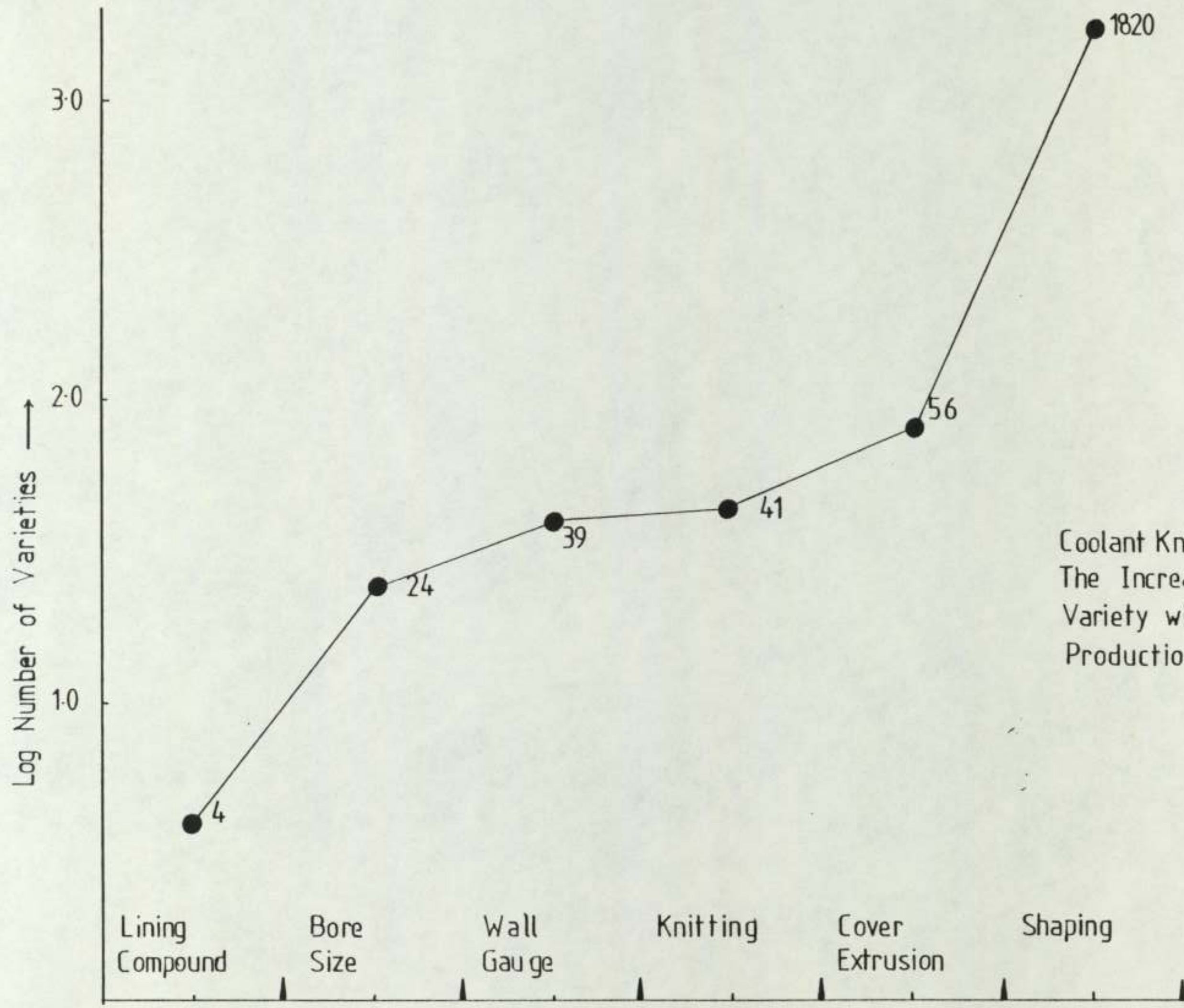
Autohose
Production Departments and the Hoses Produced
by
Coolant Hose

Diagram 3.4



Built Hose Types

Diagram 3.5



Coolant Knitted Hose – The Increase in Variety with Production Process.

KEY TO QUANTIFIED FLOWCHART

Diagram 3·6

The arrows indicate the direction of flow of products

The boxes approximate to production capability for each process. The levels within the boxes show the estimated productivity values. Boxes with no levels have not had productivities estimated.

Connection lines approximate to flows between production processes.

A QUANTIFIED FLOWCHART FOR AUTOHOSE COOLANT HOSE MANUFACTURING PROCESSES Diagram 3·6

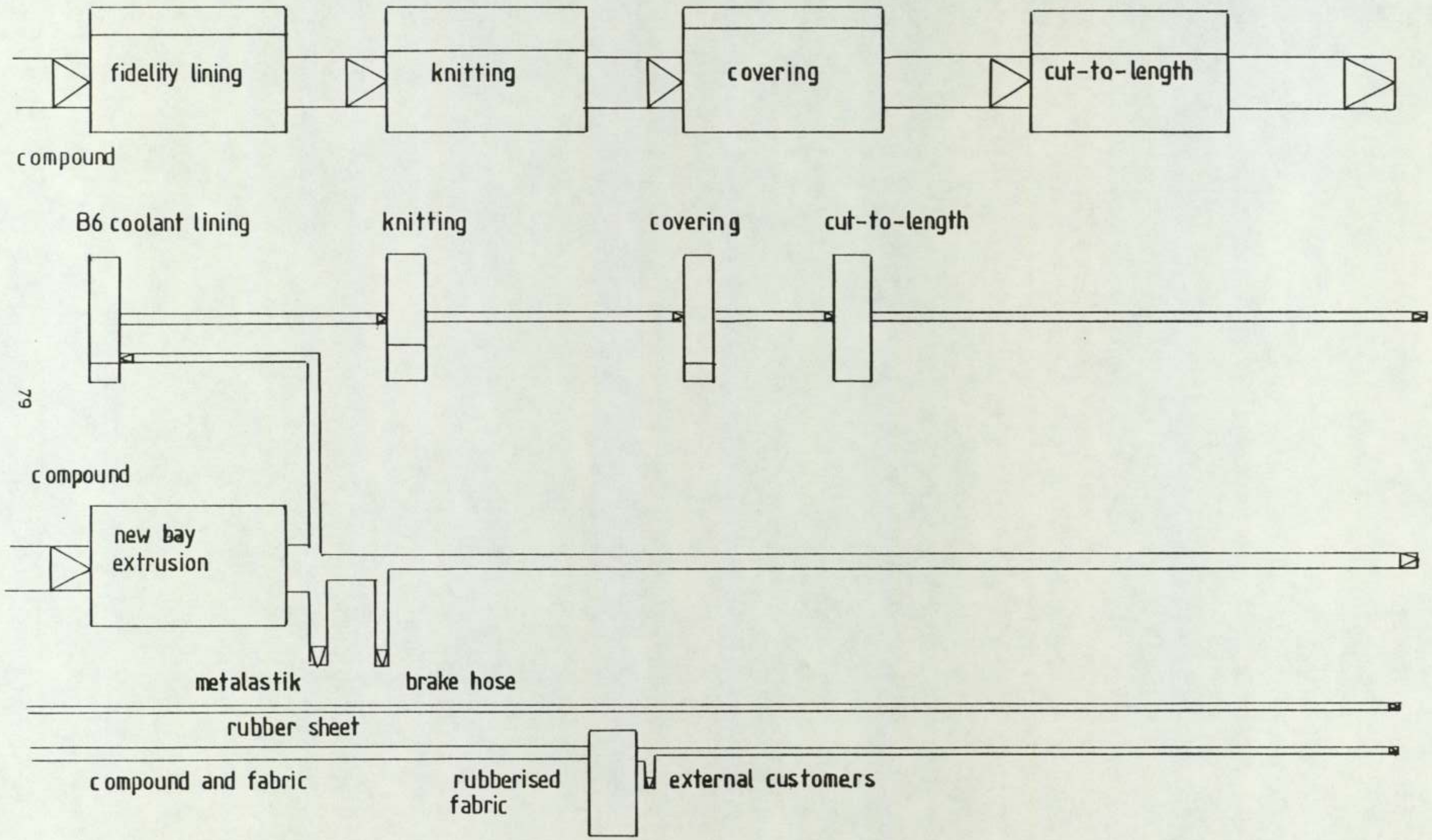


Diagram 3·6 cont.

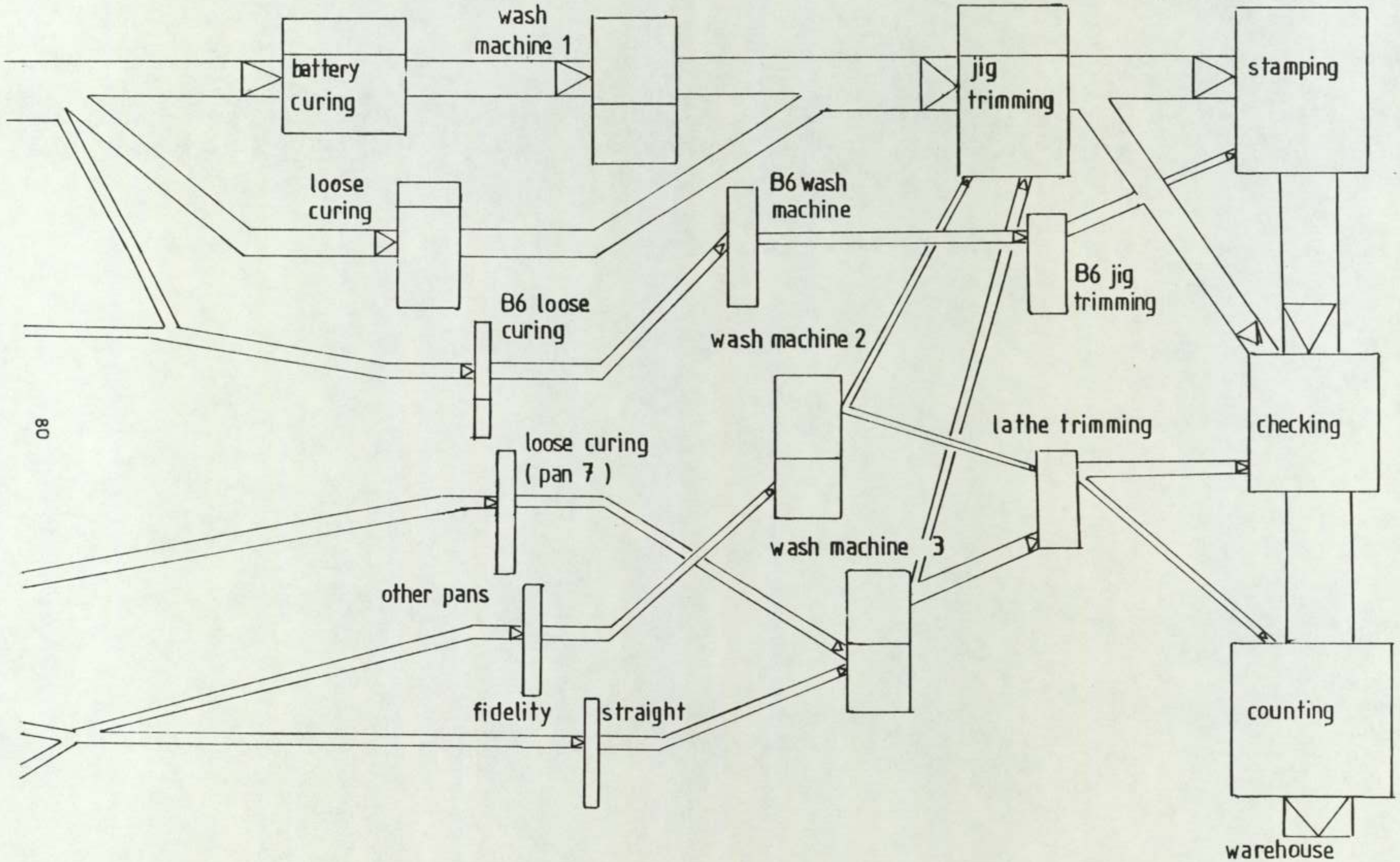
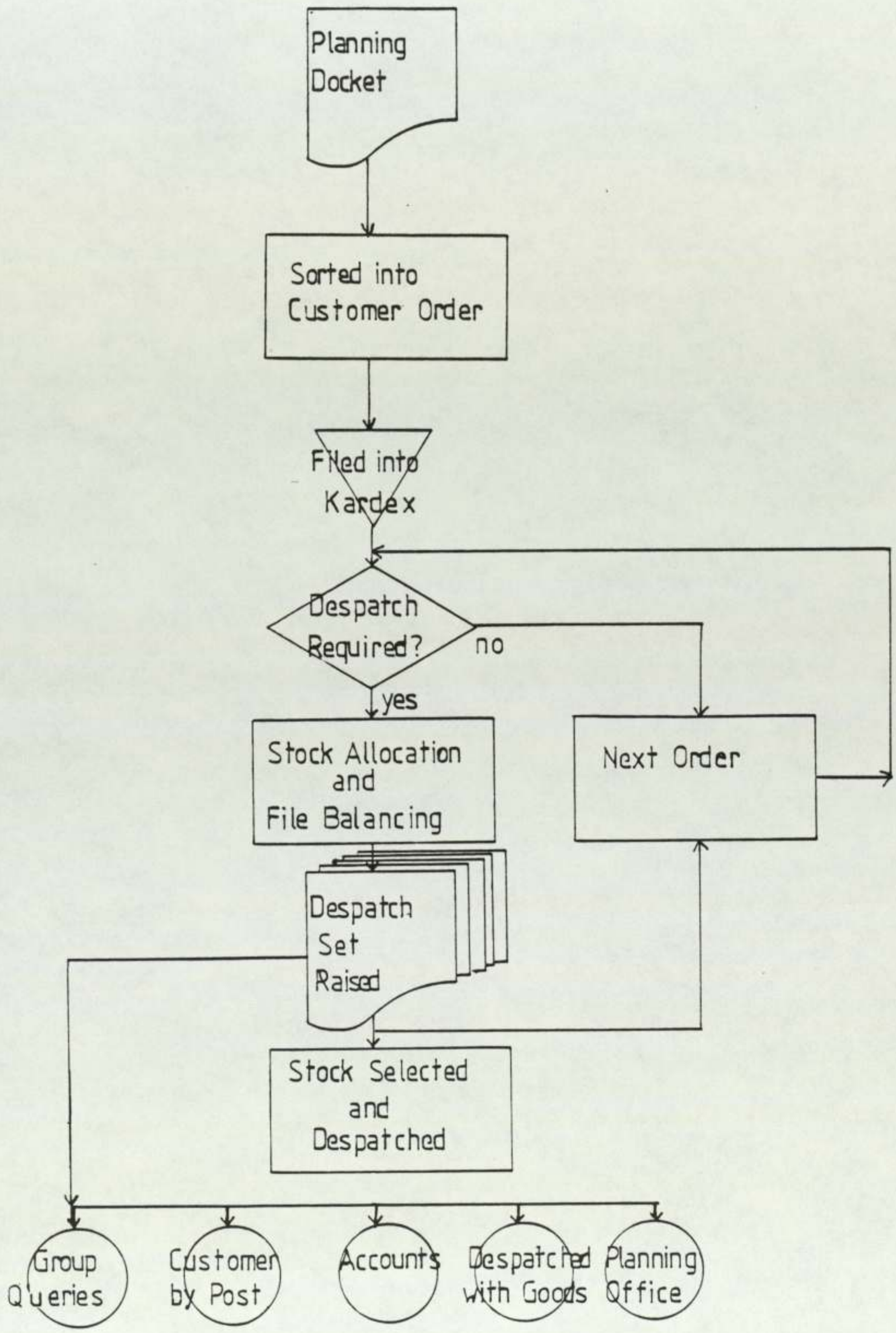


Diagram 3.7

Allocation of Stock



CHAPTER FOUR

THE ANALYSIS OF AUTOHOSE -

COOLANT HOSE

4.0 Introduction

In Chapter Three the "feel" for the situation in the factory and its environment were discussed and several problem areas highlighted. In this chapter the foundations formulated in the previous chapter are used together with an analytical model to define the nature of the problems more precisely, and to indicate the directions in which they might be alleviated.

4.1 Summary

The effective Organisational Model used in this chapter is one that was developed by Stafford Beer (3). It basically comprises five functional levels termed; Policy, Intelligence, Control, Co-ordination and Implementation.

It is the area of Control of the Implementation functions that is of most concern in this discussion. Control is effected by three main types of communication channel; Direct Command and Accountability, Co-ordination, and Monitoring. The way in which these channels interact can be used as a way of determining the efficiency of communication, which has a direct effect on the efficiency of the factory.

The Cybernetic Model has been used first of all to identify management levels in terms of the functions described above, and then to aid in the analysis of communication types. These communication channels have been sub-divided, to further facilitate analysis, into the following aspects:

* Production.
* Manpower.
* Materials.
* Machinery.
* Finance.

Analysis of the three management levels of Fidelity, Coolant Hose, and Autohose are summarised in Diagrams 4.3 to 4.5.

4.2 The Model

The Model of an effective organisation used in this investigation was that developed by Stafford Beer (3). Its main use has been to assess the effectiveness of the organisation (Coolant Hose) and to provide a framework for improving upon this effectiveness.

In this analysis the sub-division of objectives has formed the foundation for the identification of successive "management levels". Each management level therefore had its own set of objectives. It is the detailed analysis of the achievements against these objectives that the Cybernetic Organisational Model has been used for.

In the Cybernetic Model there are five functional (rather than structural) aspects that were used to define the system in any one management level. Briefly, and perhaps oversimply, these are:

* The POLICY function whose role is to choose objectives from strategies developed by the Intelligence function.

* The INTELLIGENCE function, which has the purpose of formulating the strategies in relation to the future as dictated by both internal and external environments.

* The CONTROL function, which conveys and supervises the adherence to the objectives set by the Policy function.

* The IMPLEMENTATION functions or sub-systems, to which the objectives apply.

* The CO-ORDINATION function, which prevents oscillations and refers exceptions back to the Control function.

These functions and the way in which they relate are depicted in Diagram 4.1.

It was the aspects of regulation that became the focus of this Action Research (as described in Chapter Two). These regulatory aspects were contained, in terms of the Model, in the following three of the functions described above:

* Control.
* Implementation.
* Co-ordination.

The majority of standard definitions for the requirements of a control system (1) specify:

* The passing down of objectives.

* The recognition of reference levels to achieve these objectives.

* The gathering and interpretation of information on performance against the objectives.

* The mechanisms by which the behaviour of the sub-systems could be altered.

In terms of the Model these can be specified as three main types of communication channel:

* Direct command and accountability for objectives.

* Co-ordination to achieve the objectives.

* Monitoring of performance against the objectives (Diagram 4.1).

The great value of these communications channels in analysis is that the command channel (expressing objectives) has to be balanced in terms of information received relating to the achievement of the objectives. In other words, the complexity of the objectives has to be matched by the complexity of the accountability, co-ordination and monitoring channels if the control system is to be effective.

The relative importance of each of the communication channels is dependent on the constraints imposed by the original objectives. For example, if the objectives are very specific in their nature, the need for direct accountability is implied with less emphasis on the monitoring and co-ordination channels. At the other extreme, relatively loose objectives imply less accountability and more emphasis on the co-ordination and monitoring channels.

The Cybernetic Model has been used to help identify, first of all the management levels, then the functions and then the communication types. The process of "fitting" the situation in the A.H.G. factory to the framework of the model was not a direct, simplistic one, but developed from several analyses of the Model and factory to produce the most appropriate fit.

The balances between the functions are now considered in more detail for three management levels identified within the Autohose Group (A.H.G.):

* Autohose - level one.
* Coolant - level two.
* Fidelity - level three.

The relationships between these management levels and others, outside the terms of reference are given in Diagram 4.2.

4.3 Fidelity Hose - Management Level Three

For the sake of clarity the approach adopted here has been to present the management levels from the bottom level upwards. In other words, the fundamental units are discussed first followed by further discussion of progressively higher management levels. Since the focus of the Action Research has been around Fidelity Hose manufacture the most fundamental management level, termed "Fidelity", is discussed now. Each management level has also been summarised in tabular form for the reader requiring the most salient points only (Diagrams 4.3 to 4.5).

Information Aspects

The three communications channels concerned with regulation (command and accountability, co-ordination and monitoring) are sub-divided into five aspects of information to act as convenient guide lines for analysis:

* Production level information.
* Manpower considerations.
* Materials requirements.
* Machine requirements.
* Financial considerations.

Within the Fidelity management level three distinct categories of production process were evident:

* Rawhose production.
* Transformation processes.
* Finishing processes.

Each of these is now discussed in relation to the information aspects listed above.

4.3.1 Production

Rawhose

The objective or directive for the production of Rawhose was relatively simple and concise. It was, to produce lengths of the raw material to meet the requirements of the production programme in terms of type, quantity, and due date. These requirements were stated as the footage of a particular hose type and were further divided into the Lining, Knitting, and Covering processes involved. Each directive was communicated to the operatives for each process via a display board in the Foremens' office. After each shift the production level from each process was marked up on the same display board giving a direct feedback of information (the accountability channel - Diagram 4.6). This also helped to promote co-ordination between the rawhose processes.

In terms of the Model this meant that there was a good match between the relatively specific objectives and the feedback of information on the achievement of these objectives.

There was however, no direct facility available to monitor progress which could have been aided by the use of Standard Minute Values for production rather than wages purposes.

Another aspect of the production objective was that of quality of production. This was specified by relatively stringent tolerance limits for bore size and uniformity of wall thickness. Again the accountability channel was good in so far that checks were made on these tolerances. Where this feedback of information was lacking however was in the provision of information on product scrap (that is the rejected rawhose). For example when the bonding between lining and covering of the rawhose was poor the hose length would be used for producing straight-length hoses by the use of a further (Built Hose) process in which the two compound layers would be forced together (the so called "wet wrapping" process). The distinction here is between the knowledge of product scrap by the programmers and the provision of information to provide an indication of the efficiency of rawhose production to higher management levels.

Again the lack of any suitable monitoring facilities meant that any checks on the efficiency of producing good quality hose were impossible to make.

To summarise, the control of rawhose production was in general relatively good from the point of view of the Control function (the Production Programmers) at this management level. What was poor however was the basis for this control, which was the intimate knowledge or "seat of the pants feel" for the production processes. The main reason for this was poor standard minute values for production control and as a consequence the lack of any well defined norms. While it could be argued, and rightly so, that this was a perfectly satisfactory method of control in many respects, the seat of the pants feel could not be used as a basis for providing accurate information to higher management levels.

Once rawhose lengths had been produced, transformation into a recognisable hose was achieved by the two processes of cutting-to-length and curing.

Transformation

The directives for production for these two processes were again good. The production programmes specified the length and number of hoses to be cut from the basic rawhose. Once the hoses were cut to length (by automatic guillotines) the operatives marked in on the programme the actual number of cut-lengths produced. This then provided precise information on the availability of cut-lengths for the curing process. The numbers of hoses actually cured (moulded) were also entered on the programme, but the information was not used for production control. It was instead, used by the wages department to assess payment for the curing pan operatives. The only check on production at this stage was by the Foremen to make sure that excessive production claims were not made.

Data was also available on the number of hoses not produced (in terms of standard minutes) but again this was not used for production control purposes. In addition no information was made available on product scrap so providing little basis for the measurement of efficiency, in particular, of the curing pan process.

In terms of the Model then, the accountability channel was poor and since the same measures would provide the basis for any effective monitoring channel, none existed. The control channels are summarised in Diagram 4.6.

Finishing

After curing, the final shape of the hose was effectively determined (with the exception of spouted hoses). The next process was that of washing and sorting, for which there was no directive other than to wash hoses as they came from the curing pans and to sort the resultant pile of hoses into bins according to the production programme. This meant that the hoses were sorted in no particular order other than as they came off the piles. They were then counted, labelled with dockets and stacked in bins ready for the next process, trimming.

The directives for trimming were again no more specific than to trim the hoses in the bins. The only priority for operatives evident here was one of obtaining the most generously measured hoses (in terms of standard minutes) to get the maximum performance (for wage calculations). Copies of the programmes were again filled out with the numbers of each hose trimmed but the data was mostly used for calculating operatives wages and not for production control. The recording of trimmed hoses did provide some useful information for progress chasers however, by showing that particular hoses had been trimmed. So that at least meant that the required hoses were not in the unsorted pile of washed hoses.

Subsequent finishing processes for any particular hose type were dependent on customer specifications. Some hoses were sent directly to the inspection area to be checked against inspection jigs and counted before being sent to the warehouse. Others were sent for spouting and/or stamping (with the customer part number). There was no routing information available and so progression between these processes was dependent on the intimate knowledge of the production operatives.

So there was very little in the way of directives for the finishing processes and correspondingly very little accountability or feedback of information (Diagram 4.6). This resulted in a heavy reliance on co-ordination between the processes, which worked to the extent that hoses were produced but not in an orderly, speedy manner. Again no viable monitoring channel existed because of the lack of suitable measures.

The main area of quality control for the finishing processes was at the inspection stage which made sure that hoses passed to the warehouse were mostly of marketable quality. The value of information on product scrap (obtained from the number of rejects) was diminished by the fact that most of the processes discussed here filtered out any unsuitable hoses, which were then counted as waste scrap. Again the relevance of this was not at this management level in particular, but at the level of Coolant Hose (Level Two) since the efficiencies of the processes could not be accurately assessed.

Within the three types of production processes discussed above (Rawhose, Transformation and Finishing) the objectives were in general stricter for Rawhose and Transformation, and relatively more lax for Finishing. The logic of the Model used during this analysis therefore suggests that the co-ordination channel should be more important for the Finishing processes, and this was evident in the way that the hoses were routed. There was however a need for more directive both in terms of priority and routing information.

The only existing monitoring channel in terms of the Model can best be expressed as the progress chasing function, which attempted to speed up the production of specific hoses. The role of a true monitoring channel should have been to investigate and facilitate the timely production of all hoses on the production programme and not just a select few.

4.3.2 Manpower

There were three aspects to the manpower considerations at any management level:

* Manning levels.
* Overtime.
* Absenteeism.

Rawhose

The stated objective for Fidelity was the provision of sufficient manpower or labour to meet the production schedules (programmes) (Diagram 4.7). For the rawhose production processes two different types of skill were needed, the ability to extrude (both linings and coverings) and the ability to operate the knitting machines. The general requirements for maximum hose production (all the curing pans busy) meant that two shifts of cover and lining extrusion and three shifts of knitting were required. More specifically operative performance was measured in Standard Minute for each production process. So extra production requirements could be met by either increasing productivity or sanctioning overtime. But the accuracy of these Standard Minute Values meant that appreciation of the norms were required before any useful information could be obtained from them. In turn this meant that any monitoring would be very difficult since this would require intimate knowledge of these norms.

Absenteeism during this research study was high, but despite an objective to reduce the problem little else other than the collection of data on absentees was achieved at this level. Covering for absentees and in general the co-ordination of labour between the Rawhose processes was facilitated by both knitting and extruding. But co-ordination between rawhose, transformation, and finishing was hindered by the fairly strict division of labour.

<u>Transformation</u>

Transformation processes were distinct in terms of labour not only in the skills required for the jobs but also the willingness of the operatives to do each job (work on the curing pans was a hard, hot occupation). Both cutting-to-length and curing were operated on a three shift basis to minimise the use of the curing pans which were seen as the limiting factor in terms of production levels. Here overtime (at weekends) was the only method used to increase production levels in the short term.

<u>Finishing</u>

Finishing processes required varying degrees of skill. The most skill was required in recognising hoses, particularly during the sorting process. This meant that any shortfalls in labour, mainly due to absenteeism, could not be readily made up because of the sheer number of hoses that had to be identified. In many of the finishing processes Standard Minute Values were wildly inaccurate, causing problems in assessing the work load and the number of operatives required. In other words, in terms of the Model the monitoring channel was again severely hindered by the lack of suitable measures (Diagram 4.7).

4.3.3 Materials

The materials aspect of control (Diagram 4.8) was sub-divided into four sections relating to:

* Direct materials.
* Indirect materials.
* Product scrap.
* Waste scrap.

Of these the product scrap has been considered as part of the production aspect since it is directly related to two of the main objectives of production, those of quality and efficiency. The indirect materials aspect was not considered separately in this analysis because of its relatively low contribution to costs. It was therefore considered only as an overhead.

Rawhose

Direct materials information was only relevant for rawhose manufacturing relating to the rubber compound for lining and cover extrusion and yarn for knitting. In all other processes the materials requirements were considered indirect (for example lubricating silicone for the curing pans and knives for the trimming process). However, the importance of the supply of rubber compound was not reflected by the methods used to control its supply.

The amount of rubber compound required was calculated from the footage of rawhose required by a simple weight per unit length of hose algorithm. This information however invariably reached the compounds department too late to be of use in preparing the compound for the next week's use. As a result compounds were supplied by a method of, "what was required the previous week would be required for the next week".

Information on what compounds had actually been supplied was very direct, if the batch of rubber compound was there with its label, then it had been produced and if it wasn't then it had not. Such a method of supply worked for most of the time because requirements were generally for large quantities of a few compound types, but was acknowledged by both the Compounds Department and the Production Planners as being unsatisfactory.

Balance between the demands for compound by the lining and covering departments was relatively straight forward, but difficulties occurred between production areas (for example B6 and Built Hose departments) and these are discussed in the next, higher management level. Some problems of supply were also noted in that occasional batches of compound were unusable. It was thought that this could have been avoided by better testing of the compound before delivery.

The objective for scrap levels was basically to keep them to a minimum, but there was little distinction made between the product scrap (as discussed in the Production Aspects) and waste scrap.

Scrap was also measured in the most convenient way for the operatives measuring the scrap rather than relating to each production process or even type of production process (rawhose etc.). The result was that any directive given to the operatives to reduce the scrap levels could not be directly perceived by them. The method of measurement and its timing also presented the problem of providing the facts long after the causes were apparent, therefore making any investigation more difficult. Thus again the monitoring channel was hindered but this time because the organisation of measurements was not related to the objectives.

4.3.4 Machine

The fourth information aspect was that of the machine requirements to meet the production schedules (Diagram 4.9). The objective here was seen as the co-ordination of all other production processes to maximise the use of the curing pans (ovens). For example two shifts, in general, of lining extrusion were required to meet the needs of three shifts on the curing pans.

The co-ordination of machine requirements to achieve the production schedule was the responsibility of the Senior Foremen. However little assessment was made of the use of machinery, and more importantly how effectively it was used.

Many of the problems of supply and communication within Fidelity could be linked to the maximising of curing pan use and the fitting of everything else around this aim. In other words the efficiency of one process was of very high priority even though the overall effectiveness of the operation was consequently less. For example a major problem of a huge pile of hoses by the washing machines often occurred due to the inability of the finishing processes to cope during peak production periods. In other words this pointed to a lack of co-ordination between transformation and finishing processes.

4.3.5 Financial

At this management level there was an almost total lack of any information relating to costs (Diagram 4.10). The cost of producing a hose was broken down into the following component costs:

* Overheads - machinery, floor space, heating.

* Manpower costs - labour and the supervision of labour.

* Materials cost - direct and indirect.

* Processing costs - order processing, warehousing and despatch.

Of primary concern here were the direct or prime costs, that is those that were directly proportional to production levels. These were basically:

* Manpower costs.
* Direct materials and energy costs.

Because of the lack of costing information on the shop floor there was no "cost consciousness", which meant that any directive to reduce costs was purely abstract. It also meant that there was little in the way of co-ordination to reduce costs and made the monitoring of them a difficult if not impossible task. However, to introduce costing on the shop floor would have meant radical changes in a factory such as the A.H.G. because of the long established role of an autonomous Accounts Department and the reluctance of management to give operatives detailed knowledge on costs.

But the use of a series of indices, as described in the next chapter, could circumvent the latter problem.

4.4 Coolant Hose - Management Level Two

The most fundamental management level in this analysis, called Fidelity, has been discussed above and the problems of meeting objectives highlighted. At this, the second management level, the same framework and methodology has been used to identify the communications problems. They are discussed in a similar fashion to those in Fidelity.

Some of the problems here were as a direct result of shortfalls at the lower management levels while others were due to the lack of collating information into a meaningful format.

Diagram 4.2 shows the relationship between Coolant Hose and Fidelity Hose, in addition it shows the relationships between Built and B6-Coolant Hose with both of these. Built Hose, B6-Coolant Hose and Fidelity Hose are all sub-systems of the Coolant Hose management level and are therefore of direct relevance to information aspects relating to the Coolant Hose management level. Information relating to these other two management level three units is therefore summarised for comparison in Diagrams 4.11 and 4.12.

As part of the Model of a viable organisation Coolant Hose has nested within it the same five functions as Fidelity Hose of Policy, Intelligence, Control, Co-ordination, and Implementation. It is the latter three functions again that have been considered in detail from the point of view of investigation of the information and control systems.

Within the three types of communication channel (command and accountability, co-ordination, and monitoring) the following five information aspects were again used for convenience of analysis:

* Production.
* Manpower.
* Materials.
* Machine.
* Finance.

4.4.1 Production

The production objective for Coolant Hose was seen as, the meeting of demands made by customer orders and schedules. More specifically this meant the meeting of requirements for quantity, quality and due date (delivery date). This objective, in contrast with that of Fidelity Hose was to meet demand rather than the production programme (Diagram 4.13). In an ideal situation both of these objectives would have been equivalent but in practice they were not.

On further examination the objective of meeting customer demand was modified somewhat. To start with some of the customers' orders were blatantly impossible to achieve and so these had to be filtered out. Here the main concern was with orders that were too large and/or received too near the specified due date. Quite often customers would also over order, that is they put in a larger order than actually required, so that in the long term they would get the number of hoses that they really wanted. Both of these problems would only be detected by a careful watch on incoming orders by the filing clerks and even then over ordering was a difficult if not near impossible situation to spot.

So the true objective was to meet realistic customer demands, but with little accurate information on lead times (the time taken from ordering to delivery) only very rough estimates of realistic due dates could be obtained. That is the relatively specific objective of producing the orders on time should have had a correspondingly specific accountability channel so that an accurate measure of the effectiveness of the ability of Coolant Hose to produce hoses could have been made. The only information available was in terms of the number of hoses reaching the warehouse and when they arrived there. This data was dissipated in the Kardex files, and due to the effort needed to extract more useful information, no comparison was made to provide information relating to customer orders met on time, on a regular basis.

The accurate communication of objectives is a primary element of any form of effective control system. In Coolant Hose objectives were communicated to its sub-systems (Fidelity, Built and B6-Coolant) in the form of order sheets with customer requirements for upto three months ahead.

Frequent amendments were made to these on a, theoretically, weekly basis but more often less frequently. Thus the objectives were communicated in an untimely manner, causing problems when amendments to a customer's order were made. For example when the Production Programmers received as part of the order sheet an order for a specific hose, and if the manufacture of the hose had been started when an amendment stating a reduction in the number of hoses came through, then a batch of unrequired hoses was produced. This would then cause problems in using up production time unnecessarily and occupying precious storage space in the warehouse until such time as the customer required the hoses.

Another problem with the communication of orders was with the sense of urgency of customer orders. Order Processing Clerks and Customer Liaison Clerks were in frequent contact with customers both through written orders and verbal enquiries, which produced a set of priorities, even if they were somewhat biased (because the more a customer complained the higher priority his order got). When the orders were passed down to the Order Programmers very little of this sense of urgency for orders was also communicated, which to a large extent was a good thing, but what was lacking were suitably defined priorities for customers. For example a large customer (in terms of quantities of hose ordered) would be given higher priority than smaller customers, and it often happened that the delivery to smaller customers was very late even though they had ordered several months in advance.

Co-ordination between the production aspects of B6-Coolant, Built Hose and Fidelity was very good. For instance if Fidelity was producing the maximum number of hoses it could then be that some types of hose would be shifted to the B6 department. But movement of hoses back the other way was not so good and it was probably for this reason that types of hoses processed by each curing pan varied so much. For example in B6-Coolant the main type of hose was meant to be long-length knitted hose, but by the end of this analysis all sorts and lengths of hose were being cured there. In terms of the Model then, this meant that the co-ordination channel was ineffective.

At this level the existing monitoring channel was seen as the investigation of departments in their abilities to process or meet orders and was frequently used when orders were long overdue. But to have been effective the monitoring channel should have facilitated the investigation of hose production rather than just of specific batches of hoses.

From the aspect of quality, control was relatively stringent and in turn so was the accountability channel for it. The objective was to meet customer requirements for quality, and information (collated from the Fidelity management level) was available on the hoses passed and rejected. Precisely the same problem was evident at this level as at Fidelity though, because of the way in which hoses were rejected at each production process the overall measure of the efficiency of production was distorted.

4.4.2 Manpower

The objective for this aspect (Diagram 4.14) was to provide a reasonably constant level of labour to meet production demand. Again manpower considerations were divided into:

* Labour levels.
* Overtime.
* Absenteeism.

The labour levels were calculated to meet the production demand on the premise that the basic information on productivity was accurate. From the analysis of Fidelity in management level one, it was evident that very little faith could be placed in many of the basic measurements. Therefore the setting of labour levels was a relatively subjective task involving a lot of "feel" for the situation.

At this level the justification for overtime was made, and labour co-ordinated between the departments to make up the shortfalls mainly due to absenteeism and sickness.

Investigation of high absenteeism and poor productivity (as best it could be measured) showed how little the monitoring function was used. Had better use been made of this channel then the problems could have been investigated at their conception rather than well after the event when it was too late.

4.4.3 Materials

This management level was not concerned with ordering compounds, all ordering having been done by the Production Programmers at the level of Fidelity Hose. It was perhaps the lack of ordering at this level that was causing problems in the late ordering of compounds (Diagram 4.15). If an approximate supply requirement was given at this level, on a weekly basis, and then confirmed by the Production Programmers at a later date then a better service might have resulted.

There was a marked difference in the materials supply to Fidelity, B6 and Built Hose departments. B6-Coolant was very similar to Fidelity in its method of compound supply except the compound had to be extruded into core-lengths before use. But in the Built Hose department there was a different supply route and many more materials were required (for example rubberised fabric, rubber sheet, extruded rubber hose, and "stockings"). Unlike the compound supplied to Fidelity these "raw" components were already in an advanced state of manufacture and were supplied to Built Hose rather than produced by it. Of particular note was the supply of extruded rubber by the "New Bay". This department also supplied B6-Coolant (and Metalastik), but for historical reasons it was still controlled by the Compounds Department. The result was poor communication between the departments on what was wanted and what was actually produced, which also made co-ordination between recipient departments more difficult.

The other aspect of materials control relevant here was that of waste scrap. The reduction of scrap was seen as an important way of reducing the cost of production. As a result information on scrap levels was regularly collated and compared with the level of previous periods. The bases for these reports at the lower management level however reduced their value. When high levels of scrap were noted it was then the responsibility of the Production Co-ordinator to inspect the situation and try to alleviate the problem, or in other words monitor the situation and act before the problem got out of hand. But because of the method of collating such information, by the time high scrap levels were noticed the immediate causes were no longer apparent.

4.4.4 Machine

At this management level the objectives for the machine considerations were seen as being to meet the production demand by the provision of sufficient machine time (Diagram 4.16). Three main factors dictated the amount of time any machine would be used and these were:

* The demand itself.

* Available labour to operate the machinery.

* The time that the machinery was not available due to preventive maintenance and breakdowns.

Even though the demand and the labour available could be quantified (if not accurately when this analysis was conducted) there was little information on the relative use made of any machinery. The raw data was collected but no use was made of it to provide information for planning purposes. The supply of information on machine use would have helped to pinpoint bottle-necks and to show how they could have been avoided.

The co-ordination of machine use was observed when machines broke down. For example when the knitting machine in B6-Coolant broke down the knitting process was transferred to the machines in Fidelity (A4) department.

The only monitoring of machine use evident was when detail was required to set up a new department. Then the useful machine time was estimated and used with Standard Minute Values to ascertain maximum capacity. Such an analysis was useful in setting the initial capacities, but to be of real value should have been a frequent rather than rare event.

4.4.5 Financial

The processing of available data on costs into information relating to Fidelity, B6-Coolant and Built Hose departments was not evident (Diagram 4.17), and the data that was available wasn't communicated to those people who could have reduced costs most effectively (the Foremen). The lack of information available on costs at this management level again emphasised the need for some form of cost consciousness to assist in co-ordination of effort to reduce costs.

4.5 Autohose - Management Level One

The first two sections have covered the third and the second management levels, specifically the sub-systems termed Fidelity Hose and Coolant Hose.

Autohose is the highest management level considered in this analysis (Diagram 4.2). Again within this system the Cybernetic Model has the same five functions as before and between these the same types of communication channels. The same five information aspects of Production, Manpower, Materials, Machine and Finance have been used to facilitate the discussion on the analysis of the Autohose Management System.

4.5.1 Production

The desired objective for the Production aspect of Autohose was seen as being the production targets for the factory in terms of the number of hoses that were to be produced (Diagram 4.18). But the true objective differed from this, because in reality it became to meet customer demands. The accountability or achievement against this objective was the total number of hoses produced during the target period. A comparison between objective and production level was then used as a measure of the success of Coolant Hose. There were however, certain anomalies with this form of comparison. Firstly, the measure used was an indication of performance against demand and not the budget or target.

Secondly, the basis for this "measure of effectiveness" was of low integrity. This low integrity measure was the use of the number of hoses as the basis for estimates of factory loading. If the hose mix had stayed constant then it would have been a valid measure, but when the hoses varied in size from a couple of inches to three or four feet and, the mix regularly changed then any direct comparison of numbers was meaningless.

A measure of the factory loading in more absolute terms, for example Standard Minutes would have been far more meaningful. A third factor against the above measures was that of the true demand level. In the previous section, (Coolant Hose) the over ordering was described. In such a situation it was of little value comparing any measures of production against such an intangible reference level.

Therefore the objectives which have been termed the "desired objectives" should have been, the provision of targets for true factory loading, and the accountability information should have been in a form directly comparable to them.

The true objective at the time of this analysis, then was that of meeting customer demand in terms of quantity, quality and due date. But no real measure of any achievement against such an objective existed. In short there was no measure of customer satisfaction, only indicators of customer dissatisfaction. For example the number of complaints and the number of special deliveries that had to be made due to late orders.

At this management level little was evident in the way of co-ordination between the sub-systems of Coolant Hose and Brake Hose (Diagram 4.18). This was because of the relatively autonomous nature of the two departments. There was an overlap between the two in that some basic rawhoses would be produced by Brake Hose and subsequently moulded by Coolant Hose departments but the co-ordination at this level could have helped loading levels in Coolant Hose during both peaks and recessions in coolant hose demand.

The monitoring channel could be seen as the investigations conducted into the methods used to increase production. For example investigations like this Action Research, but they were, in terms of the Model too late. Action of this nature should have been continuously conducted so as to avoid serious problems before they became apparent.

4.5.2 Manpower

At this level, the objective can again be seen as the fulfillment of the production objective in terms of manpower requirements (Diagram 4.19). Therefore the objective was to provide the level of labour required to meet production targets. In addition there was the objective of increasing productivity or in other words reducing the manning level required for any given production volume. Again the measures used to determine productivity were not accurate.

Linked to this requirement to increase productivity was a policy of reduction in overtime and the introduction of strategies to control absenteeism.

The monitoring aspect of manpower considerations was seen as the investigations being conducted at the time of this analysis into methods of increasing productivity and reducing absenteeism. These investigations focussed on the provision of a "Productivity Index" to motivate operatives and to reward them with wage increments related to the index. The interest developed in some departments over the index was of direct relevance to the provision of more effective measures for control within Coolant Hose, which are discussed in the next chapter.

4.5.3 Materials

Information requirements for Autohose were for both direct materials and for scrap materials. Estimates of the levels of these formed part of production targets. So the objectives here were to make sure that enough rubber compound and other materials could be supplied to meet budgeted production (Diagram 4.20). Also the amount of scrap produced was to be below a certain level. These objectives helped the Compounds department to plan in the longer term on the supplies likely to be required by Autohose and together with the anticipated requirements from Metalastik led to the decision to build a larger, more automated compounds mixing plant.

4.5.4 Machine

The machine capacity formed one of the "givens" or bases for the setting of production targets. Therefore the objective here should have been to keep available machinery in good working order by a policy of planned or scheduled maintenance (Diagram 4.21). Instead the policy was one of keeping the machinery going until it failed and then to mend it as quickly as possible.

A forecast for an increase in the demand for coolant hose was an initial catalyst for this Action Research. Therefore over and above the aim to increase efficiency and profitability of the existing factory there was the longer term plan of increasing A.H.G.'s market share and the desire to invest capital in reducing the effect of bottle-necks within the factory. In other words to purchase more machinery to alleviate constrictions. This possible action was seen as of secondary importance to the improving of the efficiency of operation of existing equipment.

4.5.5 Financial

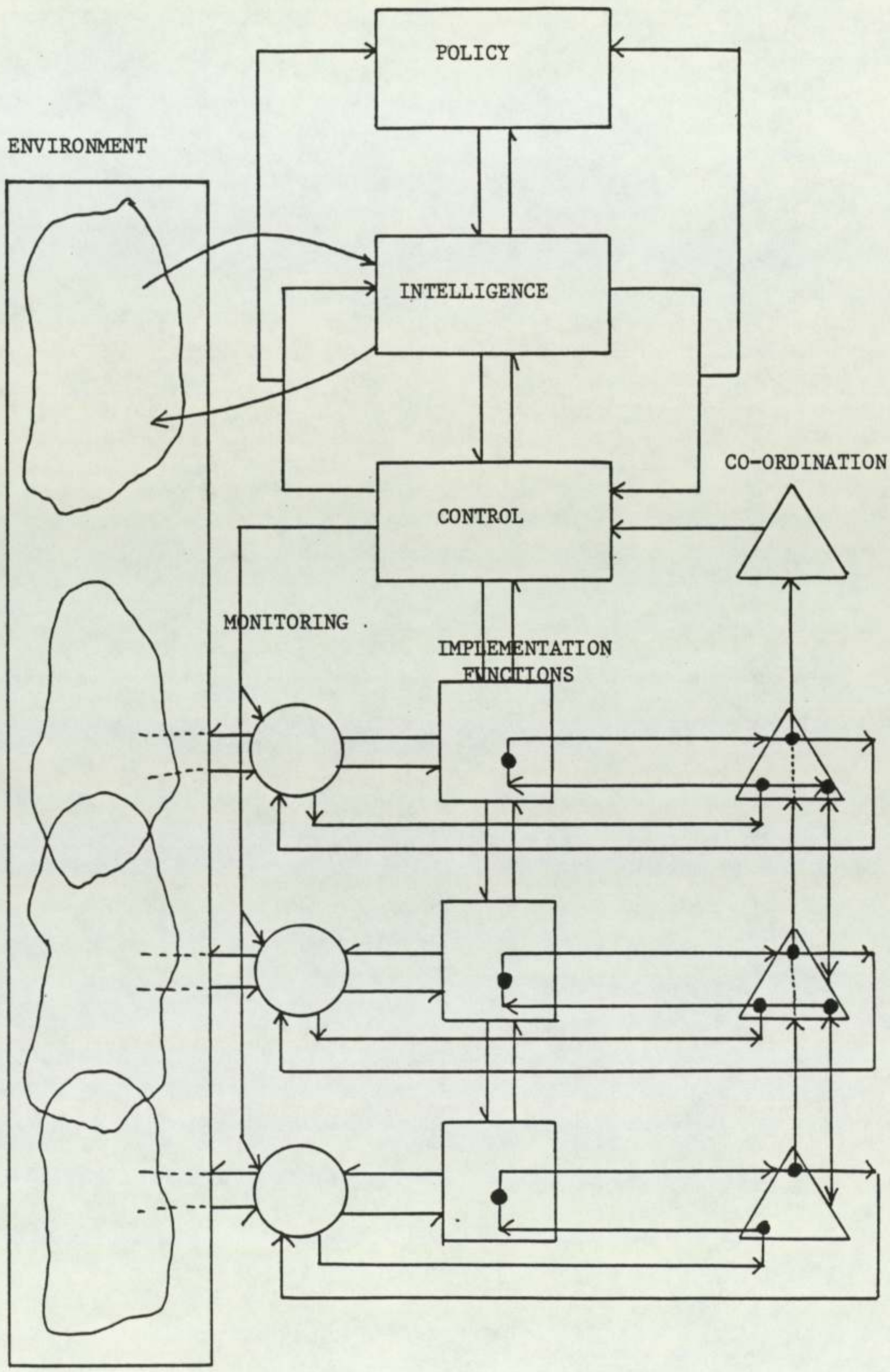
For Autohose the budget was the financial statement expressing the expected values of the goods purchased (turnover), wages, costs and capital expenditure, which formed the objective at this management level (Diagram 4.22). The major considerations in this analysis were with the direct or prime costs, which were supplied by a weekly financial control sheet. The usefulness of this information as it was presented in the form of a computer printout was very low. This was emphasised by the fact that a clerk was employed full time to extract relevant information from the weekly listings and type it up as more pertinent information relating to Coolant Hose and Brake Hose departments.

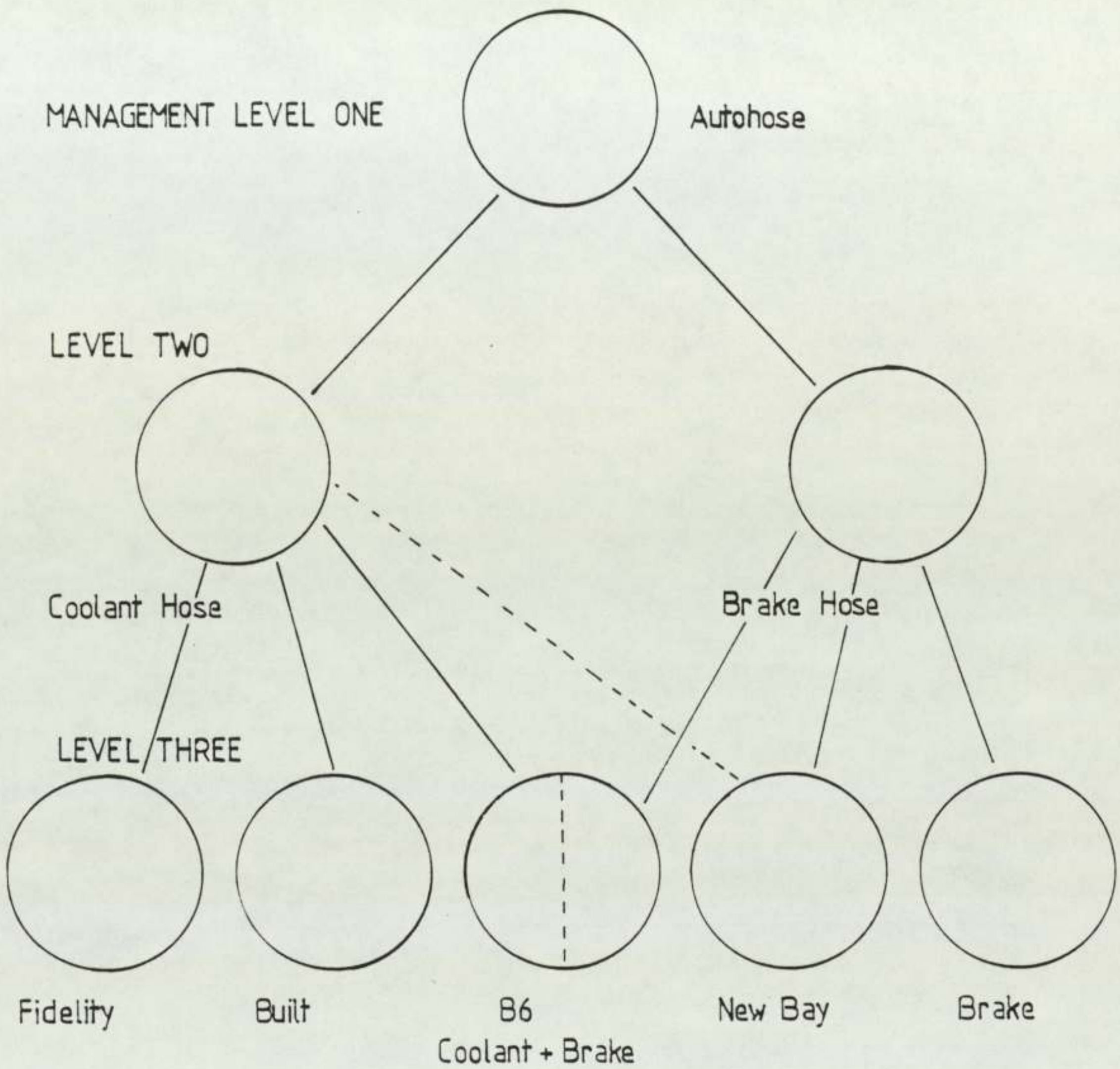
4.6 Synopsis

In this chapter the analysis of Coolant Hose has centred on the use of the Cybernetic Model as a framework. The facets of the existing organisation hung on this Model have shown areas (in addition to those identified in Chapter Two) that would have hindered the efficiency of coolant hose production (summarised in Diagrams 4.6 to 4.22). Another benefit from an analysis using the Model has been the formulation of methods to alleviate such problems. This is now the topic for discussion in the next chapter.

The Management Cybernetic Framework

Diagram 4.1





Management Levels in the Autohose Group

Diagram 4.2

DIAGRAM 4.3

	FIDELITY HOSE SUMMARY OF ANOMALIES
PRODUCTION	* Lack of information on Product Scrap (rejects) * "Seat of the pants feel" for production control rather than a system based on accurate measures. * Controls present for wages purposes but not used for production control. * Lack of priority definition or routing information
MANPOWER	* The basis for manning levels was Standard Minutes which were known to be highly inaccurate. * Absenteeism very high but no serious attempts to recuce the levels. * Relatively low skilled jobs required a datailed knowledge of each hose type.
MATERIALS	* Poor compound ordering * Lack of prior information on shortfalls in compound supply * Tight controls on scrap levels yet poor definition of what was waste scrap (as opposed to product scrap) and poor definition of scrap 'areas'
MACHINE	* Little assessment made of the use of machinery and its efficiency.
FINANCE	* No information relating to costs at this level yet objectives were set to reduce costs in production.

DIAGRAM 4.4

	COOLANT HOSE SUMMARY OF ANOMALIES
PRODUCTION	* Impossible orders placed by customers and recognition of such orders bad. * No information or indication of overall customer demand. * Inaccurate estimates for lead times for production. * No indication of orders met on time. * No priority definition. * Delays between orders and communication to the shop floor. * Poor policy on hose curing (to keep certain hose types together on one curing pan.
MANPOWER	* Inaccurate basis for calculating manning levels. * Absentee levels high but not known how to reduce them.
MATERIALS	* Lack of information on likely compounds requirements at this level. * Discrepancies in the method of control of rawhose production between Fidelity, 85+coolant and Built Hose. * Basis for scrap measurements poor. * Scrap reports produced long after scrap levels actually occurred.
MACHINE	* Poor information on machinery and breakdowns.
FINANCE	* Costing information not presented in a format relating to actual production departments.

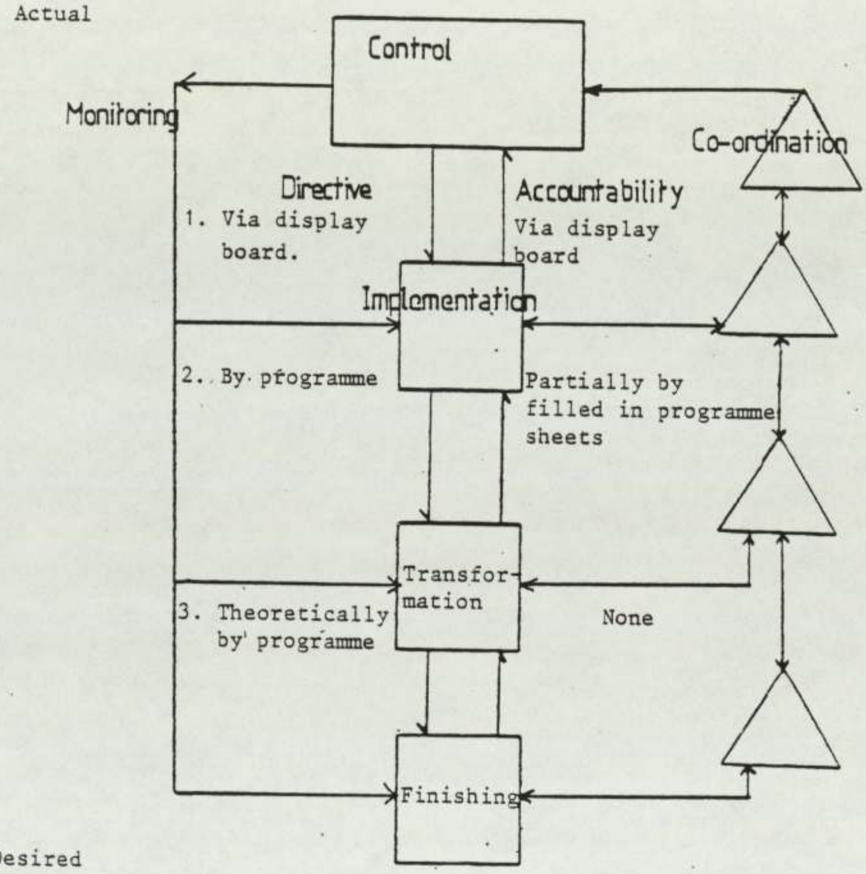
DIAGRAM 4.5

	AUTOHOSE SUMMARY OF ANOMALIES
PRODUCTION	* The measure of performance of AHG made on number of hoses produced against demand. * Number of hoses measure was a very inaccurate basis for information. * True objective of meeting customer demand not supported by measures against this. * Problems only noticed well after the event.
MANPOWER	* Standard Minute levels used for determining manning levels and measures of productivity - yet they were known to be very inaccurate.
MATERIALS	* Scrap levels set on arb itrary levels.
MACHINE	* No information on the efffective use of machi... time. * No policy of scheduled maintenance implemented.
FINANCE	* Financial information supplied as computer printout, yet in entirely the wrong format for AHG management.

Diagram 4.6

Communication Channels for Fidelity
Production Aspects

Actual



Desired

	Directive	Accountability	Co-ordination	Monitoring
1.	Production requirement in terms of type, quantity and due date.	Direct feedback of information on length, type, and time of production of raw hose.	Physical presence of draws. Too many and production would show down.	Spot checks on batches produced to check for load times, etc.
2.	Requirements for length, and number to be produced for each raw hose type	Number of hose lengths cut and cured and Standard Minutes of production achieved.	By use of productivity graphs.	As above

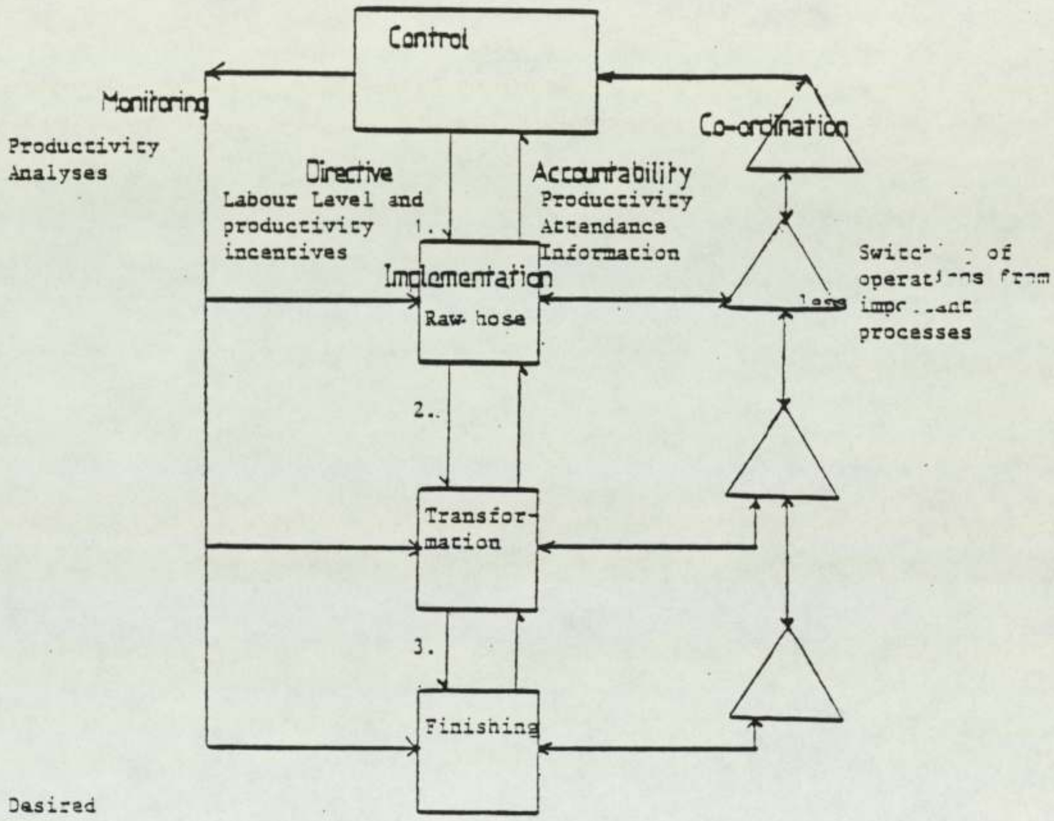
Diagram 4.6 cont.

	Directive	Accountability	Co-ordination	Monitoring
3	Batch cards specifying priorities.	Direct feedback of information on productivity.	By use of routing information on batch cards.	Investigation (by spot checking) the progress of hose batches through the Finishing Processes.

Diagram 4.7

Communication Channels for
Fidelity Manpower Aspects

Actual

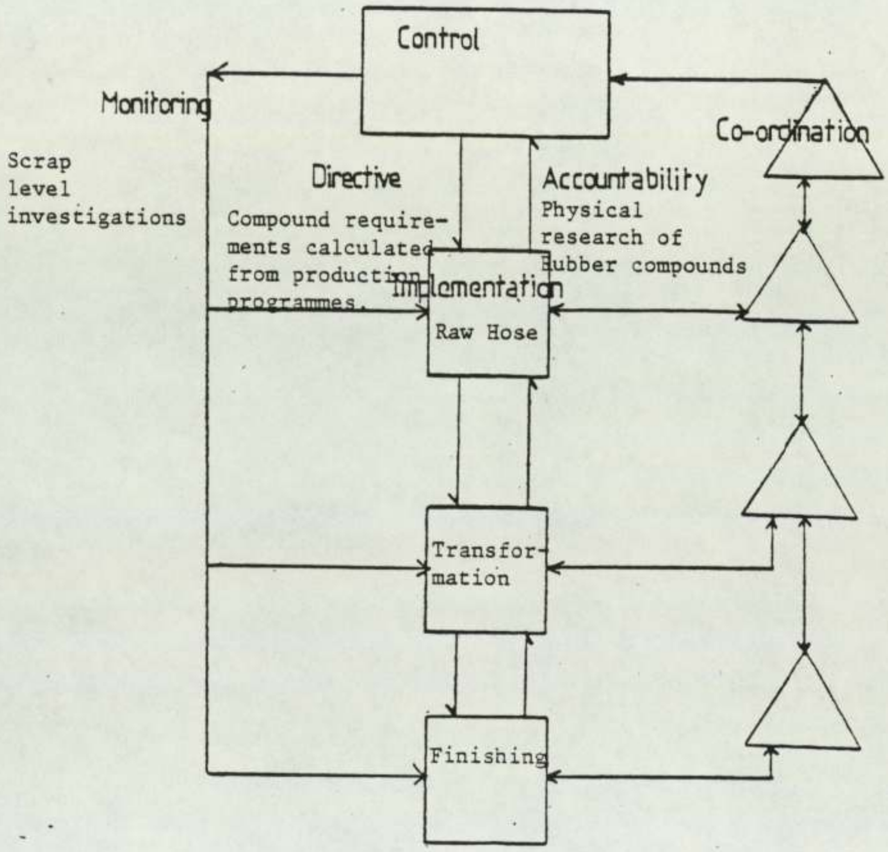


Desired

	Directive	Accountability	Co-ordination	Monitoring
1.	Provision of sufficient man-power to meet pro-duction schedules.	Operative Performance	When bottlenecks occurred, or imme-diate operative shortages were seen, labour would be switched from a "less im-portant" process	Investigations of productivity and methods of in-creasing it.

Diagram 4.8

Communication Channels for Fidelity Materials Aspects

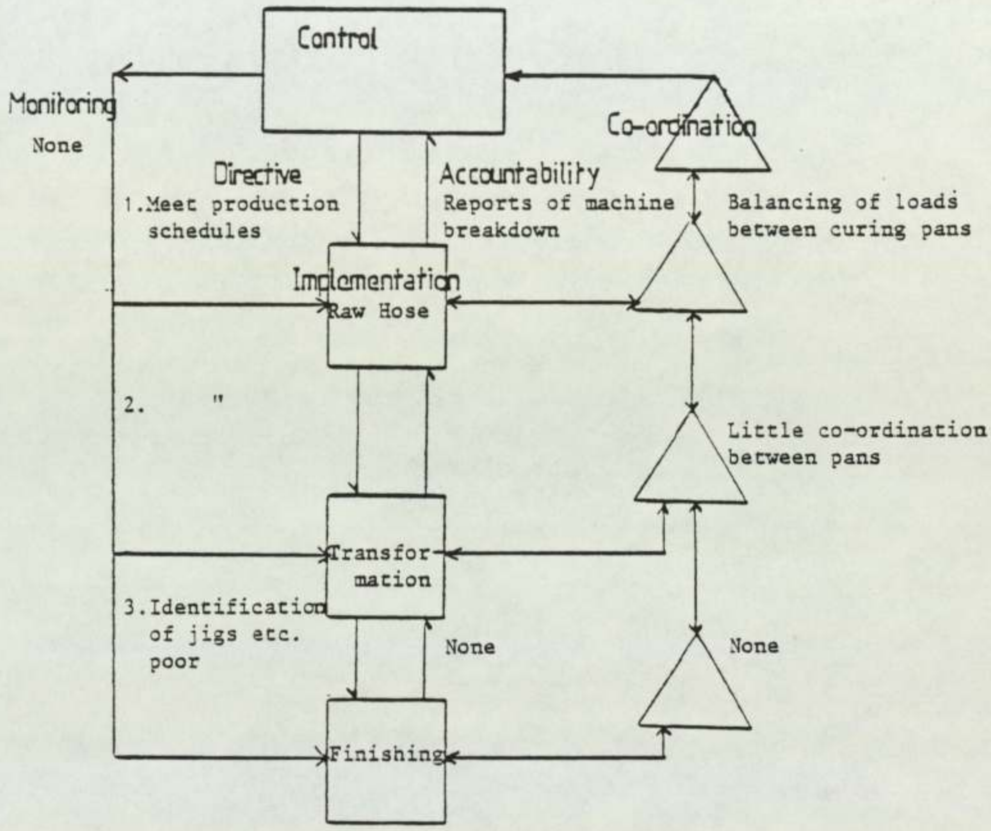


	Directive	Accountability	Co-ordination	Monitoring
1	Amount of compound required	Notification of compound delivery, and usage.	By Foremen balancing the compounds supplied, if necessary.	Continuous scrap level investigations.
2.	Amount of yarn required	Amount of yard delivered and used.		
3.				

Communication Channels for
Fidelity Finance Aspects

Diagram 4.9.

Actual



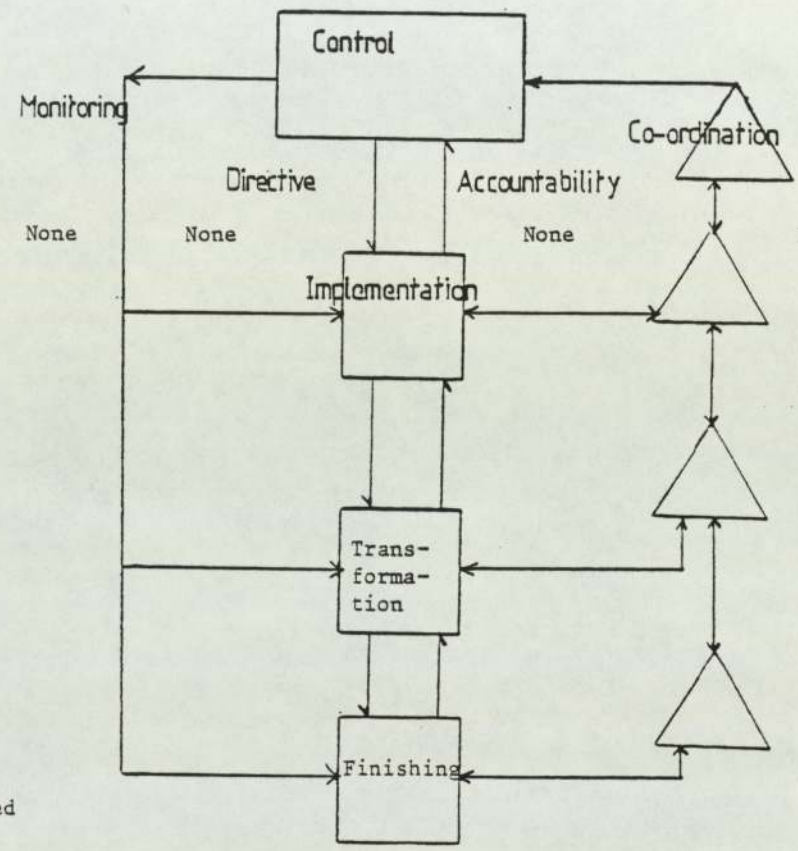
Desired

Directive	Accountability	Co-ordination	Monitoring
1. To meet production schedules.	Project measure of machine use.	Balance between mills extruders + knitting machines priority orders.	Assessments of machine utilisation.
2. "	"	Balance between pans - high priority orders first - if breakdowns occur	
3. To finish hose products.			

Communication Channels for Fidelity Finance Aspects

Diagram 4.10.

Actual



Desired

	Directive	Accountability	Co-ordination	Monitoring
	1. To produce hoses in the most cost effective manner.	1. Cost per unit production.	- Reduction of total cost, by better communication between processes + by less stoppages.	Analysis of the best methods to reduce overall costs.

DIAGRAM 4.11

	BUILT HOSE SUMMARY OF ANOMALIES
PRODUCTION	* Production programmes prepared by Foremen rather than Programmers * Co-ordination between materials preparation and production department poor. * Production treated as a skilled building process and capacities not measured (i.e responsibility given entirely to operatives)
MANPOWER	* Skilled nature of Built hoses in general meant that labour was a very significant constraint on production.
MATERIALS	* Supply of materials in advanced state of manufacture from many different sources * Control of raw materials supply by Compounds Department rather than Built Hose itself. * Physical separation between the Foremen and compounds planner produced poor co+operation. * Scrap measurements not related to production processes.
MACHINE	* No measures on machine use and capacity
FINANCE	* No costing information available.

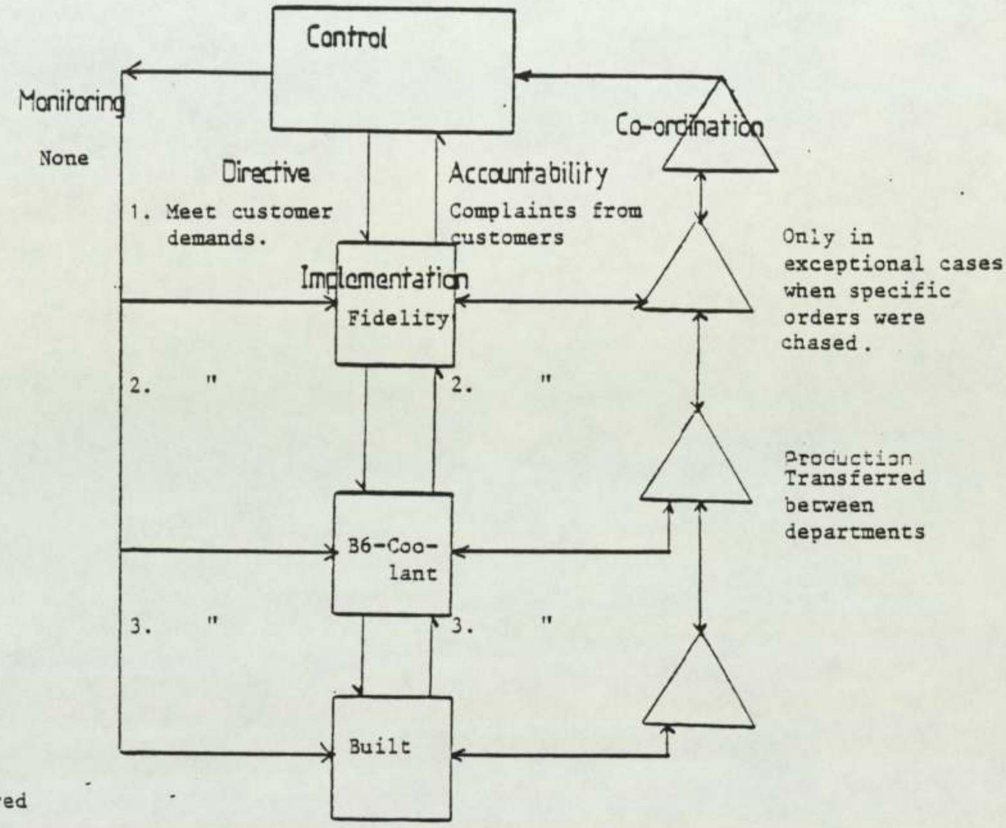
DIAGRAM 4.12

	86 COOLANT HOSE SUMMARY OF ANOMALIES
PRODUCTION	* Miscellaneous hoses produced with rawhose from various departments were contradictory to the stated aim of an autonomous department * Variations in hoses meant difficulty in planning loads for the curing pan. * Little information on productivity due to the lack of suitable measures.
MANPOWER	* Demand in 86 was far less than could be achieved by the available labour. * Lack of suitable measures to base manning levels on. * Absenteeism rife and productivity poor (despite the lack of productivity measures)
MATERIALS	* 86 Coolant ostensibly autonomous yet rawhose was supplied by Fidelity and the New Bay as well. * Scrap levels measured but not related to specific processes or compared with any form of 'norm'
MACHINE	* Lack of information on machine use
FINANCE	* No costing information at this level

Communication Channels for Coolant Production and Quality Aspects

Diagram 4.13

Actual



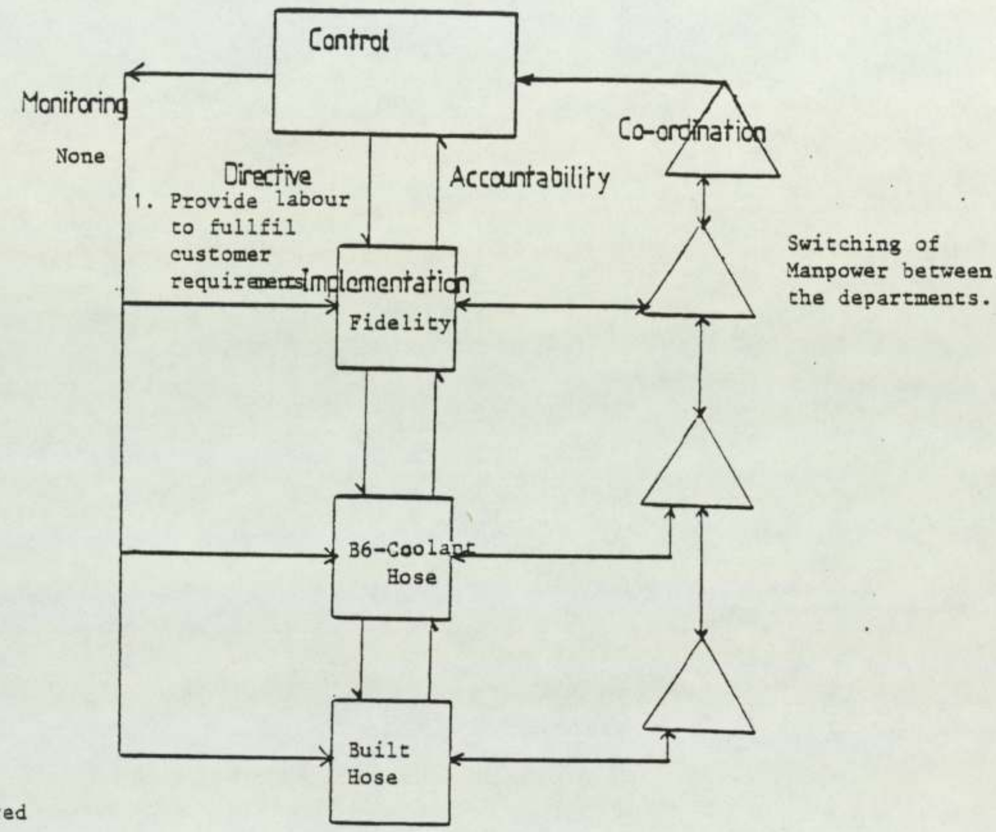
Desired

	Directive	Accountability	Co-ordination	Monitoring
	1. Meet the actual customer requirements according to set of pre-defined priorities.	The proportion of customer orders met on time + quality of the hoses produced	Co-ordination to increase the proportion of customer orders satisfied (by effective co-operation between departments)	Methods - by which the number of orders met on time could be increased.

Communication Channels for Coolant Manpower Aspects

Diagram 4.14

Actual



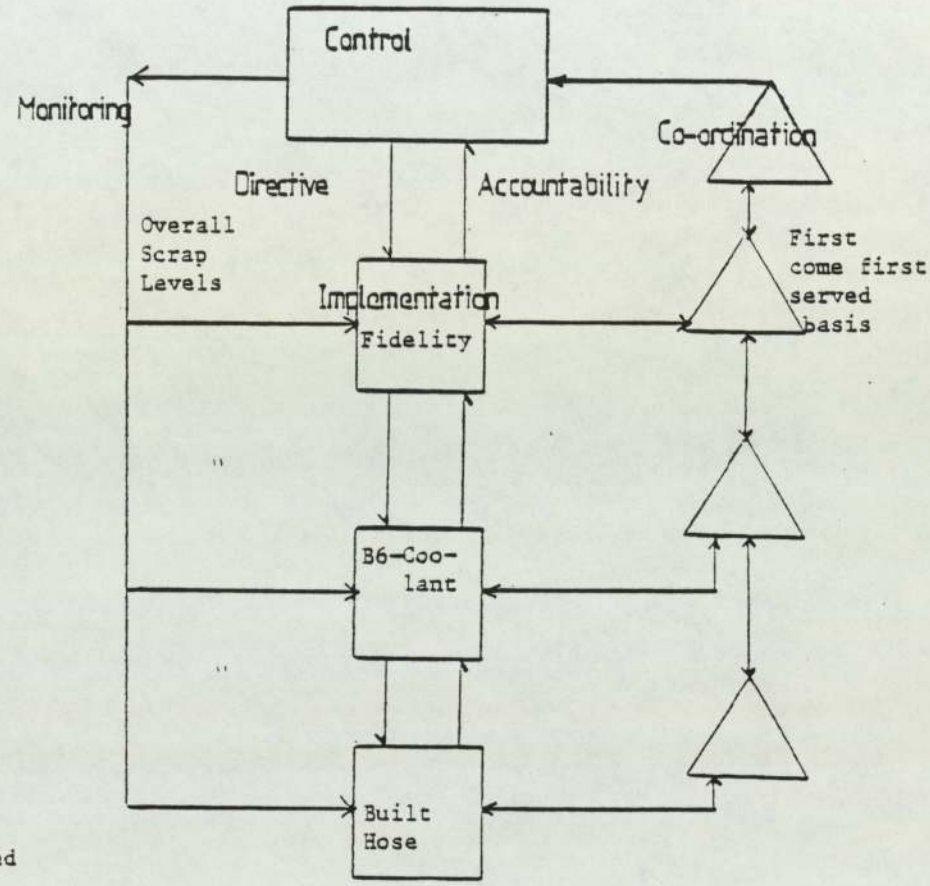
Desired

	Directive	Accountability	Co-ordination	Monitoring
	1. To provide sufficient manpower to meet customer requirements.	The effectiveness of manpower provided, to meet customer orders.	Switching of manpower to meet product in higher priority areas.	Effective manning levels - i.e. effect of increased overtime etc.

Diagram 4.15

Communication Channels for

Actual Coolant Materials Aspects



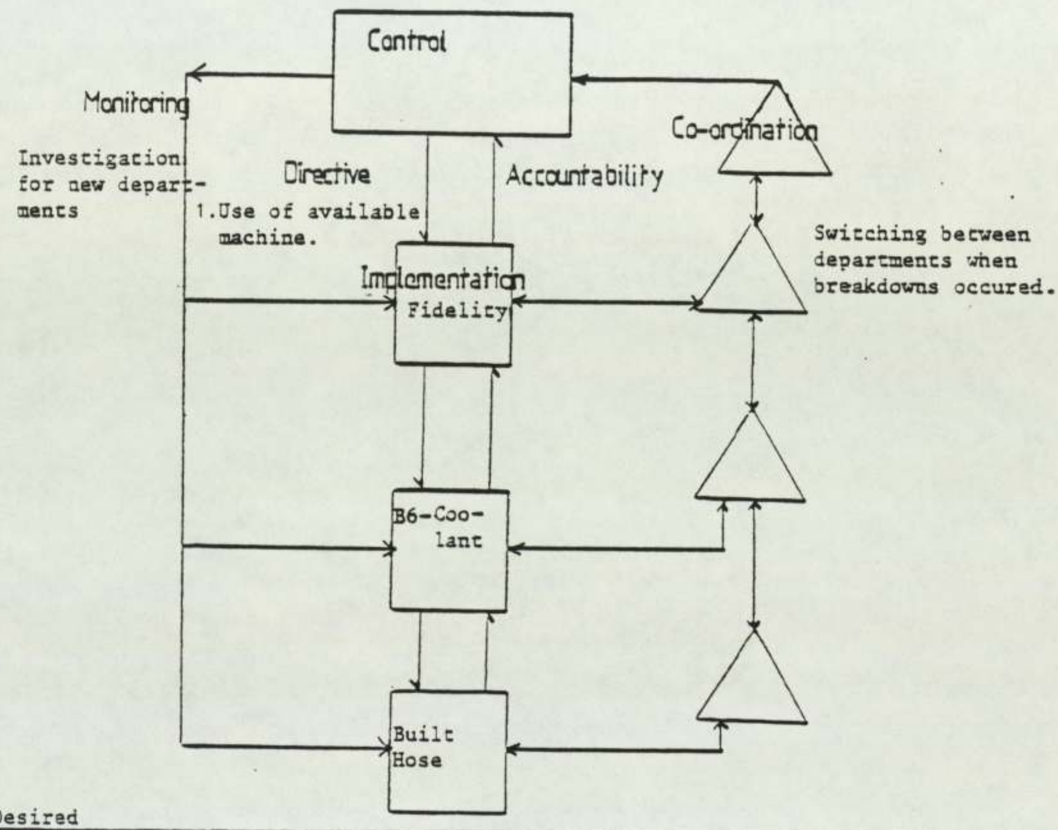
Desired

	Directive	Accountability	Co-ordination	Monitoring
1.	General require-ments for envisaged custo-mer demand.	The actual compound requirements made.	Co-ordination of available com-pound between depts on a priority basis.	Methods of in-creasing the accuracy of envisaged re-quirements.

Communication Channels for Coolant Machine Aspects

Diagram 4.16

Actual



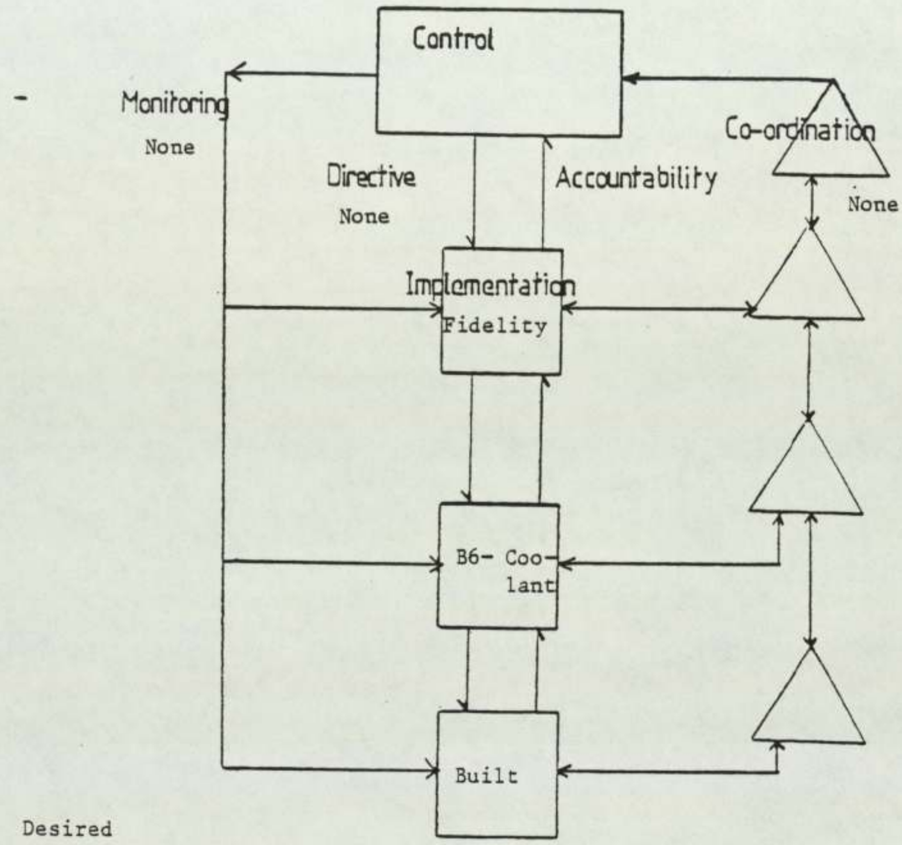
Desired

	Directive	Accountability	Co-ordination	Monitoring
	Maximise the use of machines.	Use made of available machinery.	Co-ordination between departments to maximise machine use.	Investigation of bottlenecks and methods of increasing machine use.

Communication Channels for Coolant Finance Aspects

Diagram 4.17

Actual



Desired

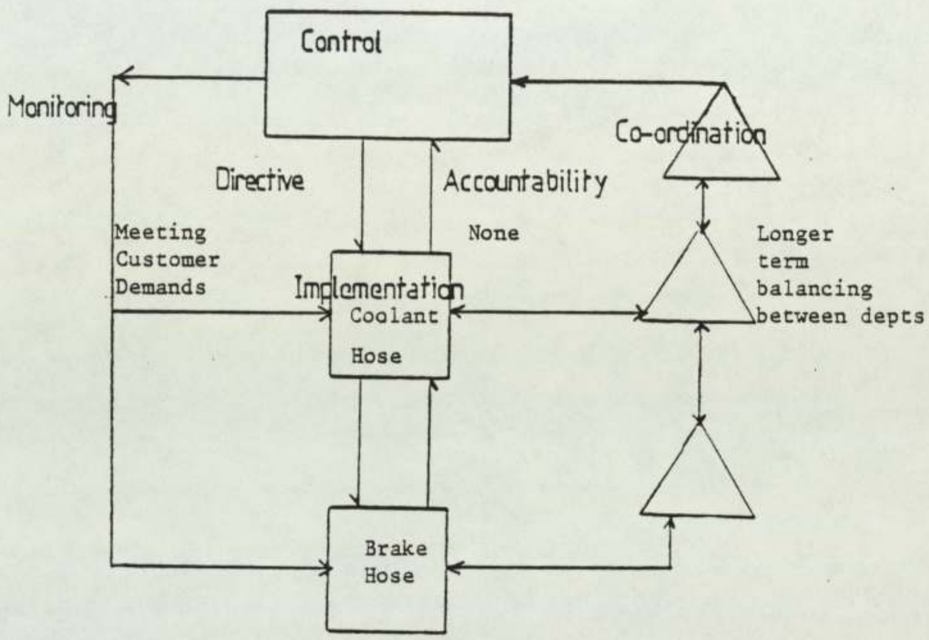
	Directive	Accountability	Co-ordination	Monitoring
	1. Reduce overall cost of production.	Cost per unit production	Switching between depts.	Methods of reducing cost. For example making autonomous departments.

Diagram 4.18

Communication Channels for

Autohose Production Aspects

Actual



Desired

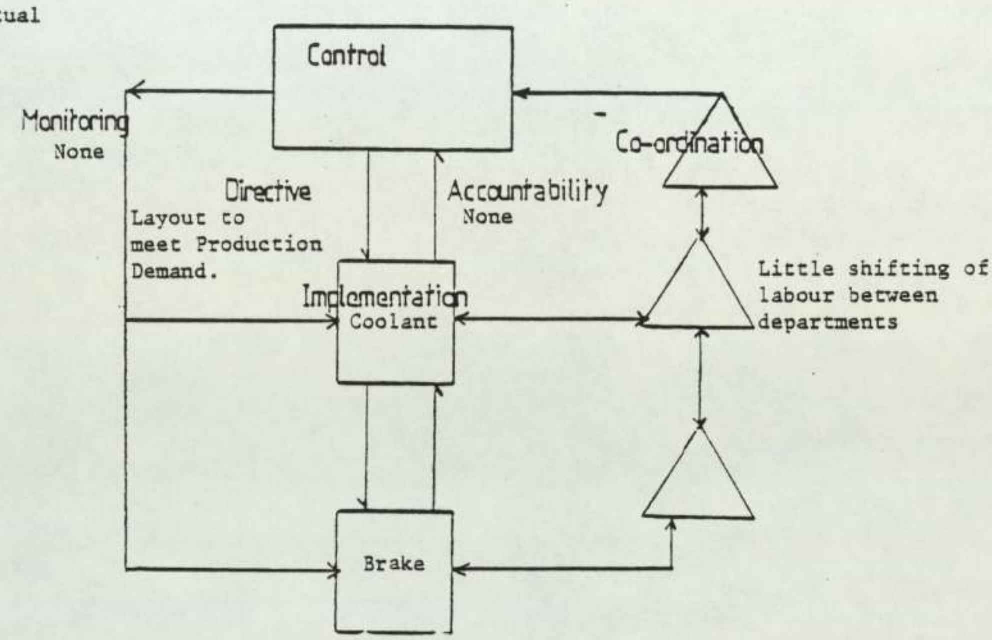
	Directive	Accountability	Co-ordination	Monitoring
	Targets for next period.	Achievement against Target.	Balancing of Production to achieve targets.	Methods of increasing likelyhood of meeting targets

Diagram 4.19

Communication Channels for

Autohose Manpower Aspects

Actual



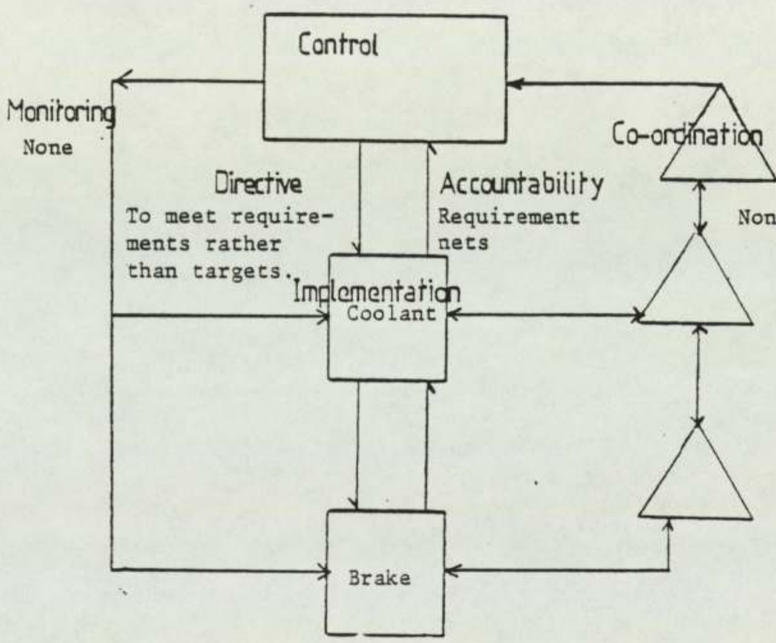
Desired

	Directive	Accountability	Co-ordination	Monitoring
	1. Labour requirement to meet Target.	Whether labour levels are sufficient to meet targets.	Switching of labour between depts according to envisaged targets.	Methods of Meeting and Increasing targets.

Communication Channels for Autohose Materials Aspects

Diagram 4.20

Actual



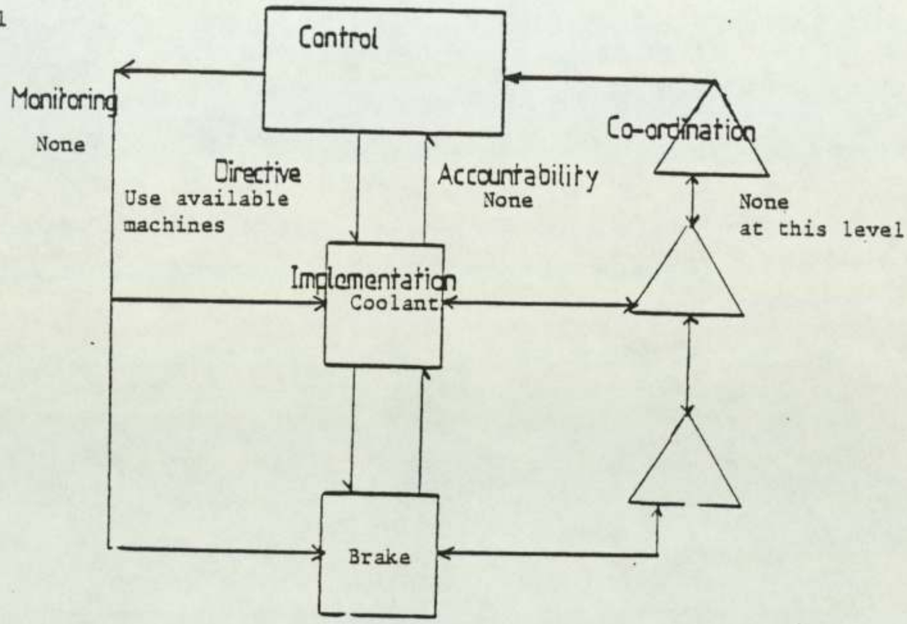
Desired

	Directive	Accountability	Co-ordination	Monitoring
	1. Envisaged requirements to meet targets.	Actual achievements against targets.	Balancing of requirements between depts.	Methods of meeting targets.

Communication Channels for

Autohose. Machine Aspects   Diagram 4.21

Actual



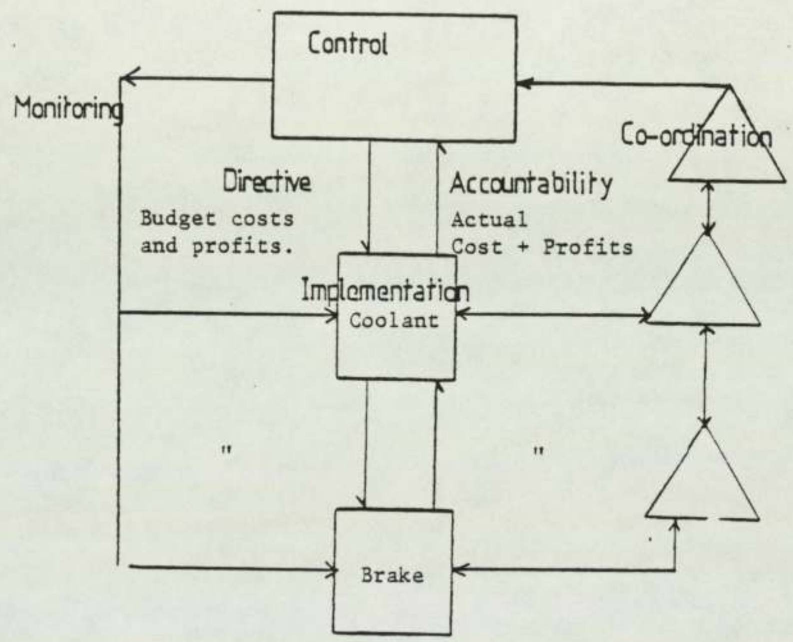
Desired

	Directive	Accountability	Co-ordination	Monitoring
	1. Maximising of machine use to meet targets	How machine use effected the meeting of targets.	Sharing of load between ovens.	Methods of increasing effective machine use, requirements for further machinery.

Diagram 4.22

Actual

Communication Channels for
Autohose Finance Aspects



Desired

	Directive	Accountability	Co-ordination	Monitoring
	1. To reduce budgeted costs and maximise profits.	Achievement against these requirements.	To keep overall costs to a minimum.	Methods available to reduce costs, and/or max. profits or investigation of specific areas.

CHAPTER FIVE

THE MANAGEMENT INFORMATION SYSTEM DESIGN

5.0 Introduction

Up to now the discussion presented has centred on pin-pointing the problem areas within the Autohose Factory. In this chapter the way in which the majority of these problems could be alleviated, by the provision of an Information System, is discussed in terms of the design of a System based on the Cybernetic Model.

5.1 The Design of the Coolant Hose Management Information System

The first stage in the design of any Management Information System (M.I.S.) is the formulation and assessment of the units or building blocks. In the case of the Coolant Hose M.I.S. developed here, many different measures are used for different information aspects, but in the main Standard Minutes are used as the basis for production levels.

In the context of the Cybernetic Model the building blocks are modified from the absolute values such as Standard Minutes into indices.

Three types of index have been designed according to guidelines recommended by Beer (23).

These are:

* Productivity.
* Latency.
* Performance.

For the moment we are concerned with the Productivity Index. The other indices will be discussed later on in this chapter and are summarised in Diagram 5.1.

The Productivity Index is formed by the comparison of levels of achievement with a reference value based on "What could have been achieved with existing resources, under existing constraints, if the organisational aspects were improved (23)". This reference value is, in terms of the Cybernetic Model, the "CAPABILITY" value and the achievement against this the "ACTUALITY" value.

Therefore:

Actuality / Capability = Productivity.

An example illustrates the point:

If the maximum "performance" for an operative producing lining extrusions was, at its highest, 1.15 (115%) (that is in 480 minutes, 552 Standard Minutes would be achieved) then in two shifts the maximum minutes of production would be 1104 Standard Minutes. If the actual production level for these two shifts was, for example, 960 Standard Minutes, then the Productivity would be 960/1104 or 0.87 (87%) of what could have been achieved.

This type of index forms the "raw material" for the Coolant Hose M.I.S. and has been applied to all production processes and other important aspects. In addition indices have been designed for information aspects (in general) for each of the production processes. They are:

* Production level.
* Reject level (Quality).

* Attendance (labour).
* Overtime.
* Materials input.
* Materials scrap.
* Machine use.
* Prime cost of materials and energy.
* Prime cost of labour.

While it is suggested that each process should have most of these indices, in many instances they would not all be appropriate or applicable. For example in the Trimming process (considered here) there is no machinery and so an index of Machine Use would be wholly inappropriate.

The advantages afforded by the use of these indices at this, the lowest in the hierarchy of the management levels (the third management level) are manyfold:

* Increased intrinsic motivation for operatives. For example, it was observed that many operatives were interested in, and actually motivated by, a "Productivity Index" incentive scheme introduced to the Polymer Engineering Division as a whole. If operatives could actually see their group productivity on a daily or even weekly basis, then they would probably have more motivation. This would also apply in principle to all other information aspects, of which absenteeism stands out in particular.

* More accurate recording would result. For example when a production figure was written down in the Foreman's ledger it could take weeks or even months before anyone would notice a mistake, and by then it would be very difficult to establish the true figure. In comparison if the production figure was immediately compared with a reference value, then it could be seen whether the figure was within the normal limits set for production variation. If it wasn't then questions would be asked immediately, and if necessary physical checks made to verify the true production figure.

* Increased co-ordination between (or self-regulation of) production groups would result from the individual groups' ability to see what was happening and where difficulties were occurring. It would then enable immediate action to be taken to alleviate the problems causing the difficulties. For example if the Curing Pan Productivity Index was high and the sorting one was low then action could be taken immediately to increase the productivity of the sorting process according to previously deviced procedures. One method of doing this for instance would be to grant overtime to the sorting operatives to cope with the increased workload. Failure to take action over a long period was the cause of very large build-ups of unsorted hoses, and the eventual shut down of Curing Pans, to enable the backlog to be

cleared.

* Accurate assessment of production levels and the balancing of production processes over longer time periods.

* The generation of consistent information with respect to time and production processes. For example indices of prime cost would relate to each production process and directly with scrap-levels. So, for instance, the reduction in scrap for a production process could be seen to have a direct effect on the prime cost. Alternatively it may well be that scrap reduction is far less important in terms of cost reduction than, say, making better use of machine time. Whatever the true situation the use of indices would provide information to establish what it was.

* Over and above the use of these indices for process level information they would also be used as the building blocks for further information at higher management levels together with other information aspects (these are discussed in the detailed design in section 5.3).

So far the basic elements of the Management Information System (M.I.S.) have been formulated. There would be two phases to the introduction of a "System" to achieve these fundamental requirements.

* The provision of meaningful measures.
* The assessment of Capability values.

Meaningful Measures

The base measures are the key factors for the introduction of an M.I.S. and without them no serious control system could be implemented. In some instances in Coolant Hose some very unstable measures were prevalent, for example in B6 (discussed in the case study in Chapter Six). Where suitable and possible all production measures have been based on Standard Minute Values, which, at the time of this analysis were being remeasured throughout the Metalastik and Autohose Groups. For information aspects where Standard Minutes were not available and were unsuitable then the appropriate measure has been used (suggested measures are listed in Diagram 5.2 together with the measures used at the time of this analysis).

Assessment of Capability Values

Once meaningful measures have been introduced, then an assessment of the Capability for each process (and information aspects) would be made.

The productivity index could then be readily calculated as described previously by:

Measure (Actuality) / Capability = Productivity.

5.1.1 Conversion of Data into Information

The provision of indices, as described above, could not really be counted as an information system for anything but the basic, lowest management level. It would simply be providing data in a slightly different form from the previous method if applied directly to higher management levels.

To provide information rather than data there are two requirements:

* The information must be in a format directly comparable to the objectives set by the management. In other words the information must be provided in a form from which the recipient could make decisions, and

* The information must be selective, that is provide information on exceptional situations initially so as to prevent an overload of data. An example of this happening was seen during a meeting with the Metalastik Order Processing Manager who was heavily overloaded with reams of computer printout (Appendix A4).

Here the usefulness of using the Cybernetic Model as a tool for analysis can be seen. For example during the analysis (Chapter Four) when relatively specific objectives were set then correspondingly specific feedback on the achievement of objectives was required. So from the objectives an assessment of the information requirements of the particular manager have been made. By design this Management Information System also caters for the other extreme cited during the analysis using the Model, that of loose objectives but correspondingly good co-ordination. The use of the indices themselves provides such co-ordination and in addition, the basis for the monitoring of the productivity of the processes or functions concerned (this is further elaborated in the section, Presenting the Information in section 5.2.5).

5.2 Techniques to Provide the Information

Two different types of technique have been used to provide information from the basic, raw or "atomic" indices:

* Filtering of the data to ascertain what pieces of it were exceptional.

* Modelling of the "Atomic" indices to provide the correct format for information, to the people requiring it.

5.2.1 Filtering

There are a number of different techniques available to filter out the most salient, exceptional pieces of information from a mass of data, and for the reader interested in more detail of these techniques they are discussed further in Chapter Six. Here it will suffice to say that limits are applied to each side (above and below) the data, as in Diagram 5.3, to determine what may be termed as exceptional. For example if the Productivity for a process was on average 0.7 (70%) and we were interested in any fluctuation in this of, say, greater than plus or minus 0.15 (15%), then any Productivity values between 0.55 and 0.85 would not interest us because they would be within our limits. But a productivity value of 0.9 or 0.5 would interest us and would therefore be termed an exceptional piece of information. There a number of methods available ranging from a simple set of cut-off values to more complicated self-adjusting limits or "smoothing". The smoothing enables the Productivity values to be, effectively, averaged so that any new values significantly different from the average may be highlighted. Over and above this facility the same techniques that are used for smoothing may be used to forecast the next expected Productivity so that any differences from this expected values can be immediately seen and investigated (Diagram 5.14). Again these topics are further discussed with examples in the next chapter.

So now having established what data is relevant it must be presented in a meaningful, aggregated form. This has been termed modelling.

5.2.2 Modelling

So far the way in which the data may be filtered so that "noise" can be removed and only the most significant deviations reported, has been discussed breifly. The question now is who wants or requires the information? In terms of the model developed in Chapter Four people were not really identified as being Controllers, Policy Makers or Co-ordinators, but the functions they performed were. The advantage of this distinction between people and functions is that, one person could perform (and invariably did) a multitude of functions, which could also cross the boundaries of the management levels described. The design of the Management Information System allows for this, and in addition, has been designed to allow for the dynamic nature of Coolant Hose. In other words there is no rigid or fixed format for this Information System.

The importance of this can be seen by the example of the inflexibility of the Autohose financial control sheets that were presented to A.H.G. by the Accounts Department. It required the employment of one person full time to systematically sort through the computer printout and put the data into the correct format for the A.H.G. Manager for him to get the information he wanted.

The design presented here and in the next section is therefore meant only as an initial step or catalyst towards the provision of an effective Management Information System, and for the management themselves to determine their exact needs. Additionally the design given here is subjectively based on discussions with managers, but this presupposes that the management knew what they actually wanted and that this interpretation is the correct one. Once an information system of the basic type discussed has been provided people would be able to see what could be made available, and it might well be that they would then realise the need for information in another form or from another source to that initially provided. This M.I.S. allows for, and is specifically designed to enable such alterations.

For example, a manager concerned with the effect of absenteeism on production levels might want to combine indices of Attendance and Production level to produce a relative index, but another manager or even the same one in different circumstances might require information to enable him to make a decision on manning loads, in which case the original attendance index would be more meaningful.

The main point here then is that the basic "atomic" indices could be used to provide any form of "molecular" or "hybrid" (combined) indices that would be required.

To further illustrate the meaning of modelling the atomic indices into molecular indices two hypothetical examples are included in Diagram 5.4.

The difference in the two examples given is in the way the atomic indices have been grouped. In example one the controllers at management level two are interested in how the indices A, B, and C interact while the index D is important enough to warrant a direct comparison with the summation of the other indices.

In example two management level two has given equal importance to each of the atomic indices but is interested in how A and B and C, and D interact together.

In both cases management level three is interested in the overall interaction but (depending on the type of summation used for the index) index F will be given more weight in example one.

In practice the same applies. For example the situation in example one could apply to four processes and represent the indices of Prime Cost. It would then mean that process D contributed more to the total cost than any of the other processes and was therefore thought to be more important in terms of control. If it was of equal importance to the other three processes then example two would apply.

A further detail concerning the Productivity Index is appropriate at this point. The Productivity Index was given (above) as the ratio of Actuality (what was done) to Capability (what could be done with better organisation). This is true for indices of, say, production level when the Capability is larger than the Actuality, but in the case, for example, of prime cost then:

Productivity = Capability / Actuality.

This is because the objective is to reduce the cost of the hose which would be lower than the Actuality value. This enables the index to be kept to a value between zero and one.

The second phase of systems design, then has briefly shown the development of filters to provide the exceptional information, and the provision of a method of modelling the "atomic" indices to provide information at a suitable level of detail that may readily be altered.

5.2.3 Coding

The question now arises of how to identify each index (atomic and molecular) so that it may readily be identified and then subsequently manipulated.

A relatively simple coding system has been devised to distinguish between all types of index. Each index has been allocated two letters, for example PR, QU, AT, and so on for the information aspects of production level, quality, and attendance. Each production process has been identified firstly by the type of process, that is "Rawhose", "Transformation", "Finishing", (RH, TR, FN, respectively) and subsequently by a number relating to the production process. The coding system for Fidelity Hose is given in Diagrams 5.15 to 5.19.

As an example, the Machine Use information aspect of Fidelity Hose Knitting would be coded as FD-4KN-MC1 and is derived in the following manner.

Fidelity Hose :	FD
Knitting Process :	4 (level four) KN
Machine Use :	MC1 (machine number one)

5.2.4 Other Indices

So far the formulation of Productivity Indices and the way in which they may be agglomerated into molecular indices has been discussed. There are also two other forms of index besides that of Productivity on which this M.I.S. is based:

* Latency, and
* Performance.

The Latency Index can be seen as the ratio of the Capability value to one of Potentiality. This potentiality value is "what could be achieved over and above better organisation by investment in machinery and the removal of constraints".

For example the investment of capital to acquire additional curing pans so that other processes could be used more fully. Thus:

Capability / Potentiality = Latency.

The product of Latency and Productivity then forms the third index of Performance, which shows how well a process or aspect is doing in relation to what could be done with "all the stops pulled out".

So the assessment of a third value, Potentiality for all aspects and processes for which a Capability value would be assessed would complete the fundamental requirements for indices for this Management Information System.

There is however, a vital aspect to the supply of information that has not yet been discussed, and that is how to present the information.

5.2.5 Presenting the Information

The design of the information system so far, could feasibly be implemented using a manual method. It would however be labourious and remove much of the immediacy of the information, and therefore its usefulness. In this section the way in which the information is presented is reliant on the use of a computer system (for which the detailed design would be the subject for further research - Chapter Seven), and more specifically the use of remote Visual Display Units (VDU's) with printers and keyboards for input. Their use is explained in the following text.

The ultimate aim of this Management Information System is to provide accurate, useful information in such a way as to be meaningful to management. The way in which this information is presented is ergonomically and psychologically one of the best methods available (3).

The recursive nature or the way in which each management level is similar to, and nested within, each higher management level means that the same methods of presentation may be used for each level. Together with the ability to use the same filtering methods this gives major advantages in terms of computation resources required.

The approach adopted here to describe the formats for presenting the information has been to take one (it could be any) management level and describe the information available.

The control function or manager at this management level would first of all receive a summary of exceptions that occurred (on a daily basis) within his areas. This would be displayed on the VDU in his office in a similar format to that in Diagram 5.5. The first column would indicate the number of the exception, and the second the area identification code (for the index). The third column would show what the exception status was (this is further discussed in Chapter Six), and the last column would then show the actual Productivity Index.

A chart similar to Diagram 5.6 would enable the manager to see exactly what area was involved (from the index code) and he could decide from this information whether any of the exceptions highlighted required further examination. The code for obtaining further information would be readily learnt but until then typing "HELP" would printout the information as in Diagram 5.7.

The information given for any particular command is depicted in the Diagrams 5.8 to 5.13. These are now described briefly.

Taxonomic Graph of Productivity (Diagram 5.8)

This graph would enable the Mean Productivities for a process to be seen immediately so that an accurate measure would be available to make decisions relating to the balancing of other processes or factors affecting the current process.

Actual Productivity (Diagram 5.9)

This diagram illustrates the way in which the Productivity Indices would be presented on request (command G) so that an immediate picture of the past and present situations for the specified Index Centre could be seen at a glance.

Actual Productivity and Forecast (Diagram 5.14)

This diagram shows, again on request, the Productivities of the process compared to the forecasted values based on the past data. So it could be seen exactly why an exception had been highlighted, plus the forecasted Productivity value for the next day.

Organisation of the Indices (Diagram 5.10)

This diagram shows how the manager would be able to request a description of the way in which the Indices were formed.

It contains both the absolute values and the indices for the currently accessed Index Centre.

Position of the Index Centre (Diagram 5.11)

Here the position of the Index Centre, in terms of management level, would be displayed on request so that a manager could immediately "get his bearings". The currently accessed Index Centre would flash on the screen to emphasise its position.

Latency and Performance Index Graphs (Diagrams 5.12 and 5.13)

These graphs would show the Latency and Performance Indices for the current and historical data relating to the currently accessed Index Centre.

Diagram 5.8 provides the link between the command entered and the respective display provided.

So although the design of the system would initially provide a limited amount of information specific to that manager, the facility would exist for examining any information within the system as a whole (by specifying the display and Index Centre identification code). In terms of the Cybernetic model this is the co-ordination function. In addition the facility would also be provided whereby the manager could obtain a hard copy (printout) of any information presented on the VDU for future reference, to supply to other people, or to provide the initial confirmation to the manager that the information system was trustworthy.

The provision of the hardcopy productivity graphs would provide the basis for the co-ordination mechansim and would be provided from a terminal in the Foreman's office at the end or beginning of each day so that operatives could see their daily Productivities.

5.3 Indices for Coolant Hose

From the first half of this chapter the reader will have recognised five stages in the development of this Management Information System:

* Provision of meaningful measure.
* Assessment of capability values.
* Filtering for exceptional information.
* Modelling the atomic indices into molecular indices.
* Presenting the information.

In this section we are concerned with the analysis of existing measures, the need for accurate new measures, and the way in which the indices formed from these measures could be arranged to meet Management Information requirements. These are best depicted in tabular and diagramatic form in Diagrams 5.2 and 5.15 to 5.19.

A more detailed explanation for Fidelity is given here to clarify the diagrams.

5.3.1 Production Productivity Indices

In Diagram 5.2 the existing and recommended measures for the basic, "atomic" indices are summarised for each production process and each information aspect associated with them for the Fidelity management level.

Thus for the Lining process the measure in use was that of the footage of each bore size (of hose) produced. While such a measure provided the basis for excellent co-ordination with the other rawhose processes of Knitting and Covering, it provided little useful data on the capacity of the Lining process. Standard Minutes were in use but primarily for wages calculations. What is suggested here is the use of Standard Minutes of production to provide more accurate information on loading and true productivity. So, in Diagram 5.15 the "Production" atomic index for lining depicts the Productivity (as previously defined in the first section of this chapter) based on Standard Minute values. Similarly the "production" atomic indices for the knitting and Covering processes are based on the use of accurate Standard Minute values.

The Cutting-to-length process for Fidelity Hose also requires measures both in terms of number of hoses cut and Standard Minutes of production. The number of hoses measured would be required to co-ordinate with the Curing Oven operatives to provide data on the actual rawhose lengths available, while the Standard Minutes measure would be used as the basis for an atomic index. The Fidelity curing process was split into the number of curing pans in use. Here the measures used were, again the number of hoses or to be more exact the number of mandril lengths produced (mandril lengths could be further cut into individual hoses). Suggested measures here are hose lengths to aid co-ordination and in addition Standard Minutes of production as the basis for the atomic index of Production. Here an atomic index of Production has been designed for each curing pan.

In addition to the Production Indices in Diagram 5.15 there are atomic indices of Quality. This index has been designed to show the efficiency of production in terms of quality of the product as discussed in Chapter Four. There is a distinction here between product rejects and scrap. For example in the Lining process lumps in the rubber would be counted as waste scrap whereas incorrectly extruded lining would be counted as product scrap.

The reason for collecting data on product scrap is important since much of the rejected hose may be used again, but the time or Standard Minutes spent producing the rejected hose can not. Thus the Quality atomic index would be based on Standard Minutes of production for reject lining extrusions. The same principle applies to the other quality indices. In most other cases the rejected product could not be re-utilised. But one outstanding exception to this was the re-use of the rejected rawhose which could be used for the manufacture of straight length built hoses when rejected for Fidelity use.

A Quality Index has not been designed for the Cutting-to-length process since there should be no product scrap, only waste scrap.

The Curing process on the other hand should produce only product scrap and no waste scrap and so in Diagram 5.15 there are no curing scrap indices.

We now come to the finishing processes which were under relativity lax control. Here the measures suggested are Standard Minutes of production for all the Production Productivity Indices.

Four Quality Indices have been included for these processes; two for Jig Trimming, one for Spouting and the final one at Inspection. These indices would be based on the number of hoses lost, so at the Jig Trimming stage where a lot of "unofficial" inspection occurred the number of reject hoses would be as closely measured as they were already, for example at the inspection stage.

The twenty two Production and eighteen Quality Productivity Indices, make up the basic atomic indices for production and quality information for Fidelity Hose.

Atomic Indices

The atomic indices provide an accurate basis for the Management Information System at higher levels of management and an important method of co-ordinating operatives at the lower management levels. So at this level each index would relate to the operatives involved with each of the production processes.

Information would be related to operatives, not as the index alone, but as part of a graph of Productivity against time (as in Diagram 5.9). The question probably now arises of how this graph would aid co-ordination between the process over and above the measures, for instance, of hose lengths. The answer is in the way in which operatives would relate not only to their own Productivity graphs but also those of closely linked production processes (which would be displayed prominently in the working area). Thus when the other processes showed adverse fluctuations the operatives themselves could take the initiative to alleviate them. For example if hose curing production was very high and sorting low, then action could be taken as soon as the fluctuation in the Wash-sort-count Production Productivity graph was noticed (after one day). In addition such fluctuations could even be anticipated by the use of a short-term forecasting system as described earlier in this chapter and in Chapter Six.

Similarly the Quality Productivity graphs would aid co-ordination of quality between processes as well as providing an immediate feedback of information which would instil a sense of pride in the work performed by the operatives.

We now come to the use of the atomic indices for higher management levels, or the modelling of the indices.

Molecular Indices

The controllers of the operatives, that is the Foreman and Programmers require information to enable them to make quick, accurate decisions. Therefore a multitude of Productivity graphs (there are forty so far and more for other information aspects), in addition to other data and tasks, would be a hinderance rather than a help to them. What they would require is pointing in the direction of any problems, and so the basic indices must be filtered to provide such information. As discussed in section one of this chapter there are two ways in which this filtering can take place.

* By aggregating the information into a better form (modelling) and,

* By selecting the information so that only unusual circumstances are highlighted.

Rawhose

The first molecular index in Diagram 5.15 (starting at the bottom left corner) is that of Rawhose Production (3RH-PR), and the best measure of rawhose production is provided by the atomic index of Cover Extrusion Production (since both the Lining and Knitting process must have been successful for this process to proceed - the broken lines in the diagram show this association). Similarly the index of

Quality for Covering will reflect the overall rejects in the rawhose production process.

So these two indices would provide the Foreman and Programmers with information on production and quality levels, but only when exceptional.

Transformation Processes

The next molecular index (to the right) is Cut-to-length production and again this would show the Foreman and Programmers when production was adversely low or even adversely high. There is no Quality Index because the nature of the cutting process means that very little rejects as opposed to scrap are produced.

The Battery Production Index shows the combined production from all the battery mandril curing areas in the "Fidelity" section. Here pan four has been included as a battery pan but it often cured loose mandrils as well. It has been included because many of the loose mandrils were for long runs, that is the mandrils were not frequently changed, whereas other loose pans had frequent mandril changes.

The index in this case is simply an average of the individual atomic indices.

Likewise the Battery Quality Index is formed from an average of the individual Quality Indices. It should be noted here that the measures used for production and quality are quite different, Standard Minutes for production and the number of reject hoses for quality. This does not matter from the point of view of information because the indices convert from absolute values into relative values. In fact this is one of the great advantages of using indices. That is, the quality is relative to a quality Capability rather than to the production level.

At first this might appear to be an odd way of assessing the quality since it (being based on reject hose numbers) is bound to vary with production levels. But this approach allows a link between reject hose and production levels without the need to assess Standard Minute values, for instance for rejects prior to curing.

So a combination of the Quality Index and Production Index could provide a third index showing quality relative to production. This type of index has been termed a combined or "Hybrid" index and is discussed in greater detail below.

Productivity Indices for loose mandril hose production and quality would be produced in a similar fashion to those of battery hose.

Finishing Processes

The molecular index for the Wash-sort-count Production reflects the average of the two atomic indices and would again be provided to Foremen and Programmers as an exception index. The same applies for all the other finishing process Production Productivities but not the Quality Productivities. These Productivities are closely linked with those of Battery Quality and Loose Quality (3BT-QU and 3LS-QU respectively) and the dotted line connecting these with Trimming Quality and Spouting Quality show this. The reason is because of "unofficial" inspection or rejection. At many of the finishing processes hoses that are considered unfit are discarded. This method of collating information on all discarded hoses will show the true efficiency of production (in terms of quality).

In Diagram 5.15, above the Battery and Loose Productivity Indices and above the Washing and Trimming Productivity Indices further molecular indices are depicted. These serve to filter the molecular indices, already explained, one step further. So, for example, the index of Transformation Production serves to highlight any anomalies in any of the transformation processes. Similarly the Hose Quality Index (3HS-QU) serves to identify any discrepancies in hose quality.

Over and above the Foremen, the Senior Foremen must identify any problems within the Fidelity production section as a whole. To meet this requirement two indices only are provided here, an index of Fidelity Production and one of Fidelity Quality. The Production Index is formed from the average of the Rawhose, Transformation and Finishing

Production Indices. But the Fidelity Qualtiy Index reflects the Hose Quality Index only (because the quality of rawhose contributes directly to the finished hose quality).

Management Level One

The highest management level is provided with two indices again, which are made up from the Production and Quality Indices of Fidelity, B6-Coolant and Built Hose production areas. The way in which these indices would be formed could be a simple average but this would not reflect any discrepancies in production volume. Accordingly the indices would be weighted, and this would be determined in the light of experience. Thus:

$$(CL - PR) = a(FD - PR) + b(BC - PR) + c(BT - PR)$$

Where CL - PR = Coolant Hose production index,

PD - PR = Fidelity Hose production index,

BL - PR = B6-Coolant production index,

BT - PR = Built Hose production index,

and a + b + c = 1.

These indices would also be provided on an exceptions basis, as described previously, so that only the most salient information would be presented other than by specific request.

Timeout

In addition there would be another form of exceptions index provided at each level of management. This would relate to those exceptions not acknowledged by the lower management level within a pre-determined time period (for example three days). For these exceptions the index would be displayed on the information menu for the next highest level of management (Diagram 5.5). This would ensure that problems were dealt with promptly and would notify managers of difficulties in lower management levels.

So far only production and quality productivity indices have been discussed. The indices relating to the other seven information aspects are now considered.

5.3.2 Manpower Productivity Indices

The two main aspects of manpower considerations are represented by the indices of Attendance and Overtime in Diagram 5.16. These indices would basically reflect the manning levels required to achieve the required levels of production. They correspond to each production process and are based on the measures of hours of attendance and overtime.

So the atomic index of Attendance shows the number of hours in attendance relative to an establishment or required value. Correspondingly the Overtime Index shows the number of hours of overtime worked relative to a pre-determined limit.

The Productivity values would provide both a direct feedback to operatives of their attendance levels and the basis for molecular and hybrid indices relating production and other Productivities to attendance and overtime.

Molecular Levels

At the first molecular level, where information would be supplied to Foremen and Programmers, Attendance and Overtime Productivities could be combined to mirror the Production Productivity Indices described above. This would enable direct comparisons to be made between the two information aspects and would facilitate the control of a particular production area such as Rawhose by a Foreman.

At higher management levels, information would be supplied as depicted in Diagram 5.16. All molecular indices would be provided from averaging the lower indices contribution to them and in a similar way to the Production Indices could be weighted if required.

5.3.3 Materials Productivity Indices

Materials aspects are represented by the two indices of Materials Use and Waste Scrap (as distinct from product scrap). Diagram 5.17 shows the processes for which one or both of these indices could be provided.

The main inputs for Fidelity are during the rawhose processes. Here the atomic indices show the compound used relative to the maximum (Capability) value. It is important to distinguish between compounds and yarn used, rather than those supplied, because supply was weekly and usage daily.

Waste scrap indices would reflect the scrap levels relative to a maximum allowance and supplied as for all other atomic indices on a daily basis. For all indices of materials use and waste scrap measures would be based on weights.

Molecular Indices

As for Manpower Indices, Materials Use and Waste Scrap Indices would mirror the Production Indices where appropriate. These are summarised in Diagram 5.17.

5.3.4 Machine Productivity Indices

The availability of machine time effectively dictates the production level for all processes where machinery is used. Reflecting the importance of machine availability, then is the Machine Productivity Index, based on the machine use relative to the theoretical maximum availability of that machine. In Diagram 5.18 the processes utilising machinery of any significance to production levels are given. Again these indices are divided into the atomic or basis indices and the summated or molecular indices which correspond to the Production Productivity Indices.

5.3.5 Financial Productivity Indices

The aim here has been to provide indices of Prime or Direct cost rather than a comprehensive costing information system (Diagram 5.19). The main value of this design is in the consistency of the prime cost with production processes and all the Productivity Indices associated with these (described above), which will enable a more accurate true cost of production to be calculated for any particular hose. Since this forms a so called "Hybrid Index" it is discussed in the section with that title below.

In summary then, the indices have been designed to convey accurate, concise information to all management levels in the Coolant Hose section of the Auto Hose Group in a consistent manner for all information aspects. But these indices have only been used in their pure (uncombined between information aspects) form so far, now their use as building blocks for hybrid indices is considered.

5.4 Hybrid Indices

The Diagrams 5.15 to 5.19 show the way in which atomic indices have been designed and modelled into molecular indices. Now the way in which any of those indices may be considered with each other is discussed.

In Diagram 5.20 the nine information aspects are represented on the left side and to the right eleven examples of hybrid indices are given. These are described below.

5.4.1 Quality to Production

The index of quality productivity whether it be atomic or molecular represents the amount of rejects relative to fixed desired level. This index would therefore vary with production levels. An index relating quality to production levels would therefore be more useful in many instances. This could be formed by multiplying the production and quality indices together so long as they were consistent in terms of level (i.e. the same index centre). Therefore:

Quality : Production index = Quality * Production.

It should be noted here that this would not give the proportion of reject hoses but an index of this proportion. The true proportion would be devised in the following manner.

Quality Index = Desired Capability (low) / Actuality (higher) = $(C1/A1)$ (1)

Production Index = Actuality (low) / Capability (higher) = $(A2/C2)$ (2)

Quality : Production Index = $(C1 / A1) * (A2 / C2)$ (3)

So if the two productivities were:

Quality (X) (4)

Production (y) (5)

then Quality : Production Index = $X * Y$ (6)

The proportion of reject hoses would be equivalent to

$A1 / A2$ (7)

since $A1 = C1 / X$ from (1) and (4)

and $A2 = C2 * Y$ from (2) and (5)

then $A1 / A2 = (C1 / X) * (1 / C2) * (1 / Y)$

$= (C1 / C2) * (1 / (X * Y))$

In other words the proportion of reject hoses would be the inverse of the Quality to Production index multiplied by the Quality Capability and divided by the Production Capability.

5.4.2 Production to Total Manpower

An index of production relative to the hours required for the production would be a useful indicator to show the efficiency of labour. It would be formed as for the previous index by multiplying the two component indices together. Again this would provide an index that could only be compared with itself. If a figure for the efficiency of the labour were required it could be determined as follows:

Production Index = Actuality (low) / Capability (high) = (A2 / C2) = (Y)

Manpower Index = Actuality (low) / Capability (high) = (A3 / C3) = (S) (9)

Efficiency = A2 / A3 (10)

then since A2 = Y * C2 (8)

and A3 = S * C3

then A2 / A3 = (Y * C2) / (S * C3)

In other words the Efficiency = (Y / S) * (C2 / C3) or the Production to Manpower index divided by the square of the Manpower index multiplied by the Production Capability and divided by the Manpower Capability.

5.4.3 Waste to Production Ratio

This index could be produced from the atomic indices in the following manner. Waste Index = C7 / A7 = R from (10)

and Production Index = A2 / C2 = Y from (11)

then Waste : Production = A7 / A2

since A7 = C7 * R

and A2 = C2 * Y

then waste : production = (C7 / C2) * (R / Y)

or the Waste index divided by the Production index and weighted by the waste Capability over the production Capability.

5.4.4 Total Direct Cost Index

The total direct cost index would be calculated from the labour and materials (or running) cost indices in the following way.

Labour cost = Capability (lower) / Actual cost (higher) = C8 / A8 = T (14)

Materials or running costs = Capability (lower) / Actual (higher) = C9 / A9 = W (15)

Direct cost = (Capability (C8) + Capability (C9)) / (Actuality (A8) + Actuality (A9)) = (C8 + C9) / (A8 + A9) (16)

since A8 = C8 / T and A9 = C9 / W (17)

then Direct Cost Index = (C8 + C9) / ((C8 / T) + (C9 / W) (18)

5.4.5 Production to Materials Used Index

An index of this form would show the materials used relative to production level. Such an index as for production to manpower would only be used relative to itself. In order to get a true value of the ratio the following transformation would be required.

Production Index = Actuality / Capability = A2 / C2 = Y (11)

Materials Used = Actuality / Capability = A6 / C6 = Z (12)

Therefore the Production : Materials value = A6 / A2 = (Z * C6) / (Y * C2)

5.4.6 Waste to Materials Used Index

This index would be formed in the following manner:

Materials Used Index = A6 / C6 = Z (12)

Waste Index = Capability (lower) / Actuality (higher) = (C7 / A7) = R (13)

therefore Waste to Materials Index = A7 / A6

since A6 = C6 * Z (14)

and A7 = C7 / R (15)

then Waste materials Index = (C7 / R) * (1 / (C6 * Z))

=(1 / (R * Z)) * (C7 / C6) (16)

5.4.7 Total Cost to Production

This index could be calculated from the total cost and production indices by:

Total cost = (C8 + C9) / (A8 + A9) from (16)

Production = A2 / C2 = Y from (11)

Cost to Production Index = (A8 + A9) / A2

A8 = C8 / T and A9 = C9 / W from (17)

Cost to Production = (C8 / T) + (C9 / W) / C2 * Y

5.4.8 Manpower to Machine Use

The manpower to machine use index would be calculated as follows:

Manpower = (A4 + A5) / (C4 + C5)

Machine = Actual use / Capability = A10 / C10 = P

Manpower Machine ratio = (A4 + A5) / A10

A4 = U * C4 and A5 = V * C5

A10 = P * C10

therefore Manpower : Machine ratio = ((U * C4) + (V * C5)) / (P * C10)

5.4.9 Total Manpower Used

The total manpower index would be formed from the attendance and overtime indices in the following manner.

Attendance Index = Actual Attendance (lower) / Capability (higher) = A4 / C4 = U

Overtime Index = Actual Overtime (lower) / Capability (higher) = A5 / C5 = V

Then the Index of Total manpower = (Actual attendance + Actual overtime) / (Att. Capability + Overt. capability) (A4 + A5) / (C4 + C5)

Since we have the indices U and V and wish to combine them we must weight each according to the number of hours specified for capability.

Therefore Total Manpower Index = ((U * C4) / (C4 + C5)) + ((V * C5) / (C4 + C5))

5.4.10 Production to Machine Use

This index could be calculated in the following manner:

Machine use = A10 / C10 = P

Production = A2 / C2 = Y

therefore Production : Machine = A2 / A10 = (Y * C2) / (P * C10)

It should be noted that for all these values calculated, a factor would have to be added to each end equation to allow for the units of the numerator and denominator so that the index would have a ceiling of the value one. The way in which this would be achieved would be to use a simple weighting of the hybrid index which would be subject to "tuning" by management to achieve the desired level of response. Examples of the Production to Manpower and Production to Machine use Hybrid Indices described above are given in the second section of Chapter Six.

5.5 Synopsis

To summarise, this chapter has described the design of the Coolant Hose Management Information System starting with the basic measurements, progressing through the way in which indices are calculated from these measurements and then manipulated to provide information for management. The techniques for providing the information fall into two categories, Filtering and Modelling.

The Modelling of the indices centres on the building of "index centres" along the framework of the Cybernetic Model described in Chapter Four. The Filtering techniques provide methods of sorting out the "noise" (that is minor fluctuations) from more important transients in, or changes in the characteristics of, the index centres.

In the following chapter the Filtering and Modelling techniques are discussed in greater detail as part of the Case Study.

DIAGRAM 5.1

THE INDEX DESIGN

```
POTENTIALITY ---------
                     :
                     :
                     :------- LATENCY ------
                     :                      :
                     :                      :
CAPABILITY   ---------:                      :--- PERFORMANCE
                     :                      :
                     :                      :
                     :--- PRODUCTIVITY -----
                     :
                     :
ACTUALITY    ---------
```

DIAGRAM 5.2

A TABLE OF EXISTING AND RECOMMENDED MEASURES FOR FIDELITY

PROCESS	PRODUCTION MEASURES		
	DETAIL	EXISTING	RECOMMENDED
LINING	extrusion of lining	footage	footage for co-ordination, remeasured SMV
KNITTING	knitting over lining	footage	footage, remeasured SMV
COVERING	final extrusion of covering	footage	footage, remeasured SMV
CUT-TO-LENGTH	cutting with guillotines	number of hoses cut	number of hoses, remeasured SMV
CURING	curing of hoses to fix shape of hose	number of hoses cut	number of hoses, remeasured SMV
WASHING, SORTING, COUNTING	washing of hoses after curing to remove lubricant	number of hoses sorted	number of hoses and SMV
JIG+TRIM	trimming of hoses to correct length	number of hoses trimmed	number of hoses and SMV
STAMPING	stamping of hoses with specified part number	no measures	SMV
CHECKING	checking hoses against inspection jigs for quality	no measures	SMV
COUNTING	counting the number of hoses	no measures	SMV

DIAGRAM 5.2 cont.

A TABLE OF EXISTING AND RECOMMENDED MEASURES FOR FIDELITY

PROCESS	MANPOWER	MEASURES	
	DETAIL	EXISTING	RECOMMENDED
LINING	four operatives - two shifts	attendance in hours - overtime when applicable	as for existing measures
KNITTING	one operative three shifts	as above	as above
COVERING	four operatives two shifts	as above	as above
CUT-TO-LENGTH	three operatives two shifts	as above	as above
CURING	two operatives - three shifts per day	as above	as above
WASHING, SORTING, COUNTING	three operatives - three shifts	attendance in hours - overtime when applicable	as in existance
JIG+TRIM	six operatives - three shifts	as above	as above
STAMPING	two operatives one shift	as above	as above
CHECKING	two operatives - one shift	as above	as above
COUNTING	two operatives - one shift	as above	as above

DIAGRAM 5.2 cont.

A TABLE OF EXISTING AND RECOMMENDED MEASURES FOR FIDELITY

PROCESS	MACHINE	MEASURES	
	DETAIL	EXISTING	RECOMMENDED
LINING	three inch Barwell Extruder	number of mins. breakdown	total number of minutes used
KNITTING	three knitting machines - for diff. bore sizes	as above	as above
COVERING	two extruders only one used	as above	as above
CUT-TO-LENGTH	three automatic guillotines	as above	as above
CURING	six curing pans three battery and three loose	as above	as above
WASHING, SORTING, COUNTING	three washing machines	as above	as above
JIG+TRIM	none	none	none
STAMPING	none	none	none
CHECKING	none	none	none
COUNTING	none	none	none

DIAGRAM 5.2 cont.

A TABLE OF EXISTING AND RECOMMENDED MEASURES FOR FIDELITY

PROCESS	MATERIALS	MEASURES	
	DETAIL	EXISTING	RECOMMENDED
LINING	compound received and checked by programmers	weight of each batch of compound	as for existing measures
KNITTING	various yarn types	weight of yarn used	as above
COVERING	as for lining	as for lining	as above
CUT-TO-LENGTH	none	none	none
CURING	none	none	none
WASHING, SORTING, COUNTING	none	none	none
JIG+TRIM	none	none	none
STAMPING	none	none	none
CHECKING	none	none	none
COUNTING	none	none	none

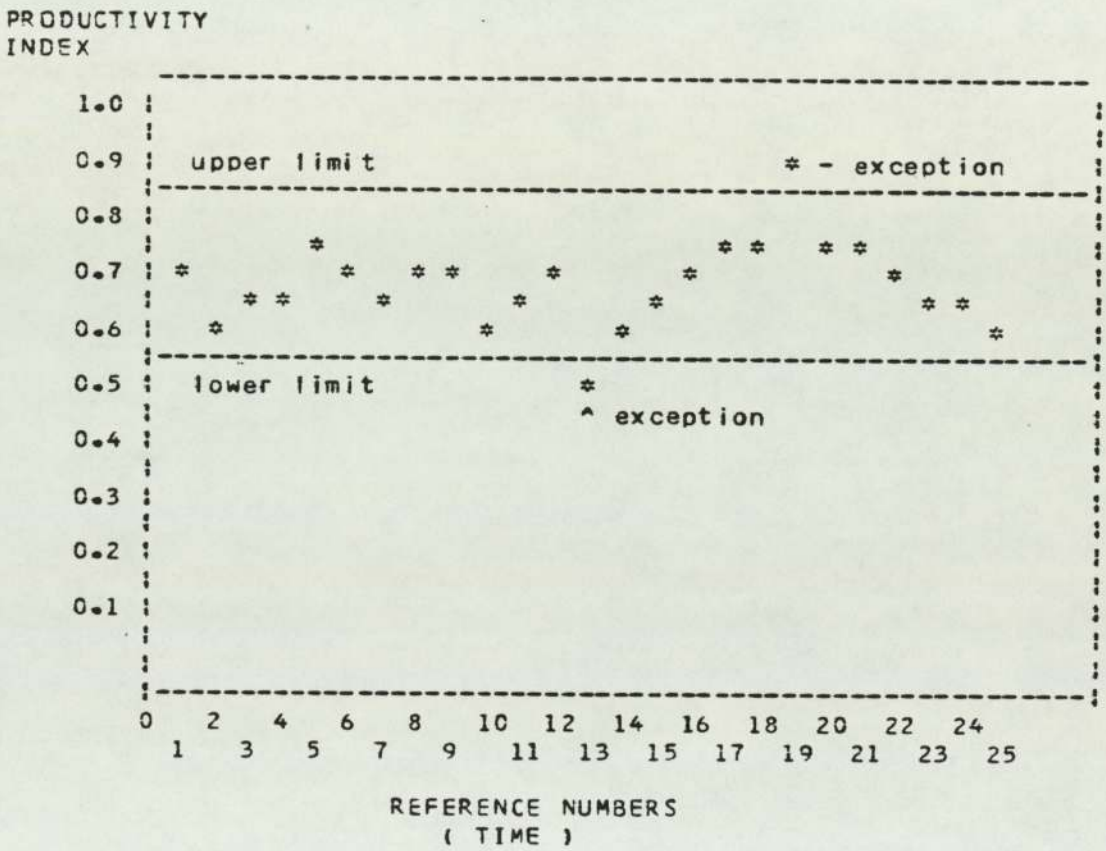
DIAGRAM 5.2 cont.

A TABLE OF EXISTING AND RECOMMENDED MEASURES FOR FIDELITY

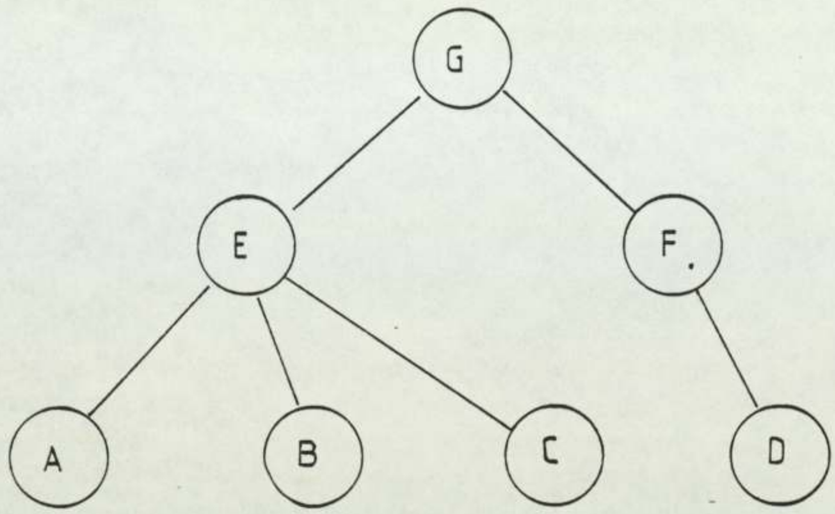
PROCESS	FINANCIAL MEASURES		
	DETAIL	EXISTING	RECOMMENDED
LINING	Accounts Dept assessment of compound per pound. labour costs	not used indirectly ass'd	cost of compound actual cost
KNITTING	cost of yarn per unit weight labour costs	as above	as above
COVERING	cost of compound labour costs	as above	as above
CUT-TO-LENGTH	labour costs	as above	as above
CURING	labour costs	as above	as above
WASHING, SORTING, COUNTING	labour costs	as above	as above
JIG+TRIM	labour costs	as above	as above
STAMPING	labour costs	as above	as above
CHECKING	labour costs	as above	as above
COUNTING	labour costs	as above	as above

DIAGRAM 5.3

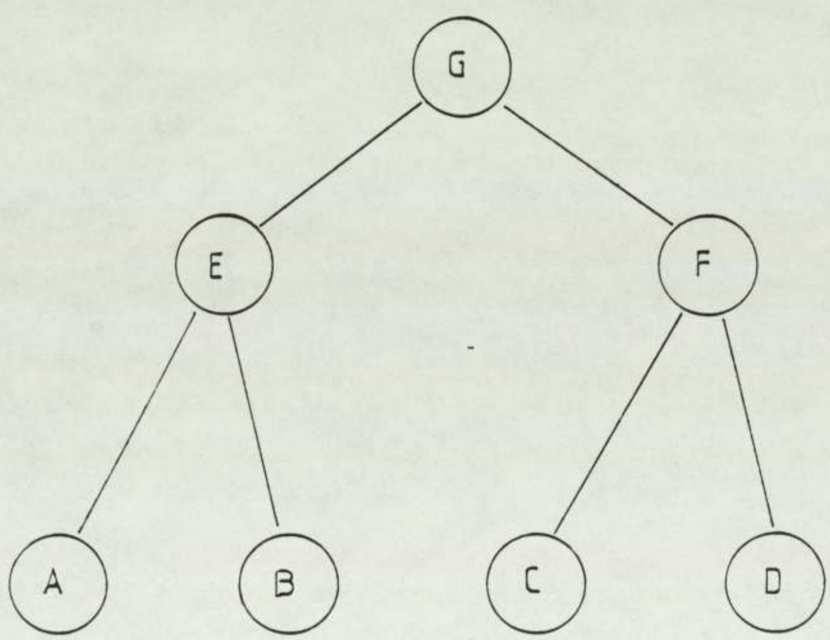
AN EXAMPLE OF THE LIMITS FOR EXCEPTIONS REPORTING



Index Modelling Examples Diagram 5·4



Example 1



Example 2

DIAGRAM 5.5

DAILY EXCEPTIONS REPORT
(EXAMPLE)

EXCEPTION NUMBER/CODE	DAY/MONTH	EXCEPTION STATUS	PRODUCTIVITY INDEX
1/FD-4KN-PR	9/9	HIGH	0.9
2/FD-4CV-AT	10/9	LOW	0.6
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
10/FD-4CR-PR1	10/9	HIGH	0.85

MORE DETAIL ON FACILITIES ? IF YES TYPE 'HELP'.
OTHERWISE TYPE THE REQUIRED COMMAND.

DIAGRAM 5.6

THE INDEX CENTRE OF LINING AND ITS ASSOCIATED AREAS   (EXAMPLE)

```
 ---------------
|               |
|***************|-----------
|***************|---------  |
 ---------------          | |    the index centre ( flashing )
                          \ /
                          ===============
                         I               I
                         I###############I-----------
                         I###############I---------  |
                          ===============           \ /
                          / \                       ---------------
                          | |                      |               |
 ---------------          | |                      |***************|-----\
|               |         | |                      |***************|-----/
|               |         | |                       ---------------
|               |         | |
|***************|---------  |
|***************|-----------
 ---------------
```

DIAGRAM 5.7

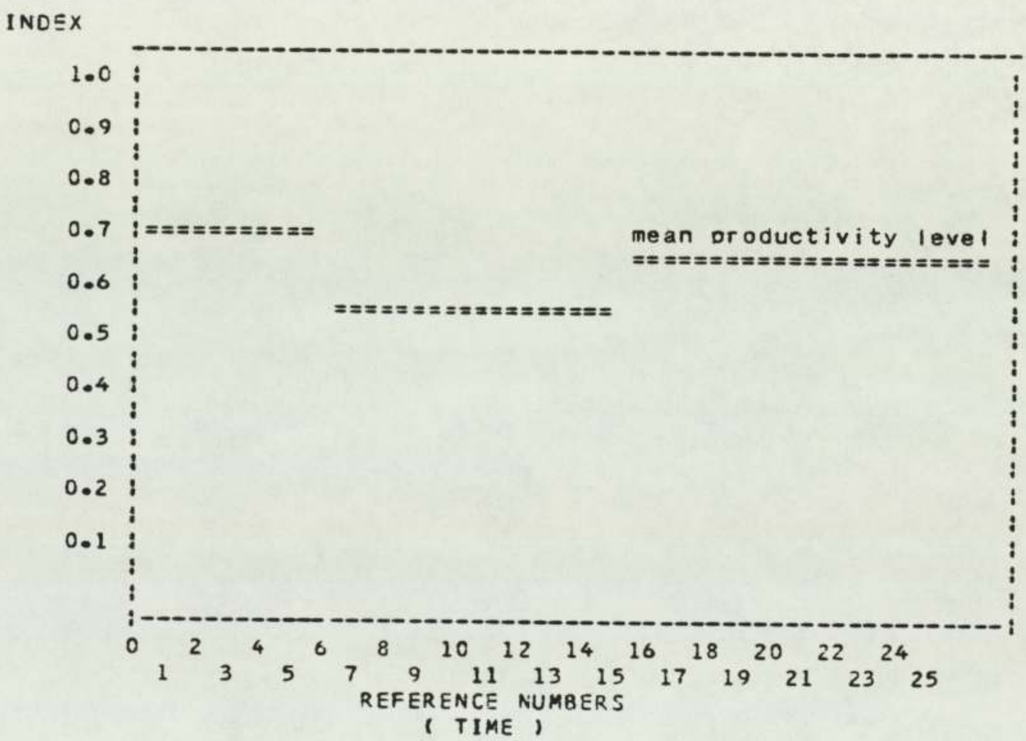
THE FACILITIES AVAILABLE ON EXCEPTIONAL INFORMATION ARE :

COMMAND	DISPLAY
*******	*******
<exception no. only>	TAXONOMIC GRAPH
G <index centre i.d. > <cr>	PRODUCTIVITY GRAPH
D <index centre i.d. > <cr>	INDEX DESIGN WITH ABSOLUTE VALUES
F <index centre i.d. > <cr>	QUANTIFIED FLOWCHART
M <index centre i.d. > <cr>	MOLECULAR INDICES
GL <index centre i.d. > <cr>	LATENCY GRAPH
GP <index centre i.d. > <cr>	PERFORMANCE GRAPH
H <cr>	HELP FUNCTION (this display)

<cr> = carriage return.

DIAGRAM 5.8

A TAXONOMIC GRAPH OF PRODUCTIVITY (EXAMPLE)



PRODUCTIVITY INDICES (EXAMPLE)

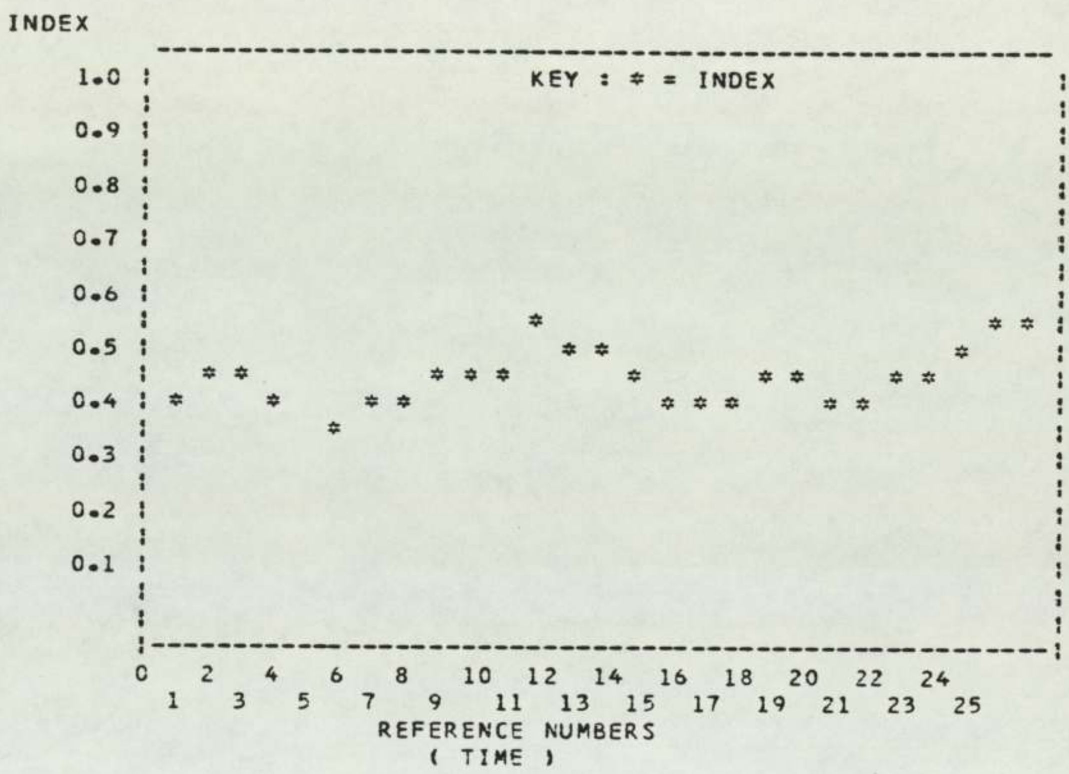


DIAGRAM 5.10

THE ORGANISATION OF THE INDICES (EXAMPLE)

( ) - ABSOLUTE VALUES   [ ] - INDICES

```
POTENTIALITY -( 50 )--
                     :
                     :
                     :------- LATENCY ------
                     :        [ 0.6 ]      :
                     :                     :
CAPABILITY   -( 30 )--:                     :--- PERFORMANCE
                     :                     :      [ 0.15 ]
                     :                     :
                     :--- PRODUCTIVITY -----
                     :        [ 0.24 ]
                     :
ACTUALITY    -( 7  )--
```

THE POSITION OF THE INDEX CENTRE
(EXAMPLE)

```
 MANAGEMENT LEVEL 1         --------------
                           :              :
                           :              :
                           :              :
                            --------------
 MANAGEMENT LEVEL 2             : :
 ==============                 : :               -------------
: index centre :                : :              :             :
:  ( flashing ):--------------     --------------:             :
:              :                                 :             :
 =============    ----------------------          -------------
      :  :                              :
      :   ------------------            :
MANAGEMENT LEVEL 3            :          -------------
      :                       :                       :
 --------------     -------------          -------------
:              :   :             :        :             :
:              :   :             :        :             :
:              :   :             :        :             :
 --------------     -------------          -------------
```

DIAGRAM 5.12

A GRAPH OF THE LATENCY INDEX (EXAMPLE)

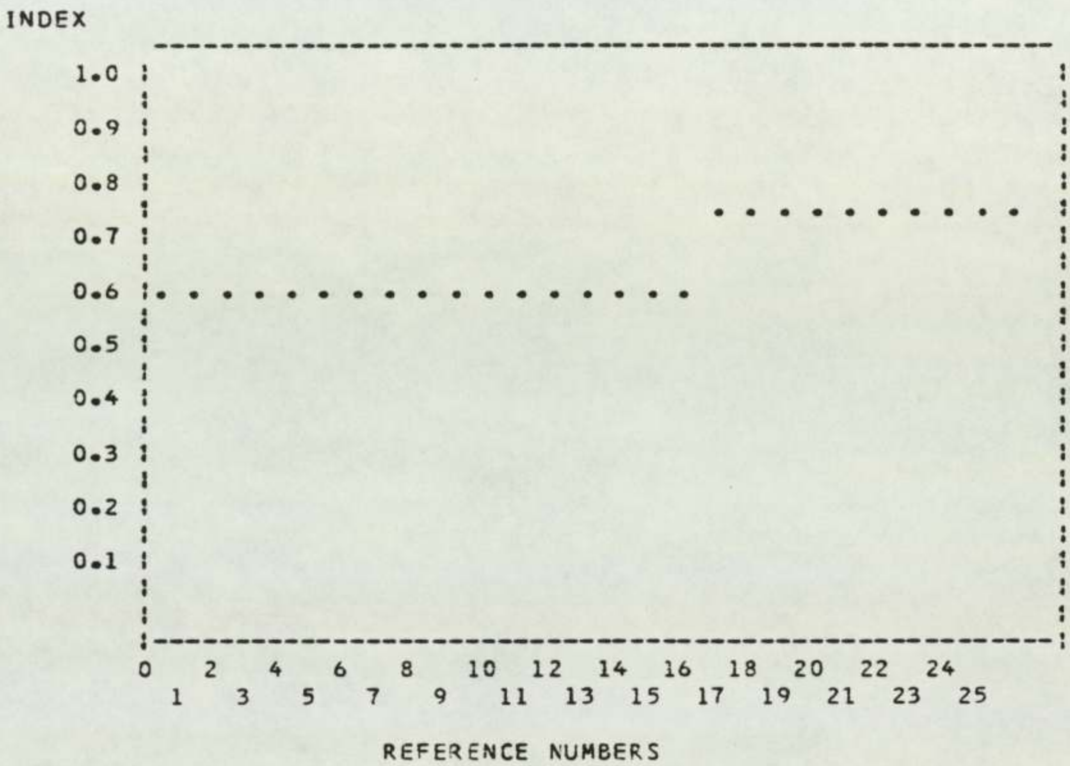


DIAGRAM 5.13

A GRAPH OF THE PERFORMANCE INDEX (EXAMPLE)

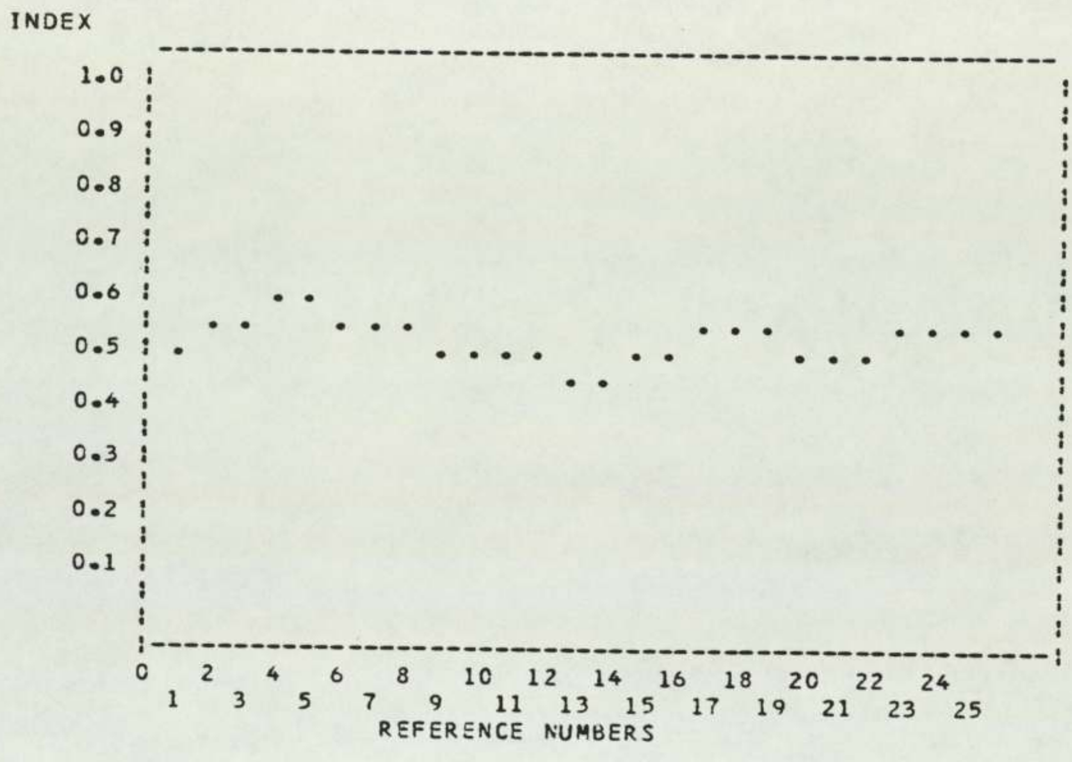


DIAGRAM 5.14

PRODUCTIVITY - ACTUAL AND FORECAST (EXAMPLE)

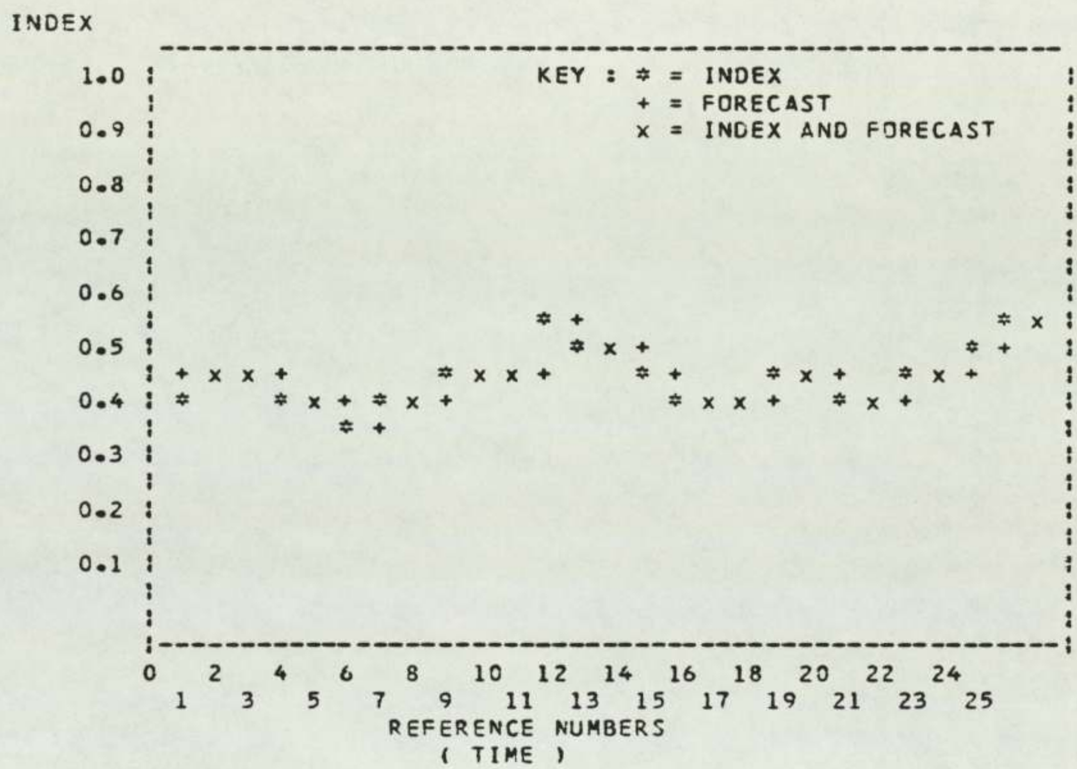


Diagram 5·15

KEY TO DIAGRAMS 5.15 to 5.19

BC = B6 Coolant Hose
BT = Built Hose
CL = Coolant Hose (Fidelity)
FD = Fidelity
3 = Management Level Three
4 = Management Level Four
RH = Rawhose
TR = Transform
FN = Finish
LN = Lining
KN = Knitting
CR = Covering
BT = Battery Curing
LS = Loose Curing
WS = Wash-Sort-Count
TM = Trim
ST = Stamping
IN = Inspection
LB = Label
DR = Drill
BF = Buff
SP = Spout

PR(no.) = Production
AT(no.) = Attendance
OT(no.) = Overtime
MT(no.) = Materials Supply
SC(no.) = Materials Scrap
QU(no.) = Quality (Product Scrap)

CL(no.) = Cost of Labour
CT(no.) = Running and Material costs
MC(no.) = Machine use

(no.) = Machine Number

_______ = Connections between atomic indices and molecular indices

- - - - = Shows the logical connection between atomic and molecular indices, but atomic index centre is not used for calculating molecular indices.

FIDELITY PRODUCTION AND QUALITY INDEX CENTRES

Diagram 5.15

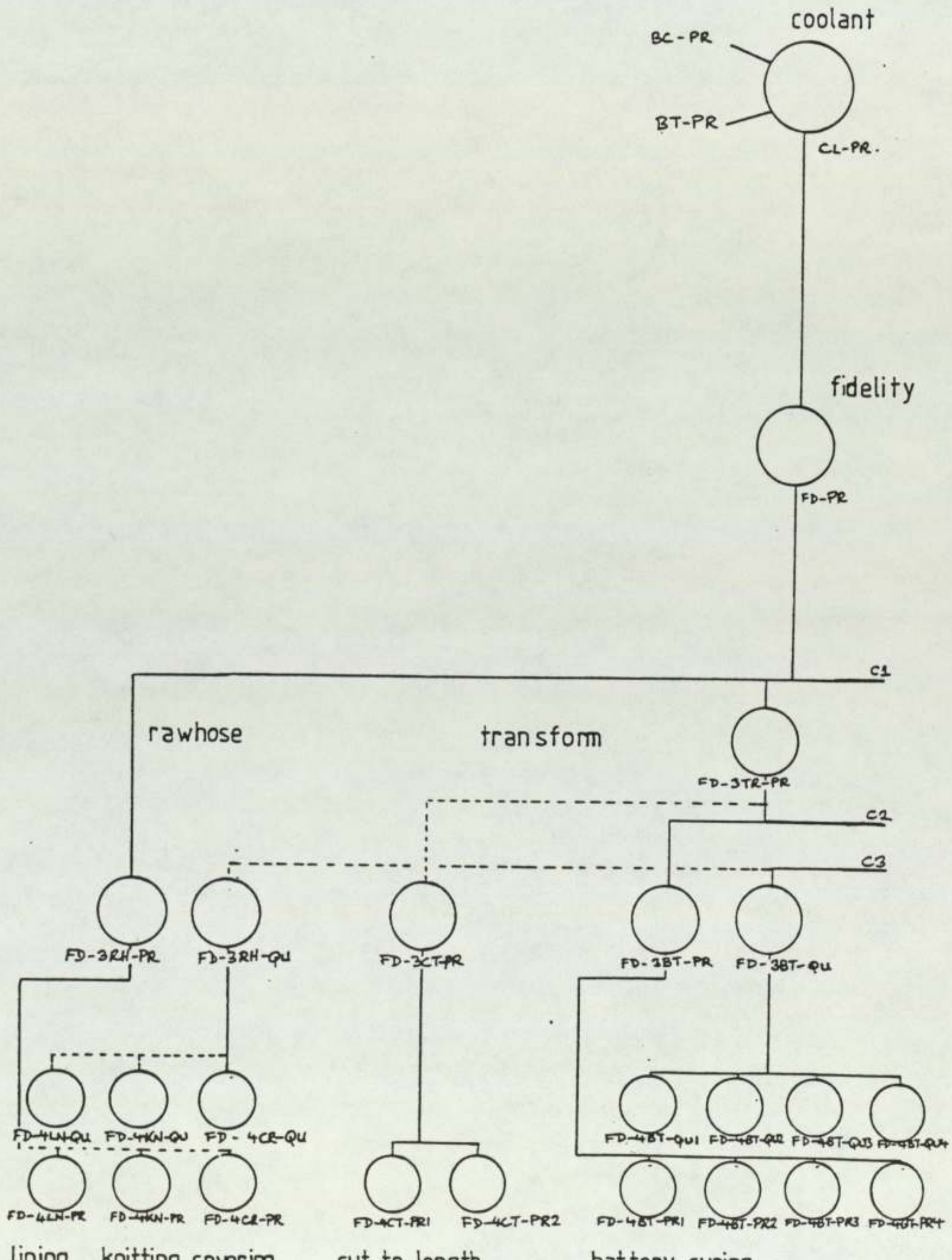


Diagram 5·15 cont.

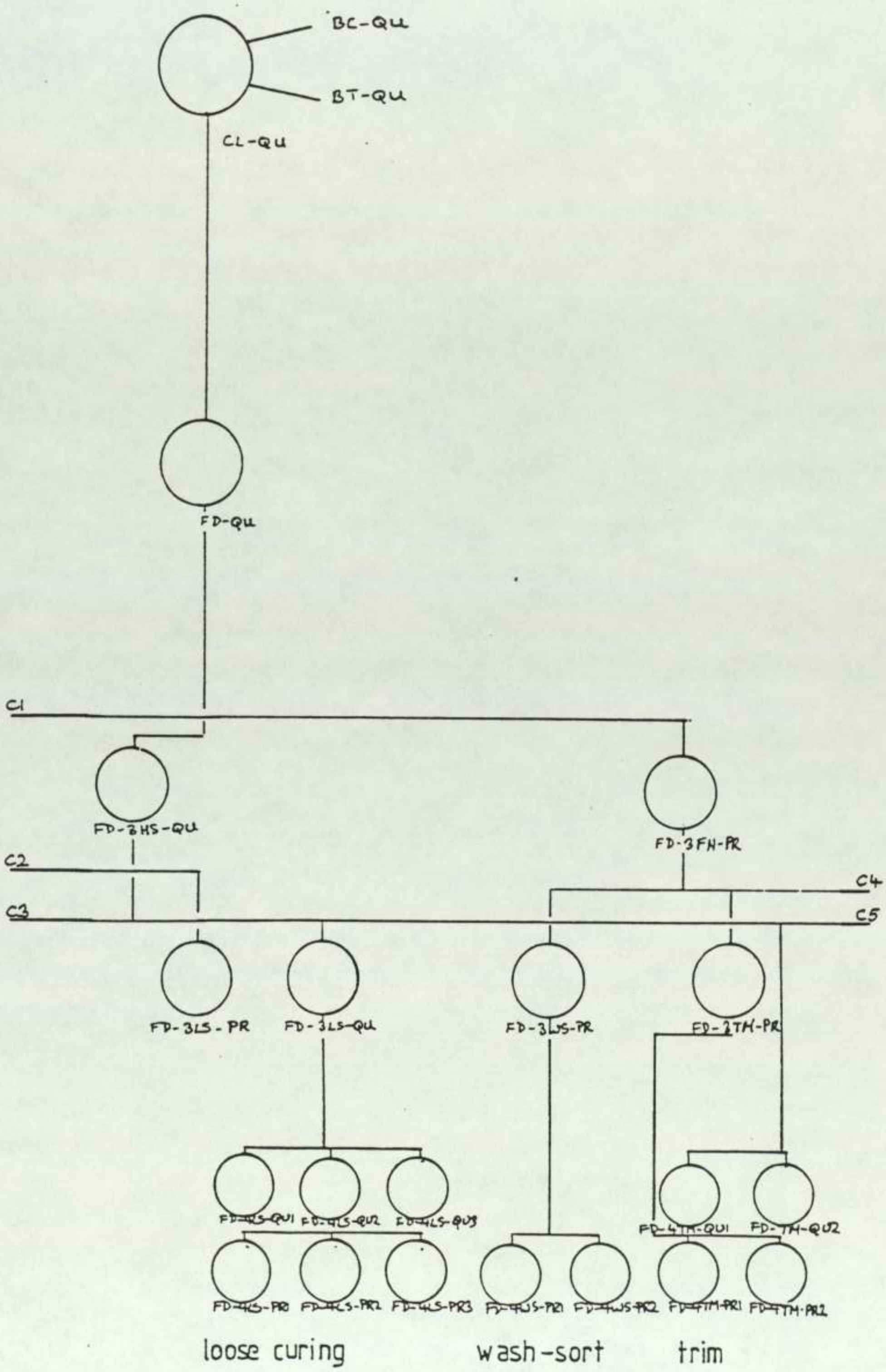
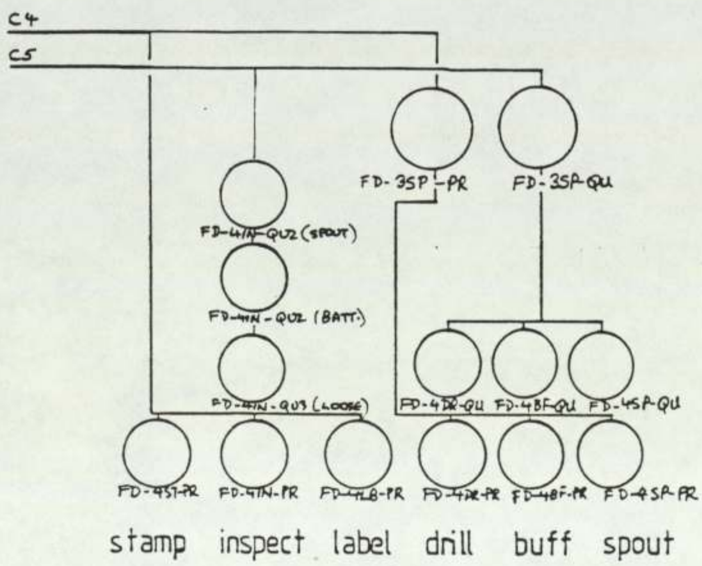


Diagram 5·15 cont.

finishing



FIDELITY MANPOWER INDEX CENTRES

Diagram 5·16

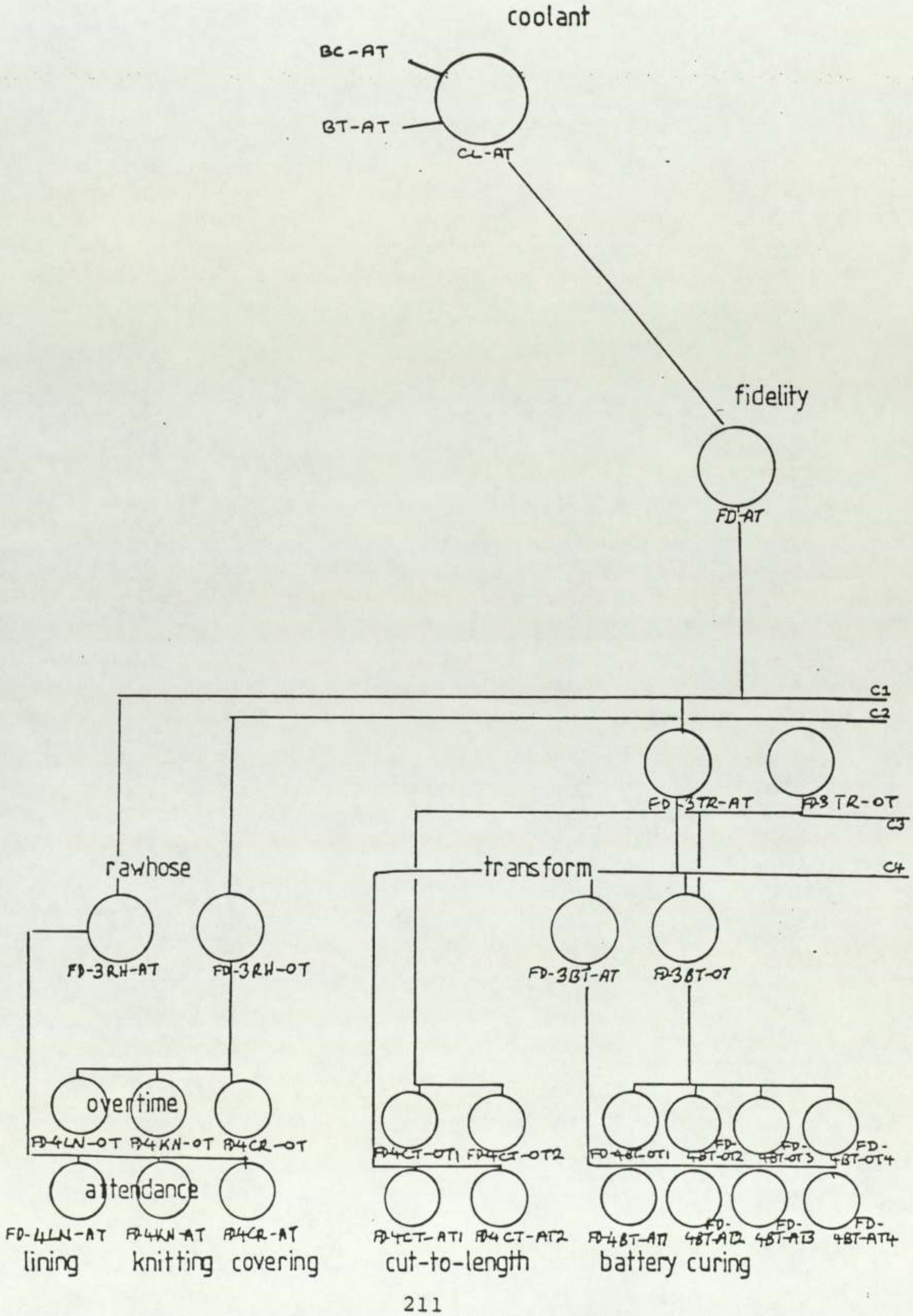


Diagram 5·16 cont.

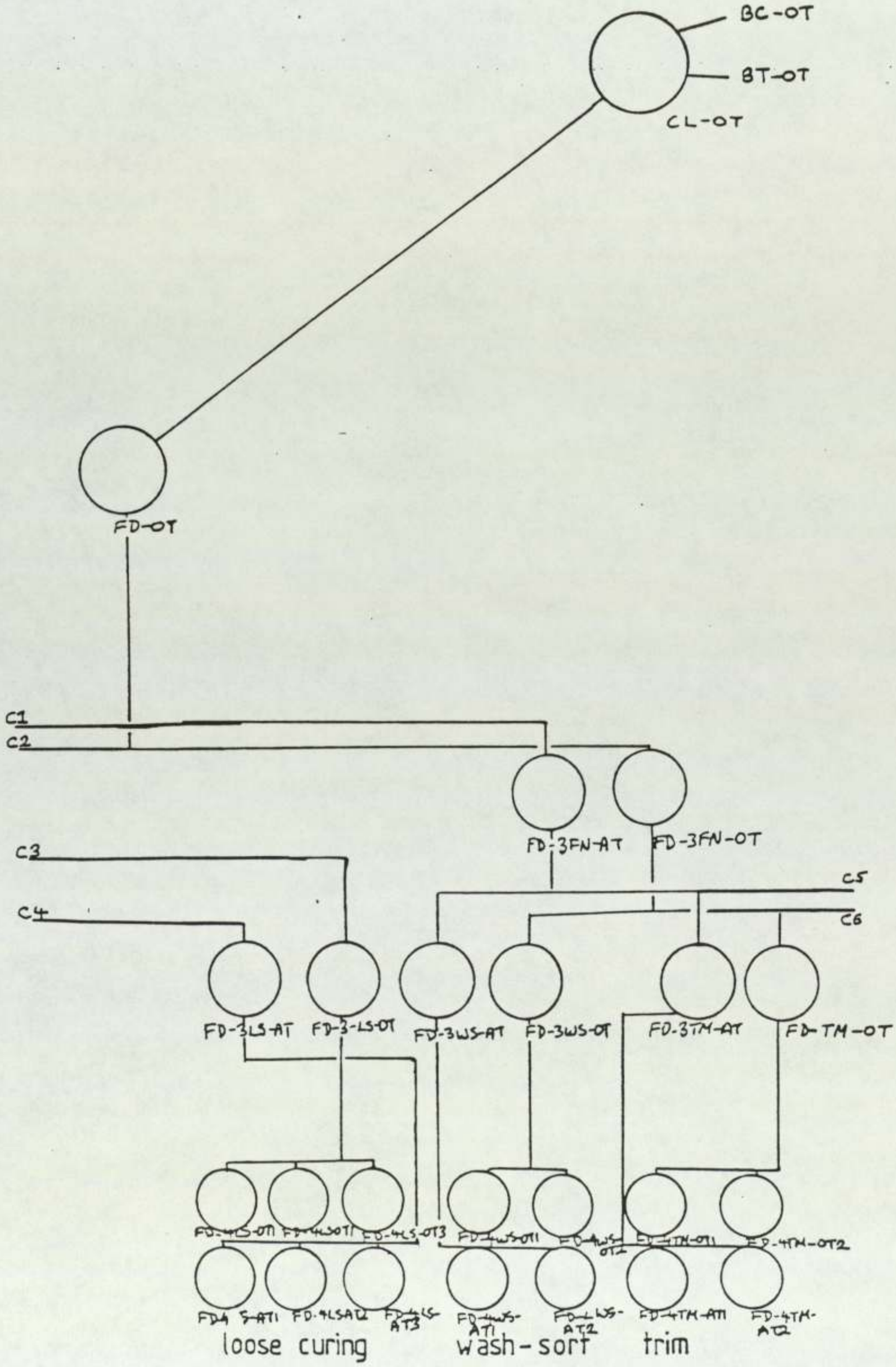
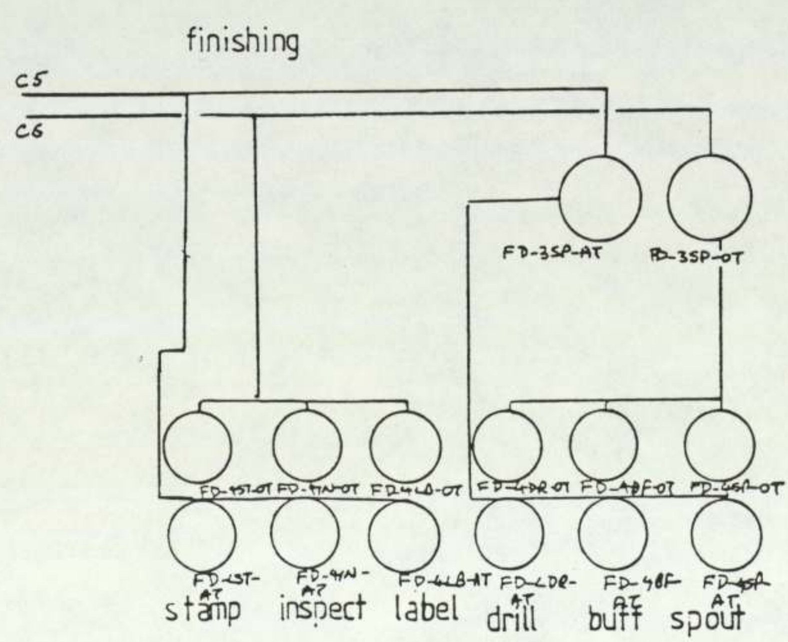


Diagram 5·16 cont.



FIDELITY MATERIAL INDEX CENTRES

Diagram 5.17

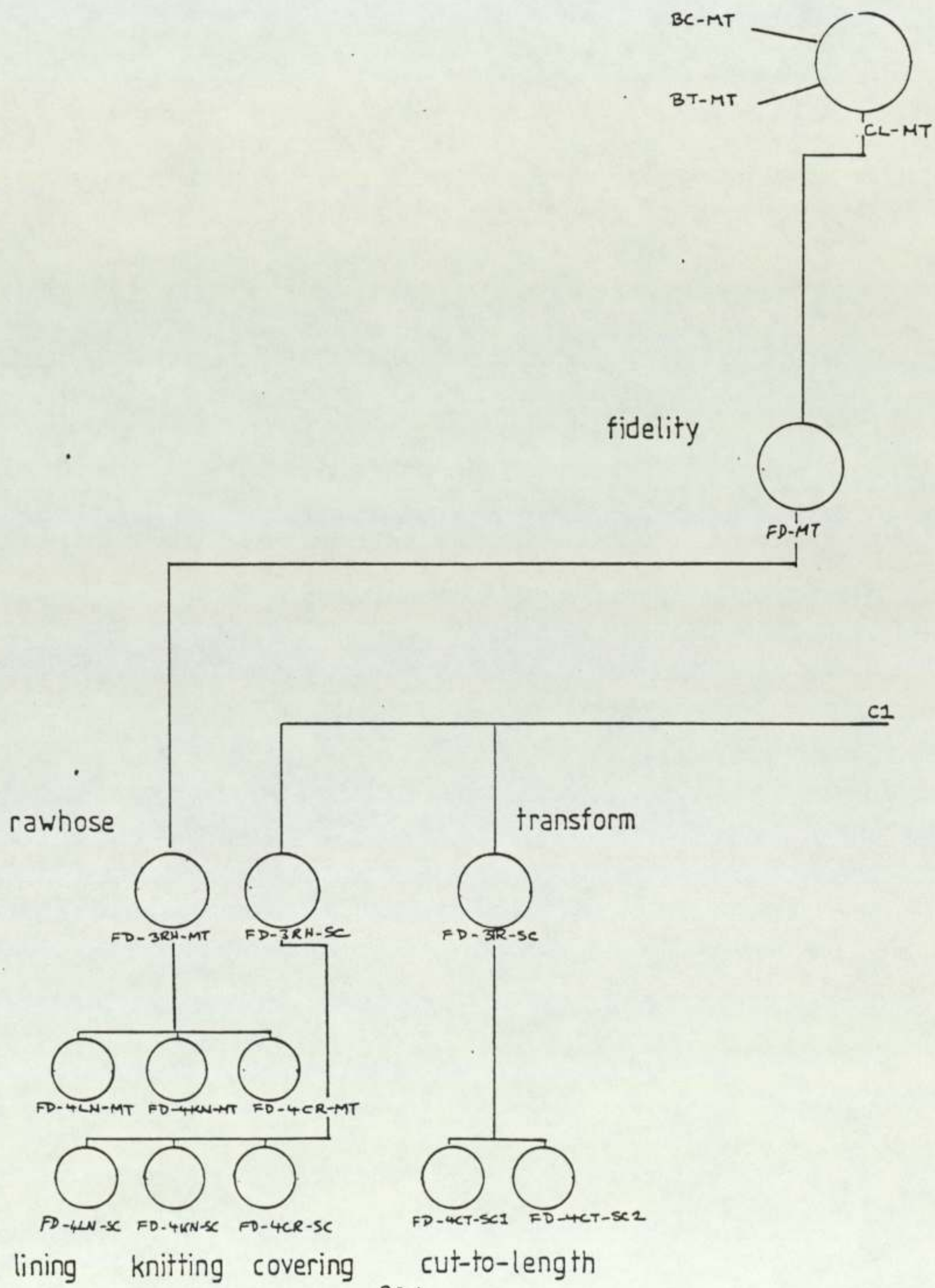


Diagram 5·17 cont.

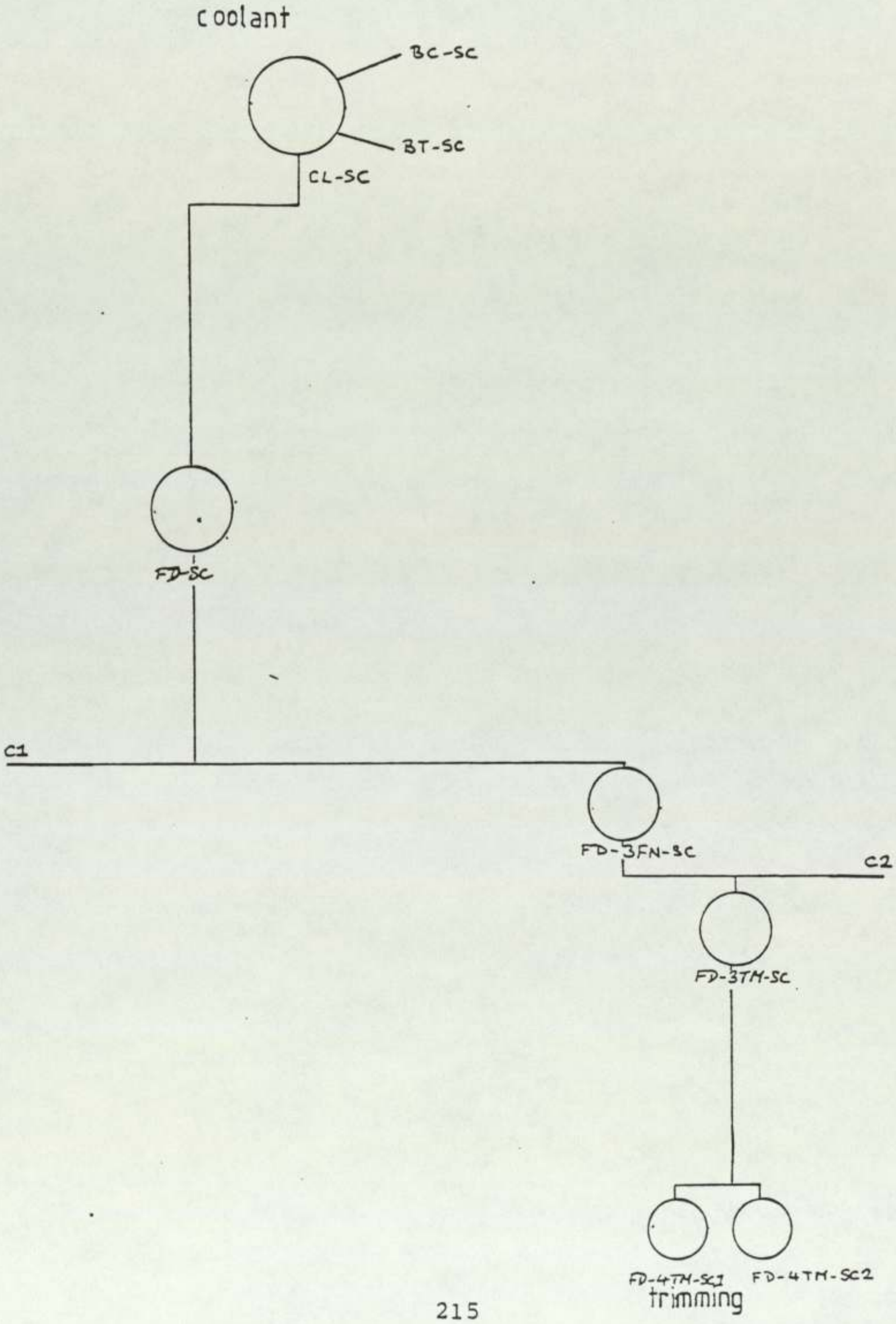
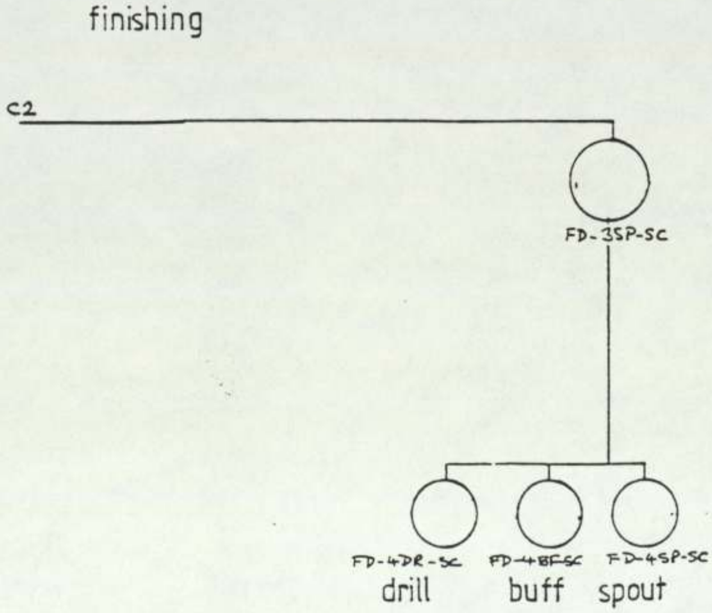


Diagram 5·17 cont.

finishing



FIDELITY MACHINE
INDEX CENTRES

Diagram 5.18

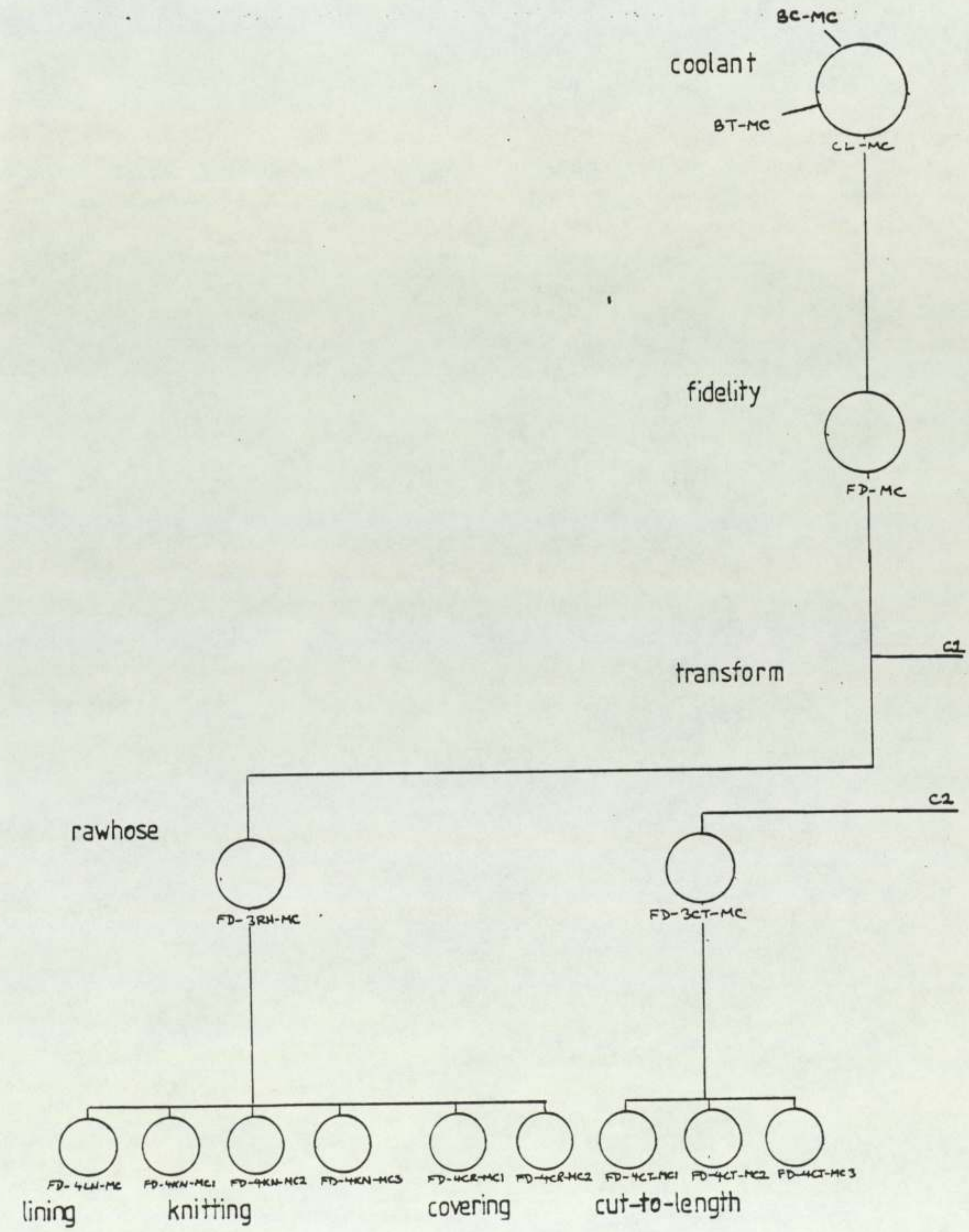


Diagram 5·18 cont.

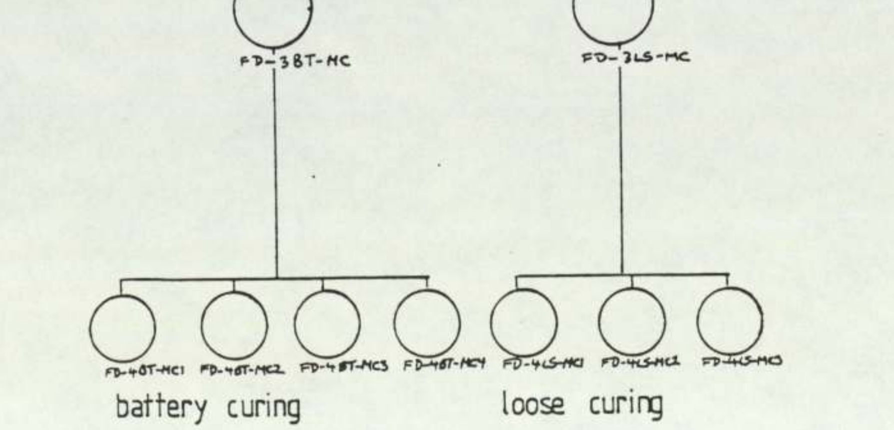
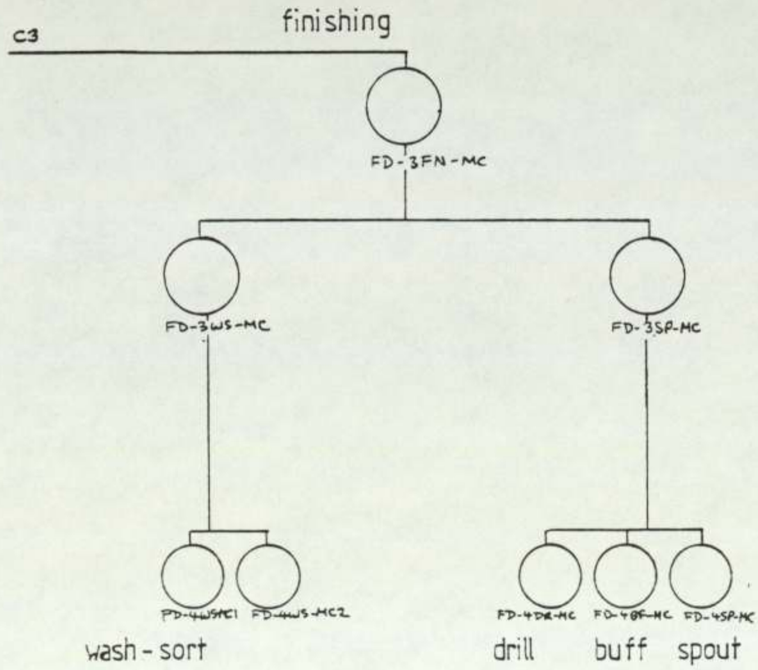


Diagram 5·18 cont.



FIDELITY FINANCIAL
INDEX CENTRES

Diagram 5.19

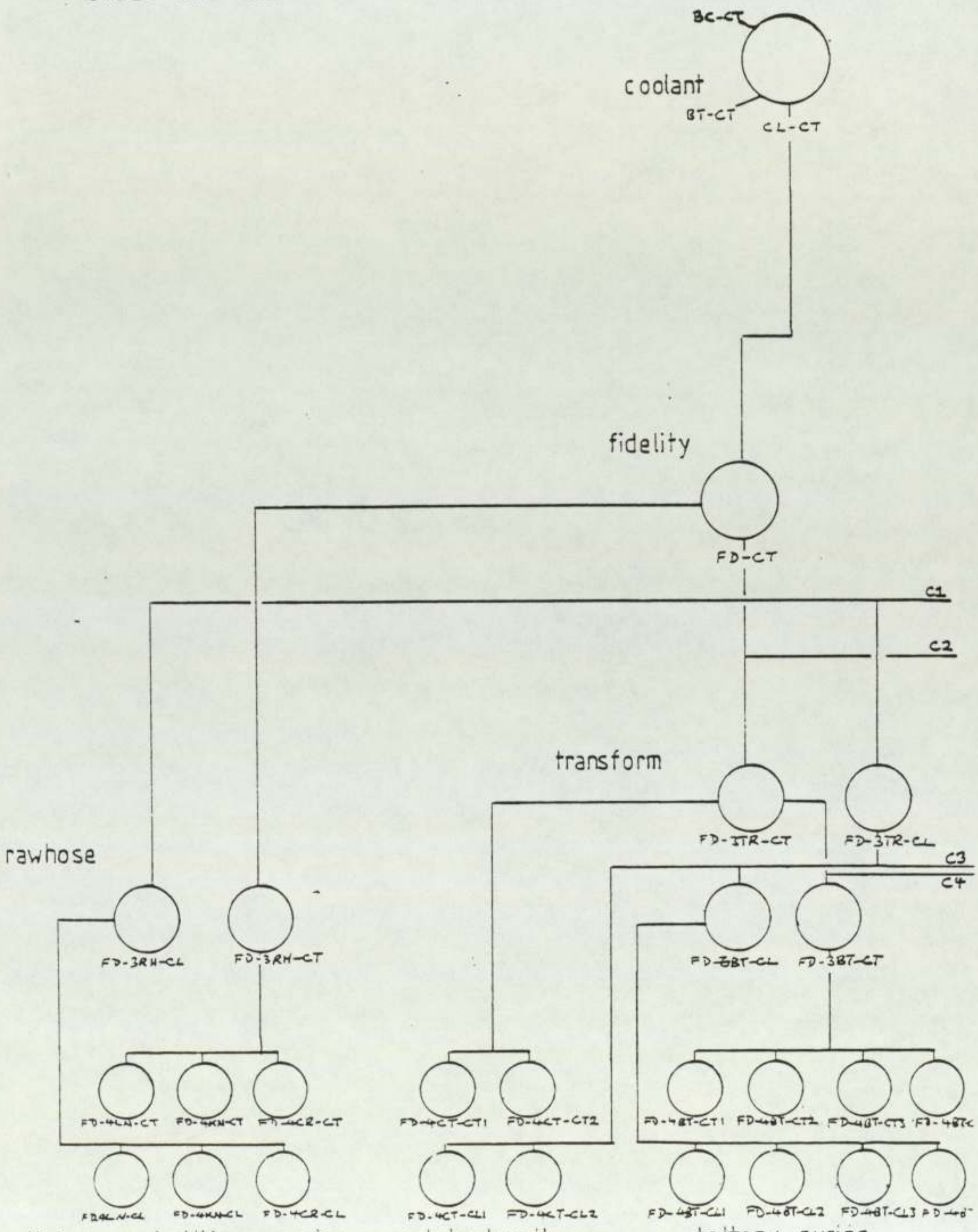


Diagram 5·19 cont.

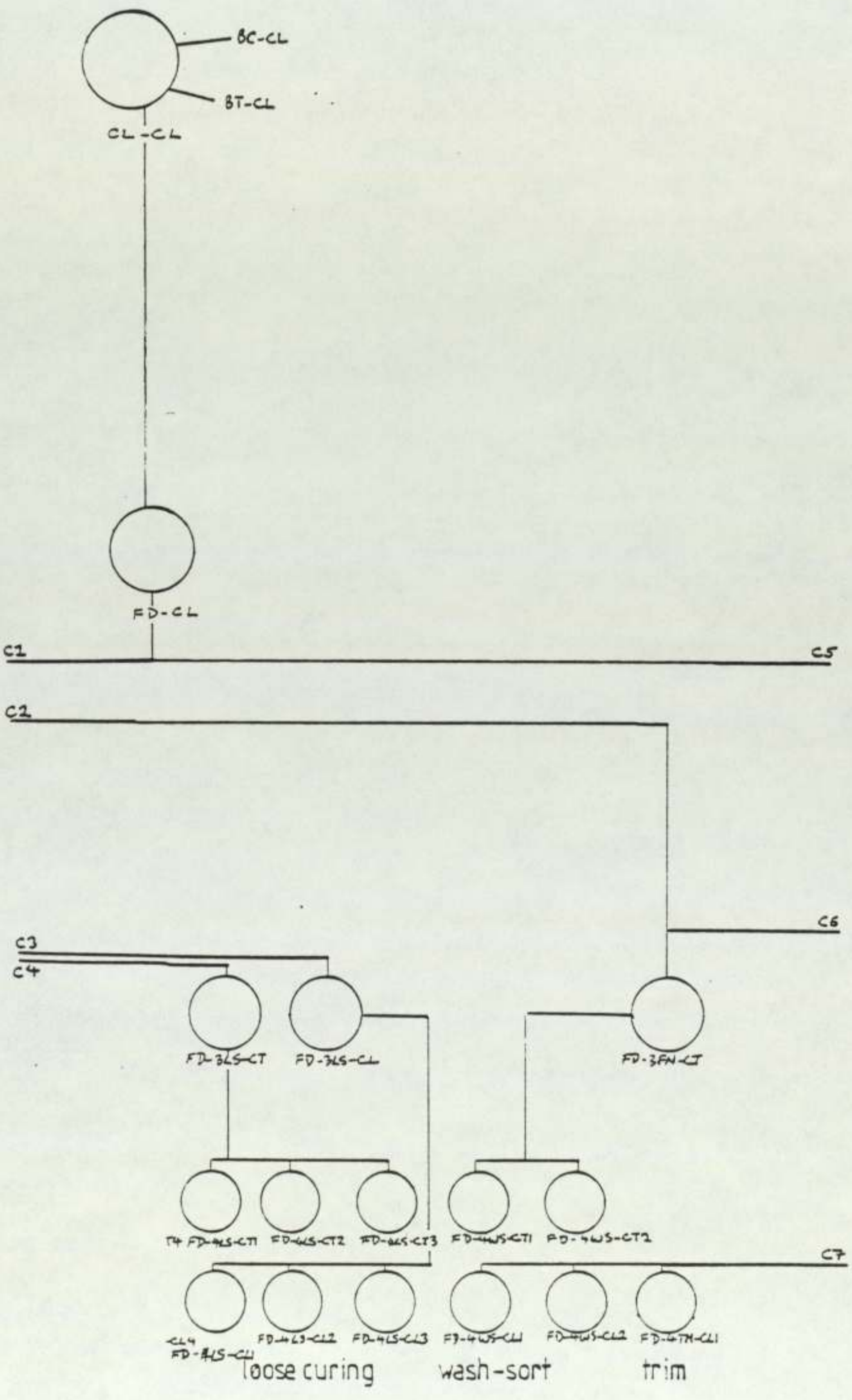


Diagram 5·19 cont.

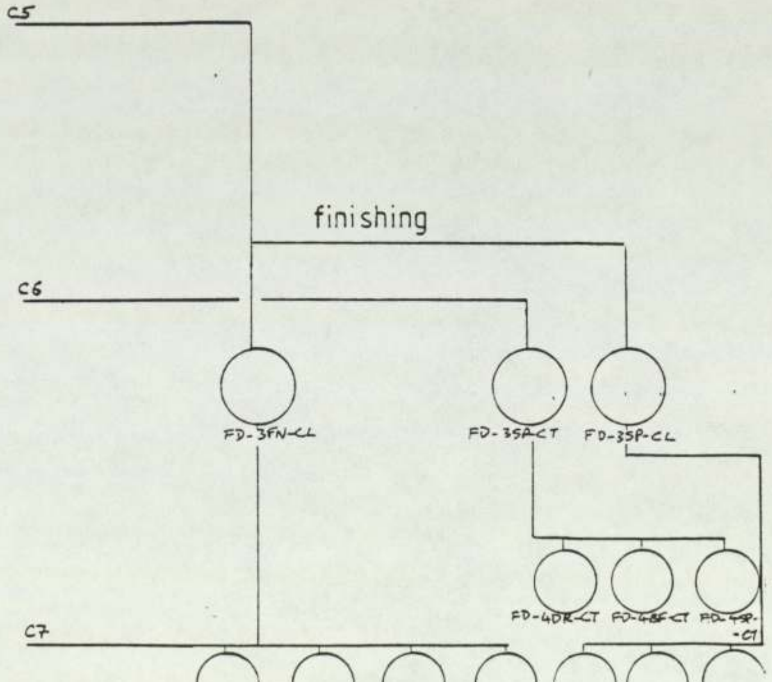
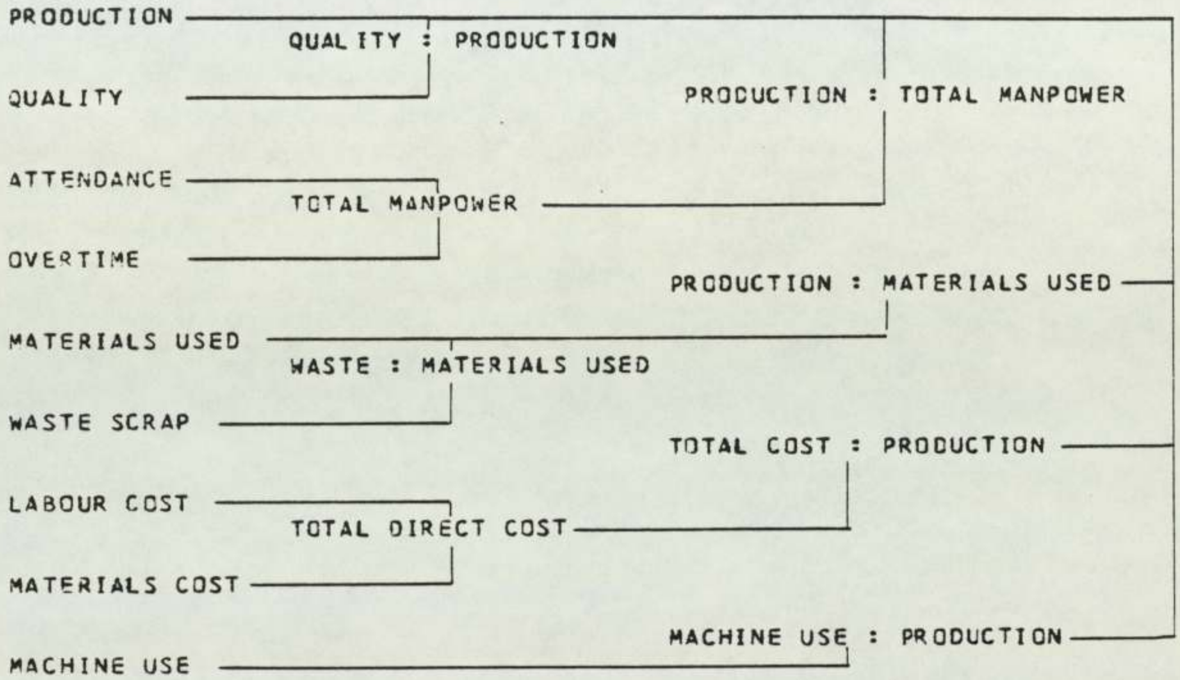


DIAGRAM 5.20

THE FORMATION OF HYBRID INDICES
(EXAMPLES)



CHAPTER SIX

A CASE STUDY OF B6-COOLANT AND FIDELITY HOSE DEPARTMENTS

6.0 Introduction

In this chapter, the Case Study, two sections of Coolant Hose are discussed. Firstly, the Coolant Hose section of B6, and secondly the rawhose aspects of 'Fidelity'.

The B6 department was chosen for this Case Study as an example to illustrate the introduction and use of indices within the factory. The first section of this chapter, then describes the attempts made to introduce Productivity Indices on the shop-floor in B6-Coolant Hose, and the difficulties that were encountered.

In the second section of this chapter the rawhose aspects of 'Fidelity' have been chosen to show the way in which basic data may be manipulated, using the techniques developed in Chapter Five, and converted into information.

6.1 The Introduction of Indices into B6-Coolant Hose

The B6 Department was originally set up as an autonomous department to produce long length hose of both the coolant and brake variety. In the absence of the anticipated demand for long lengths of coolant hose the Coolant Hose section of B6 was utilised in the main for the production of large coolant hoses and the overspill from the main Fidelity production area during peak periods. Thus a wide range of hose types were in fact produced by B6-Coolant Hose. This large variety of hoses meant that B6 could not be truly autonomous because of the need to "import" already cut rawhose lengths and "export" shaped hoses for further finishing.

In Chapter Five three phases were given for the introduction of the Management Information System,

* The provision of meaningful measures.

* The assessment of Capabilities.

* Convertion of data into information. These phases are now described.

As with the analysis in Chapter Four B6-Coolant Hose was divided into the three main sections of Rawhose, Transformation, and Finishing (Diagram 6.1).

Rawhose

In B6-Coolant Hose (as for Fidelity) there was again three aspects to rawhose production: Lining Extrusion, Knitting, and Cover Extrusion. Both Lining and Covering were produced on one extruding machine, and the Knitting performed on one of two knitting machines depending on the size of hose being processed.

Production Level

Production requirements for rawhose were calculated from the production programme in the normal manner described in Chapter Two. These requirements were then divided into rawhose to be produced in the Fidelity section of the factory and that to be produced in B6-Coolant. In general only three bore sizes were produced in B6 (7/16, 5/8 and 3/4 inch) all other bore sizes being produced by Fidelity.

The measures available for the B6 rawhose processes were in terms of the footage produced per shift. However, on closer examination the values given transpired to be estimates of footage based on the average length of rawhose that could be wound onto a standard drum. Discussions with the operatives to record actual lengths of rawhose produced met with little enthusiasm, and Standard Minute Values had not been introduced for these processes. In consequence the only measure available was that of estimated footage for the three processes of Lining, Knitting and Extrusion.

The production levels for these three rawhose processes are given in Diagrams 6.2 to 6.4.

Capabilities for these processes were then used to calculate the Productivity Indices.

Capability values were calculated in the following manner:

The maximum number of working hours was eight for every day except Friday when five and a half hours were worked (37.5 hours per week). So a first estimate could be made from the length of hose extruded in a certain time. Therefore when it took 2.5 hours to extrude 5542 feet of lining, in 8 hours 17,735 feet of hose could be extruded. On Fridays this figure would be 12,193 feet. The normal number of shifts worked for these processes was two, therefore on a normal working day the Capability was 35,470 feet of lining and 24,386 feet on Fridays. However, these figures are based on the assumption that the extruder was used solely for Lining production and that machine use was one hundred percent. The extruder was in fact also used for Cover extrusion, and so if it is assumed that fifty percent of the machine time could be used for lining extrusion this gives a figure of 17,735 feet for normal days and 12,193 for Fridays. If ten percent is then added to these figures as a likely contingent for inaccuracies in the measures used, then the estimated Capabilities become 19,508 feet for normal days and 13,412 feet for Fridays.

The Lining Productivity Indices were then calculated as the actual production figures divided by the Capability.

PRODUCTIVITY = ACTUALITY / CAPABILITY

So for example 5542 / 19508 = 0.28 (reference number 3 Diagram 6.2). In Diagram 6.5 the Productivity Graph is given, based on the Lining Productivity Indices (Diagram 6.2). This shows the large under utilisation of the Extruder for the Lining process, and the extreme fluctuations in production, which can be explained partly by the lack of demand for hoses produced in B6, and partly by the supply of rawhose by Fidelity.

Knitting

The figures for Knitting production are given in Diagram 6.3 and the Capability again calculated as above to give the Productivity graph in Diagram 6.6 which again shows severe under utilisation of the knitting machines.

In Diagram 6.4 the figures are given for the Covering process, Capabilities are again calculated in a similar fashion to the Lining Capabilities and the Productivity Graph in Diagram 6.7 again shows the under utilisation of the extruder for the Covering process.

Since the extruder was in fact used for both Lining and Covering a combined index (a simple average of the two indices) has been calculated and the combined Productivity Index Graph is given in Diagram 6.8.

Transformation

The next section, transformation consisted of cutting-to-length and curing the hoses. Many hose lengths were cut to length by Fidelity automatic guillotines leaving the remainder to be cut by hand. For the cutting-to-length process the measures were very poor. Some idea of the production level was gleened from the operatives, but normally no measures existed. Data on production levels for the Curing process was available, but only in terms of mandril lengths produced per cure (curing pan load) and per shift. From these mandril lengths the number of hoses they would produce could be calculated from data on the number of hoses per mandril given on the production programme. At the time of this investigation there were no established Standard Minute values. In Diagram 6.9 the production levels for the period of the investigation are given. There are no figures for cutting-to-length because it was impossible to get any form of useful measure for this process. The best available measure was the number of drums of hose cut, but this relied on the honesty of the operative who, it appeared gave the first number that entered his head as the production figure.

The Capability value for Curing was again calculated from the maximum production figure, extrapolated to two shifts, plus a contingency of ten percent. Diagram 6.10 shows the Productivity Graph for the Curing process, again clearly showing the under utilisation of the curing pan.

Finishing

The process of washing hoses produced in B6 was again not solely performed by the washing station in B6, many hoses were also washed in Fidelity washing machines. In addition no measures existed for this process, hoses were simply washed after the curing process.

Jig-trimming for B6 hoses was in the majority of cases performed in B6, but again some were "exported" to be trimmed. Here again the production figures were totally inaccurate and unreliable. The other Finishing processes for hoses produced in B6 were conducted in the Fidelity department (for example, stamping and counting).

In consequence no Productivity Indices or Productivity Graphs for the Finishing processes could be calculated, and are therefore not presented here.

The overall impression given from the production measures was the urgent need for the introduction of measures for cutting-to-length, washing and trimming. In addition there was a need to modify the existing measures to accurately reflect the true productivities.

So before any of the techniques described in Chapter Five could be used to any effect, accurate Standard Minute values for production purposes would have to be introduced.

Another problem to be overcome would be the attitude of operatives which was one of distrusting anybody measuring anything and total lack of co-operation. For example one operative was assigned to aid this investigation in the measurement of scrap levels. His work was not totally satisfactory and when told of this went absent for two weeks.

The lack of measures for production processes was more evident for the information aspects of Manpower, Machine Use, Materials and Finance, and so again have not been included here.

B6-Synopsis

In conclusion then, the introduction of indices into the B6-Coolant Hose department could not be achieved. The most important reason for this was the lack of suitable measures, but in addition there was an un-willingness by operatives to participate in any survey that appeared to measure their personal achievements. Until suitable measures could be introduced and the attitude of the work-force could be significantly changed, no form of effective Management Information or Control System could be introduced.

The problem of introducing measures against the will of the operatives, while very relevant to this Action Research, was something that would have to be solved by the Autohose management and would require the resources of a specialised department such as the Management Services department.

In addition the lack of utilisation of the B6 facilities could be interpreted as a failure of the Autohose management to realise the effect of using a department for the production of hoses it was not designed to produce. B6 was designed as an autonomous department for the production of long length hose, but could not provide the facilities required for the production and finishing of normal coolant hose on its own.

The basic measures available from B6-Coolant Hose would not effectively illustrate the Management Information System described in Chapter Five. For this reason measures previously obtained from the Fidelity department are discussed in the next section to illustrate the Information System.

6.2 Fidelity Rawhose Indices

The previous section has showed the complete lack of control in the production of coolant hose in B6, but could not be used as an example for the Management Information System designed in Chapter Five, other than to highlight the need for accurate measures.

In this section the rawhose aspects of the Fidelity department (as defined in Chapter Four) are discussed and used to illustrate the use of the Management Information System. Although the measures used here are far better than those available in B6 (in terms of integrity), it should be noted that the Standard Minute Values given have been calculated from the Wage Claim forms written by the operatives and have not been obtained from accurate measures of Standard Minutes of production. Despite these restrictions the data presented below will serve to illustrate some of the M.I.S. design features. The approach adopted here is to show, from the top downwards, the information that would be available to management. In this case the management for Fidelity Rawhose would be the Foremen and Senior Foremen.

The first piece of information presented to the management would be the Exceptions Report (Diagram 6.11). This shows the days on which "exceptional" productivity occurred. "Exceptional" in this case has been defined as when the Productivity Index is twenty five percent or more different from the forecasted Productivity Index (that is, twenty five percent is the threshold value for the upper and lower limits for exceptional information). While this report shows a number of exceptions over a period of time this is only included for this example, normally only one day (the last exception) would be shown for each index centre (also, in this case only the index centre for Rawhose production is discussed).

The facilities available to the Foremen are shown in Diagram 6.12. By depressing the carriage return key on the display terminal the Taxonomic Graph (showing the mean productivities) would be displayed (Diagram 6.13). This is a graph of the average Productivity values calculated from the forecasted values for Productivity (Diagram 6.14). The basis for a change in mean productivity has been selected as when the forecasted values significantly change (in this case a change of plus or minus three percent was used, but this would be subject to "tuning" to achieve the desired level of response for the recipients of the information).

The forecast used in Diagram 6.14 is an exponential forecast, which effectively provides the equivalent of a moving average over nine values (with a weighting constant of 0.2). Such a forecasting technique serves to illustrate the way in which the information on productivities can be used to provide an adapting base level from which to determine exceptional information. The ability of this technique to accurately forecast the next production level is however, limited by its simplicity because it can take no account of cycles or trends in productivity (further techniques are described at the end of this chapter).

Other information available at this management level includes the Index Design (Diagram 6.15), the Quantified Flowchart (Diagram 6.16), Current Management Level (Diagram 6.17), Latency (Diagram 6.18) and Performance (Diagram 6.19). The Performance and Latency Graphs are based on a simple estimate of Potentiality as the production level that could be achieved by bringing production upto a three shift system (Diagram 6.15).

All the above information could be obtained by typing the commands specified in Diagram 6.12.

So far the information described has been for the Rawhose level, but any index centre could be selected by specifying the identification code for that centre after entering the selected command (Diagram 6.12). The default value for the identification code is the currently accessed index centre so this may be omitted when accessing further information for one particular index centre.

The Productivity and Forecast Graph, Taxonomic Graph and the data for each of the Lining, Knitting and Covering processes are presented in Diagrams 6.20 to 6.31 (all the information described above would also be available at this level). It should be noted that the Molecular index for Rawhose is the same as the index for Covering, this is because the Covering process effectively determines the end product for rawhose production (Chapter Five Diagram 5.15).

Hybrid Indices

Only "pure" indices have so far been considered, but the facility exists within this M.I.S. to manipulate indices to produce combined or "Hybrid" Indices (Chapter Five). These are now described:

In Diagrams 6.32 to 6.37 the Productivity Graphs for Manpower Attendance and Machine Use for Lining, Knitting, and Covering are given. From these, the Hybrid Indices of Productivity to Attendance and Productivity to Machine Attendance and Productivity to Machine Use have been calculated as follows:

Production Productivity Index / Attendance Productivity Index = Production to Attendance Index.

Production Productivity Index / Machine Use Productivity Index = Production to Machine Index.

The use of a Hybrid Index such as the Production to Manpower Index is a useful tool for examining the productivity of the workforce at differing levels of attendance. In this case the Hybrid Index has been calculated as above, but in addition has been weighted (see Chapter Five) to bring the index within the range zero to one (the weighting here is 1/1.03). The weighting in practice, would be subject to the preference of the manager receiving the information, and as with other information presented here could be "tuned" in the light of experience. The Productivity Graphs and their respective forecasts are given in Diagrams 6.38 to 6.43 (the data and Taxonomic Graphs are given in Appendix H).

6.3 Notes on the "Techniques"

One of the most useful techniques used in the above examples has been the exponential forecast (actually smoothing) which has allowed the calculation of a "moving" basis for the definition of exceptions. The values used for the weighting constant (0.2) has given the smoothing technique a bias equivalent to a moving average of nine data points (reference 9). This means that the effect of transients in the data is relatively small. To show the different effects of weighting an example is given of the exponential smoothing (for Fidelity Lining) with a weighting factor of 0.3 (Diagram 6.44) which is equivalent to a moving average of eight points. The effect of transients on the forecasted or smoothed values can readily be seen.

In addition to changing the weighting for the smoothing technique its sensitivity may also be changed so that the forecast for the next data value is weighted according to the accuracy of forecast for the previous data value. One method of achieving this is by using Trigg's tracking signal to weight the forecast (reference 9). An example of this method (again for Lining) is given in Diagram 6.45 which shows the increased sensitivity of the forecast to transients.

The examples of different sensitivity forecasts have been included here to show that it is a matter of tuning with the correct bias to achieve the level of filtering of data required. The examples given in section 6.2 have been chosen to illustrate the information techniques and so in practice would require tuning to the required level of sensitivity by the managers themselves.

More advanced than the Exponential smoothing techniques, is another technique, that of Bayesian Forecasting (references 35, 36) which would provide better smoothing and forecasting as well as more information on the trends of a set of Productivity Indices. But currently this area requires further research before the technique can be used effectively in the capacity outlined here.

Transforming the Indices

Another technique that has also been used in the presentation of the forecasts in Section 6.2 is that of transforming. This basically is a method of ensuring that the indices analysed approximate to a Normal Distribution (reference 23) because the indices tend towards an upper value of one. The exponential smoothing technique requires that data follows a normal distribution and so all indices have been transformed in this way in the above examples. The transforming algorithm used is as follows:

T = arc sine (sqr(I))

where:

T = angle in degrees,

sqr = square root, and

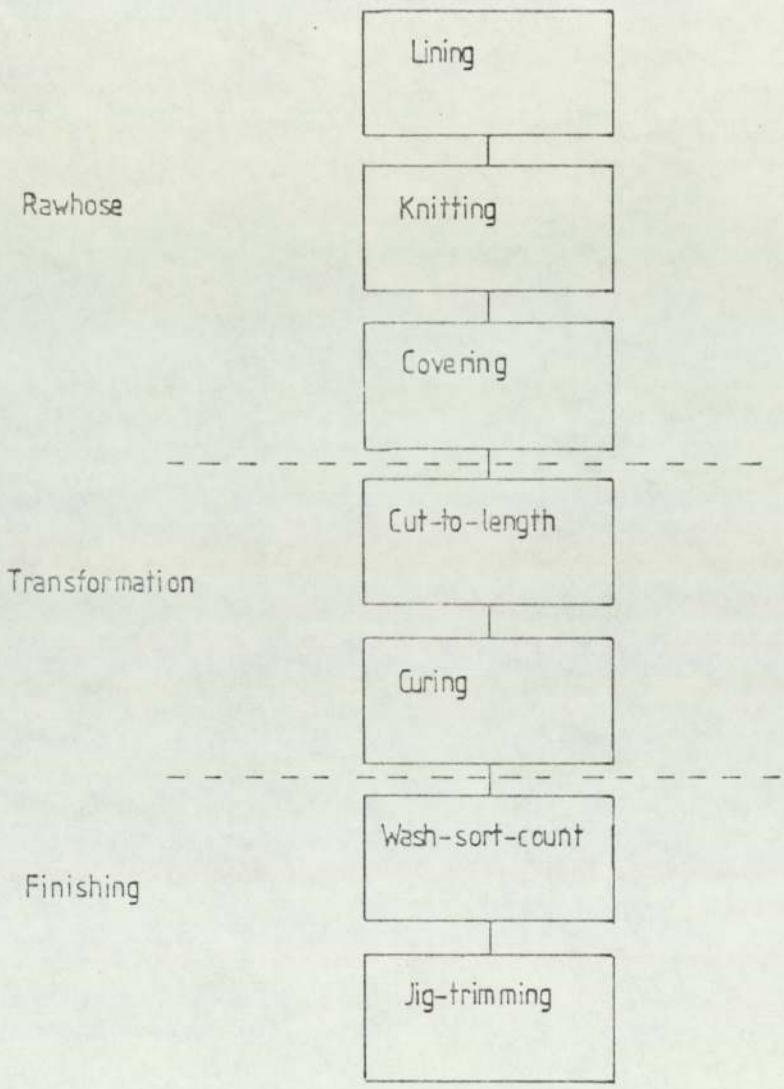
I = the index value.

6.4 Synopsis

The example selected for discussion in section 6.2 is the set of Production Productivity Indices for Fidelity Rawhose. The Molecular Index shows the level of Productivity for Rawhose (which is the same as the Productivity for Covering) and from the exceptions information generated from this index the series of information displays are presented.

The Main Production Processes for B6-Coolant Hose

Diagram 6.1



B6 LINING PRODUCTION LEVELS DIAGRAM 6.2

Reference Number		Date	Lining Extrusion FT	Lining Productivity Index
1		14.11	0	0
2		15.11	0	0
3		16.11	5542	0.28
4	F	17.11	0	0
5		22.11	0	0
6		23.11	6400	0.33
7	F	24.11	0	0
8		29.11	3900	0.20
9		30.11	5654	0.29
10	F	1.12	0	0
11		4.12	0	0
12		5.12	0	0
13		6.12	0	0
14		7.12	0	0
15	F	8.12	0	0
16		11.12	0	0
17		12.12	0	0
18		13.12	2620	0.13
19		14.12	0	0
20	F	15.12	0	0
21		18.12	2618	0.13
22		19.12	0	0
23		20.12	0	0

Capability Basis :	5542 feet extruded in 2.5 hours
Capability for two shifts :	35469 feet
Capability at 50% machine use :	17734 feet
Capability plus 10% contingency :	19508 feet
Capability Fridays only :	13412 feet

F = Fridays

B6 KNITTING PRODUCTION LEVELS DIAGRAM 6.3

Reference Number		Date	Knitting FT	Knitting Productivity Values
1		14.11	4418	0.57
2		15.11	1217	0.16
3		16.11	0	0
4	F	17.11	2350	0.44
5		22.11	2507	0.32
6		23.11	0	0
7	F	24.11	2775	0.52
8		29.11	2827	0.36
9		30.11	2399	0.31
10	F	1.12	970	0.18
11		4.12	0	0
12		5.12	0	0
13		6.12	0	0
14		7.12	0	0
15	F	8.12	0	0
16		11.12	0	0
17		12.12	4100	0.53
18		13.12	3942	0.51
19		14.12	3365	0.43
20	F	15.12	0	0
21		18.12	0	0
22		19.12	4515	0.58
23		20.12	710	0.09

Capability Basis : 4418 feet in 5 hours
Capability for one shift : 7069 feet
Capability plus 10% contingency : 7776 feet
Capability Fridays only : 5346 feet

F = Fridays

86 COVERING PRODUCTION LEVELS DIAGRAM 6.4

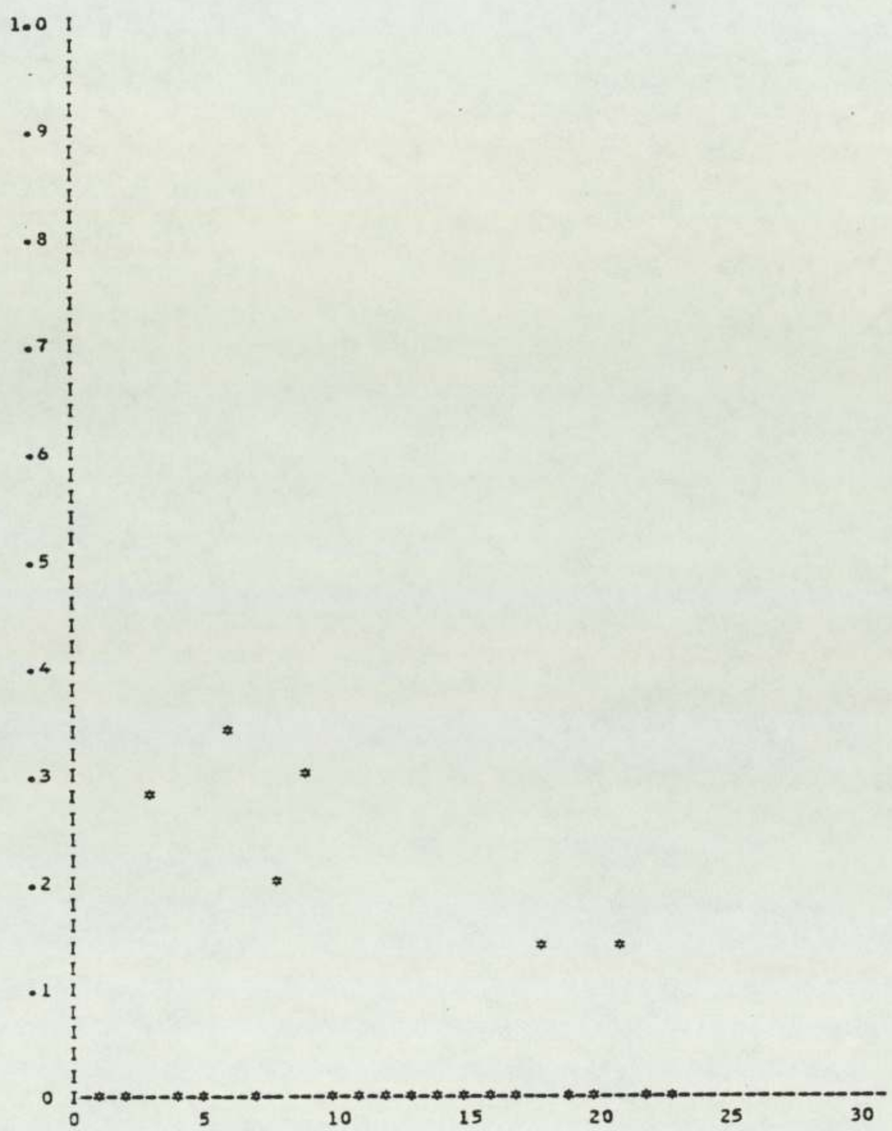
Reference Number		Date	Cover Extrusion FT	Covering Productivity Indices
1		14.11	0	0
2		15.11	3996	0.18
3		16.11	2619	0.12
4	F	17.11	0	0
5		22.11	5014	0.23
6		23.11	0	0
7	F	24.11	0	0
8		29.11	0	0
9		30.11	0	0
10	F	1.12	3369	0.15
11		4.12	0	0
12		5.12	0	0
13		6.12	0	0
14		7.12	0	0
15	F	8.12	0	0
16		11.12	0	0
17		12.12	3400	0.15
18		13.12	3200	0.15
19		14.12	0	0
20	F	15.12	0	0
21		18.12	2507	0.13
22		19.12	0	0
23		20.12	5185	0.26

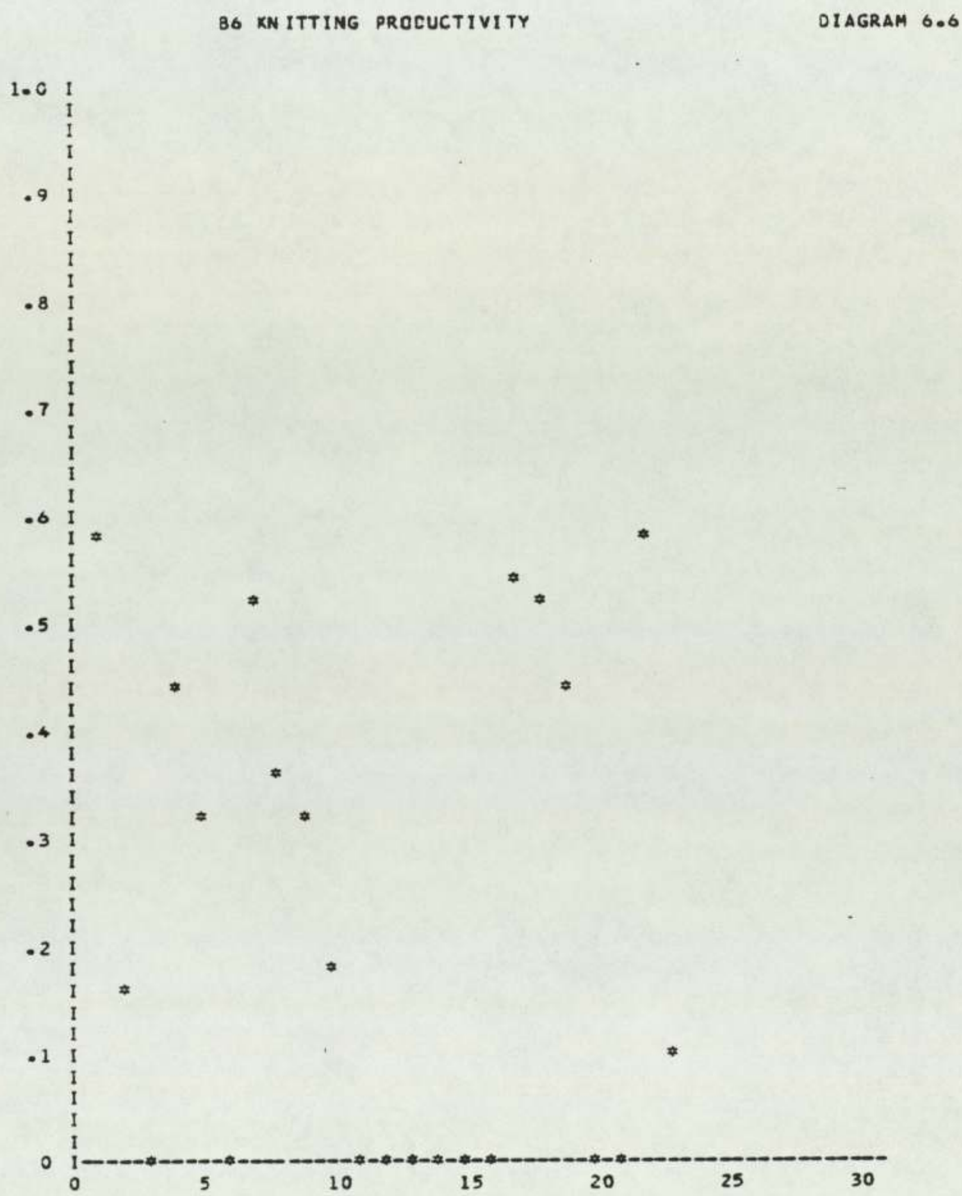
Capability Basis :	3996 feet in 1.6 hours
Capability for two shifts :	39960 feet
Capability for 50% machine use :	19980 feet
Capability plus 10% contingency :	21978 feet
Capability Fridays only :	15110 feet

F = Fridays

86 LINING PRODUCTIVITY

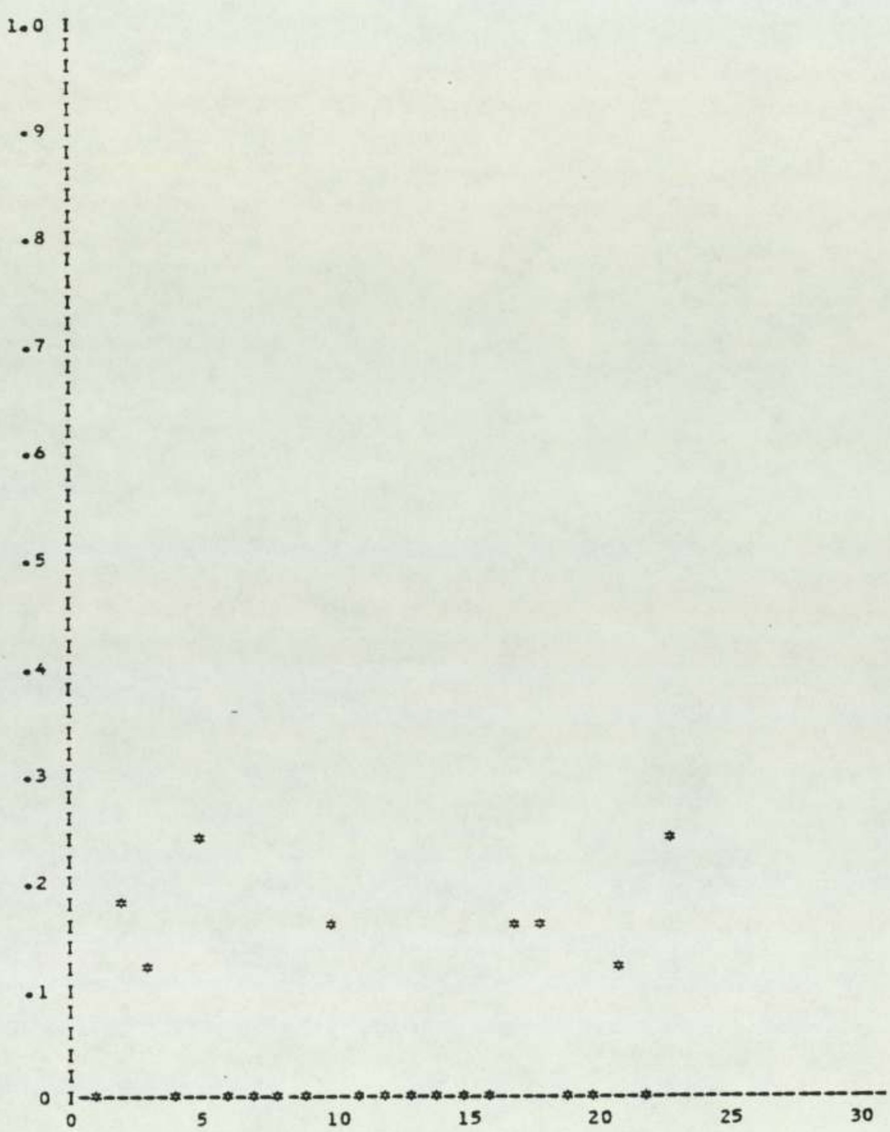
DIAGRAM 6.5



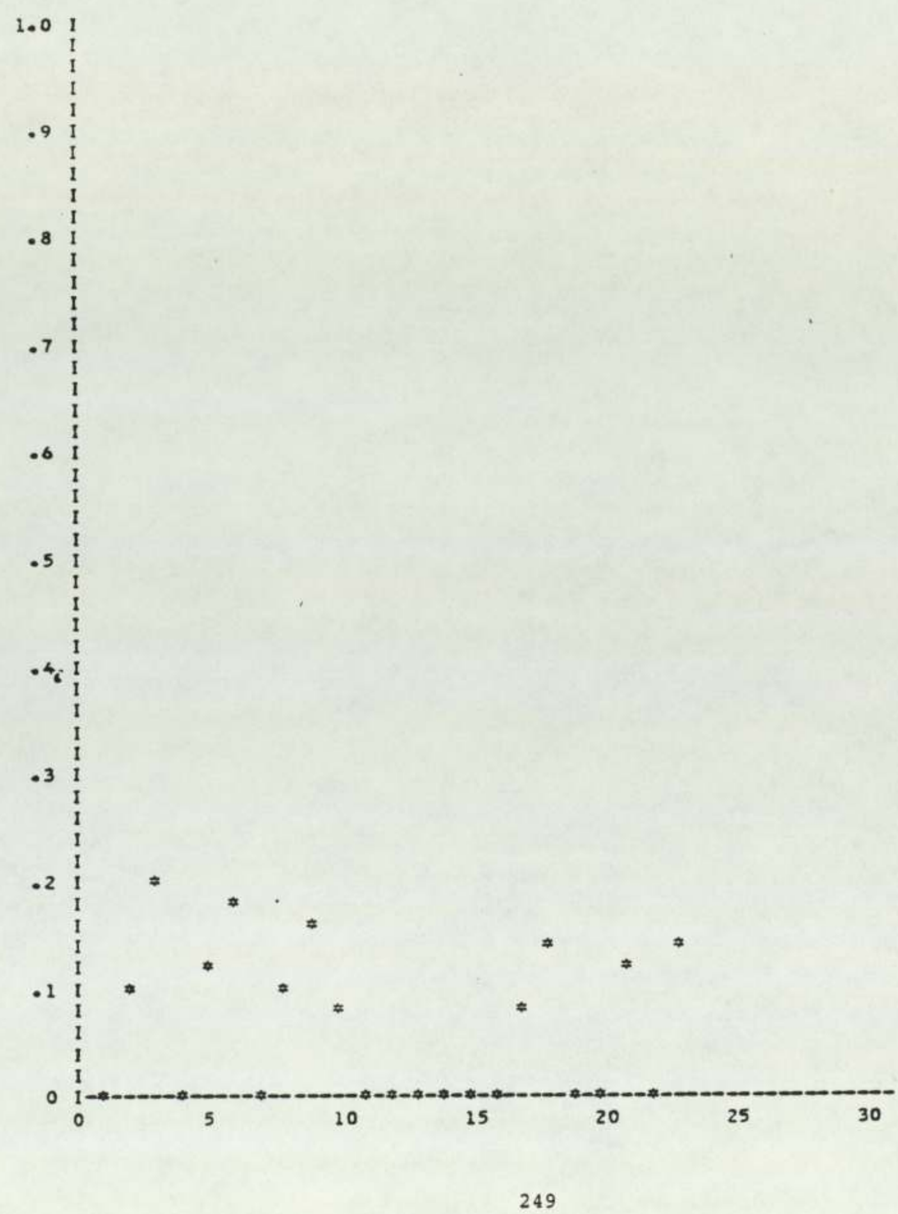


B6 KNITTING PRODUCTIVITY
DIAGRAM 6.6
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
5
10
15
20
25
30

B6 COVERING PRODUCTIVITY DIAGRAM 6.7



86 LINING AND COVERING PRODUCTIVITY DIAGRAM 6.8

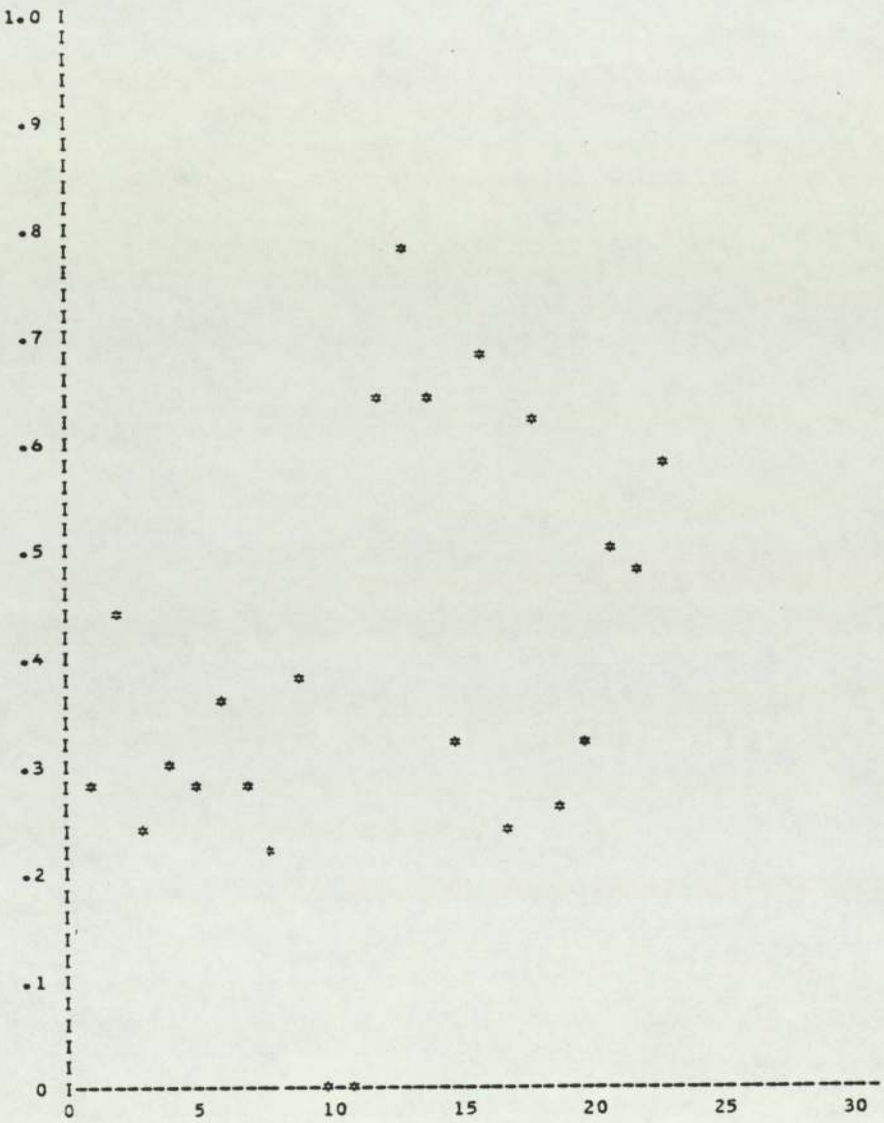


CURING PAN PRODUCTION FIGURES DIAGRAM 6.9

Reference Number	Date	Number of Cures	Number of Hoses	Number of Mandrils
1	14.11	14	1720	1370
2	15.11	18	2010	2205
3	16.11	18	2006	1196
4	F 17.11	10	1170	1030
5	22.11	14	1722	1372
6	23.11	18	2007	1765
7	F 24.11	10	1130	935
8	29.11	12	1270	1122
9	30.11	16	2385	1845
10	F 1.12	0	0	0
11	4.12	0	0	0
12	5.12	32	3885	3171
13	6.12	36	4698	3852
14	7.12	34	4400	3186
15	F 8.12	10	1265	1080
16	11.12	32	3696	3408
17	12.12	12	1466	1136
18	13.12	34	3749	3043
19	14.12	14	1569	1289
20	F 15.12	10	1679	1105
21	18.12	30	3131	2499
22	19.12	30	2917	2413
23	20.12	28	3562	2839
CAPABILITY				5000
CAPABILITY FRIDAYS ONLY				3437
F = FRIDAYS				

DIAGRAM 6.10

B6 CURING PRODUCTIVITIES



FIDELITY RAWHOSE EXCEPTIONS REPORT DIAGRAM 6.11

EXCEPTION NUMBER/CODE	DAY/MONTH	EXCEPTION STATUS	PRODUCTIVITY INDEX
1/FD-3RH-PR	17/07	HIGH	0.43
2/FD-3RH-PR	18/07	LOW	0.91
8/FD-3RH-PR	26/07	HIGH	0.54
13/FD-3RH-PR	02/08	HIGH	0.55
14/FD-3RH-PR	03/08	HIGH	0.53
19/FD-3RH-PR	10/08	HIGH	0.57
29/FD-3RH-PR	24/08	HIGH	0.65

DIAGRAM 6.12

THE FACILITIES AVAILABLE ON EXCEPTIONAL INFORMATION ARE :

COMMAND	DISPLAY
*******	*******
<exception no. only>	TAXONOMIC GRAPH
G <index centre i.d. > <cr>	PRODUCTIVITY GRAPH
D <index centre i.d. > <cr>	INDEX DESIGN WITH ABSOLUTE VALUES
F <index centre i.d. > <cr>	QUANTIFIED FLOWCHART
M <index centre i.d. > <cr>	MOLECULAR INCICES
GL <index centre i.d. > <cr>	LATENCY GRAPH
GP <index centre i.d. > <cr>	PERFORMANCE GRAPH
H <cr>	HELP FUNCTION (this display)

<cr> = carriage return.

Diagram 6·13

KEY TO DIAGRAMS

ALPHA = Forecast weighting parameter (exponential/forecasting/smoothing)

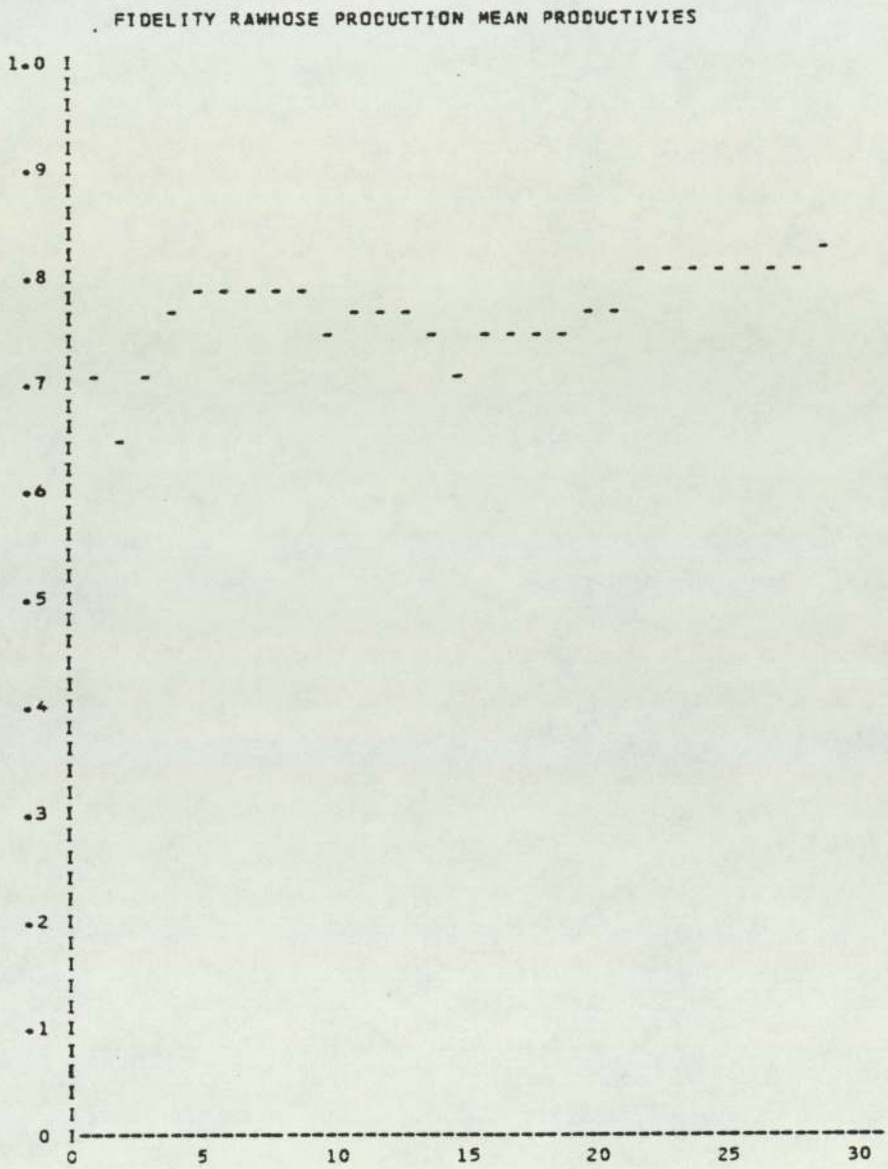
FORECAST = Initial estimated forecast

TYPE = N is Normal forecasting. A is Adaptive forecasting(using
Trigg's tracking signal)

LIMIT = Limit chosen for exceptional information threshold (the
percentage difference between the forecast and actual value)

* = Actual index
~ = Mean Productivity
x = Forecasting index
\+ = Forecasting and Actual Index (same values)

DIAGRAM 6.13



FIDELITY RAWHOSE PROCUCTION MEAN PRODUCTIVIES
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
5
10
15
20
25
30

DIAGRAM 6.14

FIDELITY RAWHOSE PRODUCTION PRODUCTIVIES AND FORECASTS

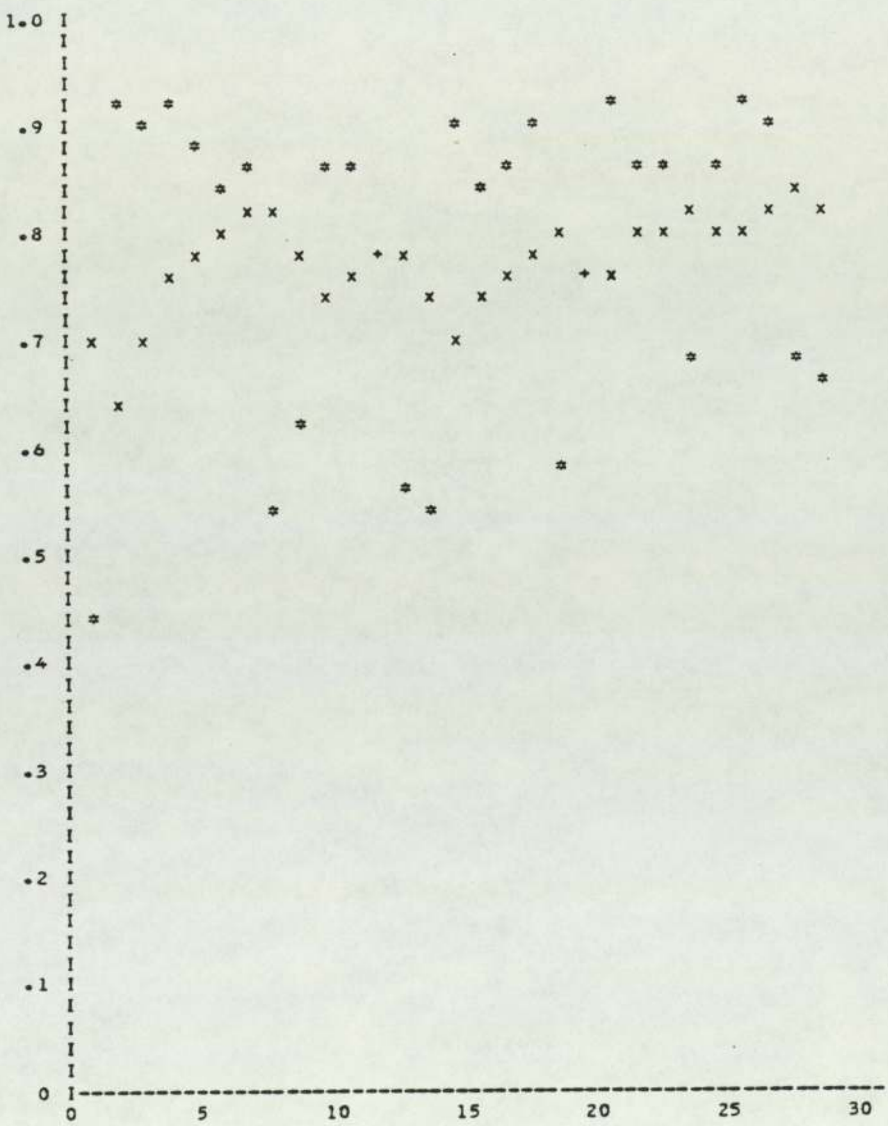


DIAGRAM 6.15

THE ORGANISATION OF RAWHOSE PRODUCTION INDICES

REFERENCE : 29

```
        ( ) - ABSOLUTE VALUES    [ ] - INDICES

POTENTIALITY -( 2534 )-
                      :
                      :
                      :------- LATENCY ------
                      :        [ 0.67 ]      :
                      :                      :
CAPABILITY  -( 1690 )-:                      :--- PERFORMANCE
                      :                      :      [ 0.43 ]
                      :                      :
                      :--- PRODUCTIVITY -----
                      :        [ 0.65 ]
                      :
ACTUALITY   -( 1099 )-
```

DIAGRAM 6.16

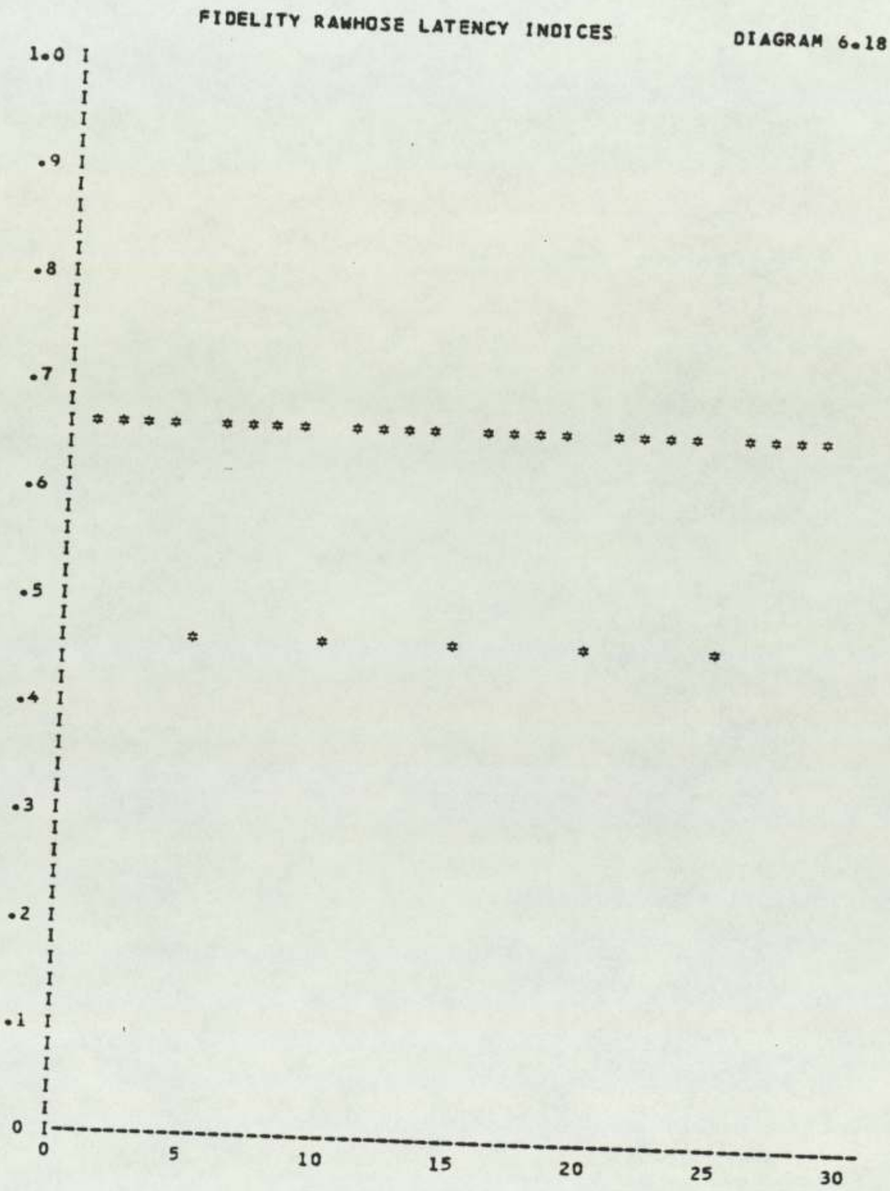
THE RAWHOSE INDEX CENTRE OF LINING AND ITS ASSOCIATED AREAS

```
                       !------------
COMPOUND               !---------   !
                                ! !   RAWHOSE
                                \ /
                              ===============
                             I               I
                             I###############I------------
                             I###############I---------   !
                              ===============            \ / FIDELITY TRANSFORM
                                ! !                     --------------
                                ! !                    !              !
                                ! !                    !**************!-----\
                                ! !                    !**************!-----/
                                ! !                     --------------
        86 TRANSFORM            \ /
                           ----------------
                          !                !
                          !................!
                           ----------------
                                ! !
                                \ /
```

DIAGRAM 6.17

THE POSITION OF THE RAWHOSE INDEX CENTRE

```
MANAGEMENT LEVEL 1        --------------
                         : AUTOHOSE     :
                         :              :
                         :              :
                          --------------
MANAGEMENT LEVEL 2               :
 --------------                  :
: FIDELITY     :                 :
:              :-----------------
:              :
 --------------   ------------------------
      :  :                               :
      :   -------------------            :
MANAGEMENT LEVEL 3               :        ------------
      :                          :                   :
 ==============           --------------      --------------
: RAWHOSE      :         : TRANSFORMAT- :    : FINISHING    :
:              :         : ION          :    :              :
:              :         :              :    :              :
 ==============           --------------      --------------
```


FIDELITY RAWHOSE LATENCY INDICES
DIAGRAM 6.18
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
5
10
15
20
25
30

FIDELITY RAWHOSE PERFORMANCE INDICES DIAGRAM 6.19

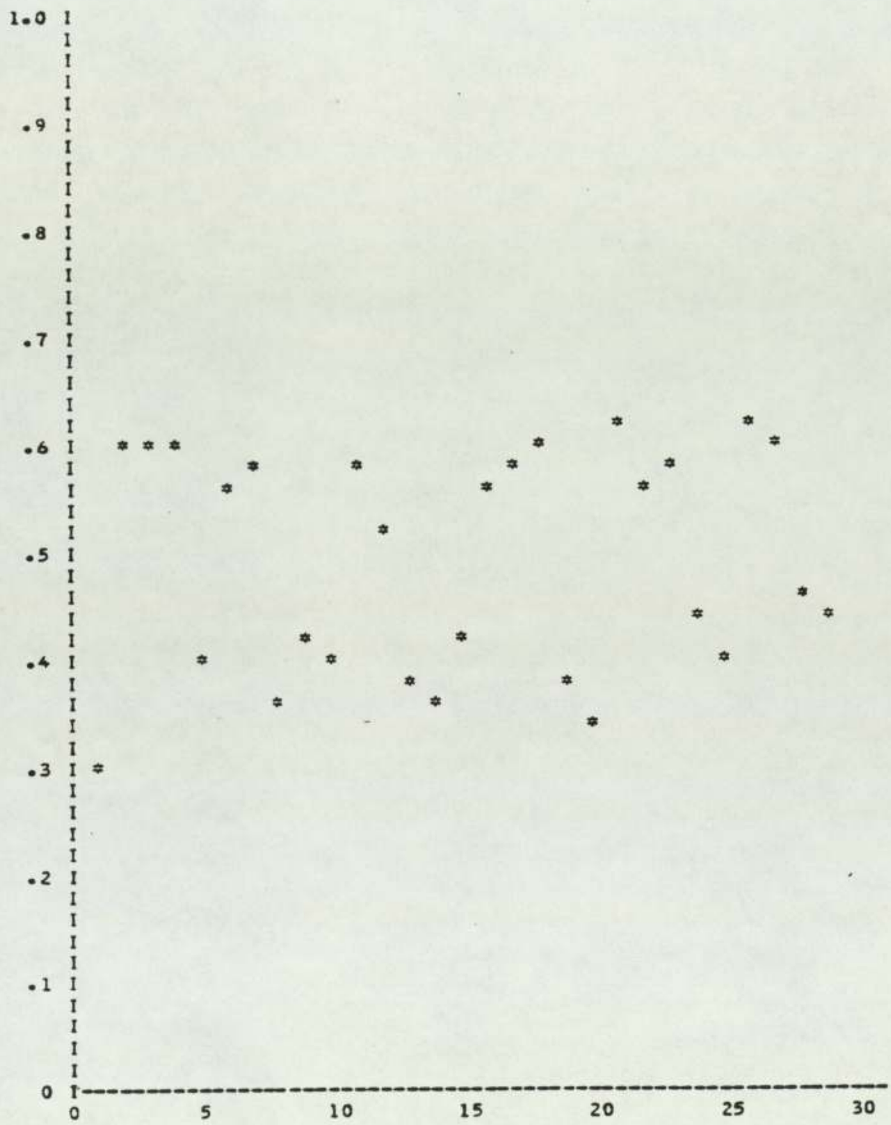


DIAGRAM 6.20

FIDELITY LINING PRODUCTIVITIES AND FORECASTS

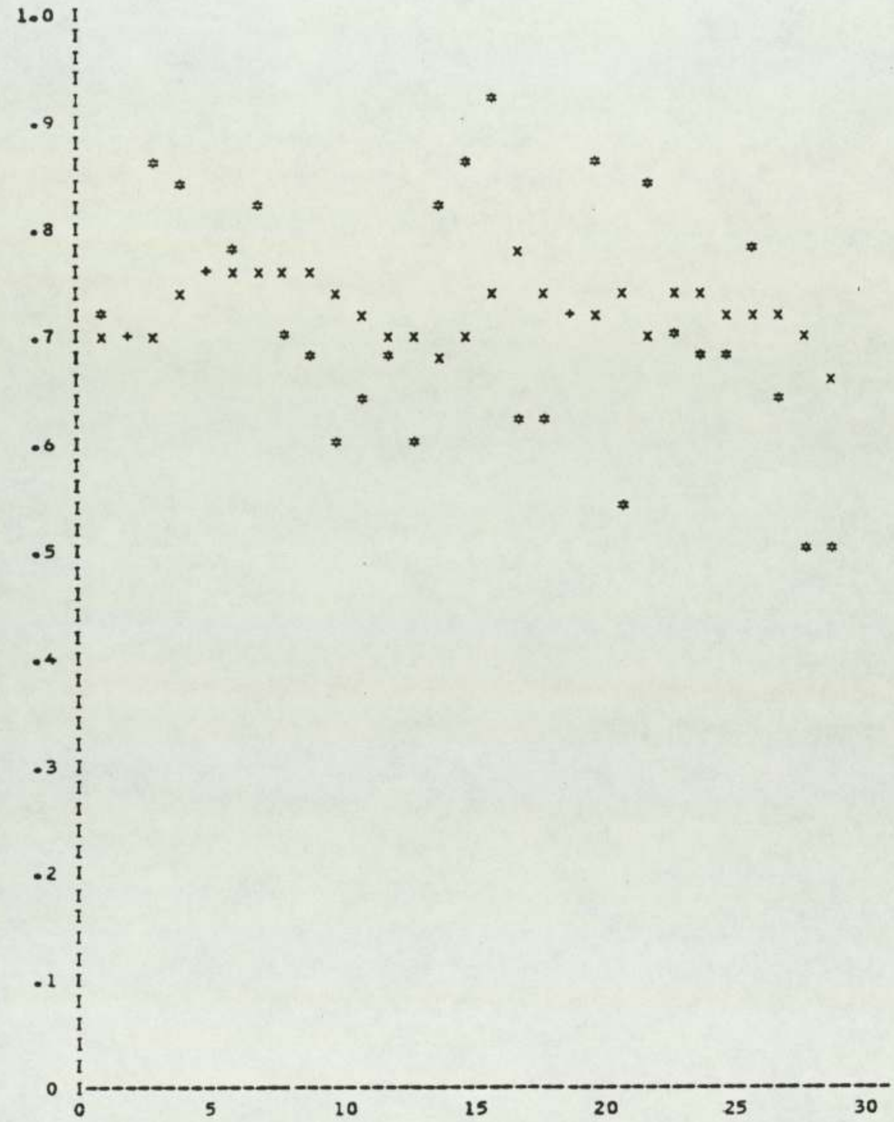


DIAGRAM 6.21

FIDELITY LINING MEAN PRODUCTIVITIES

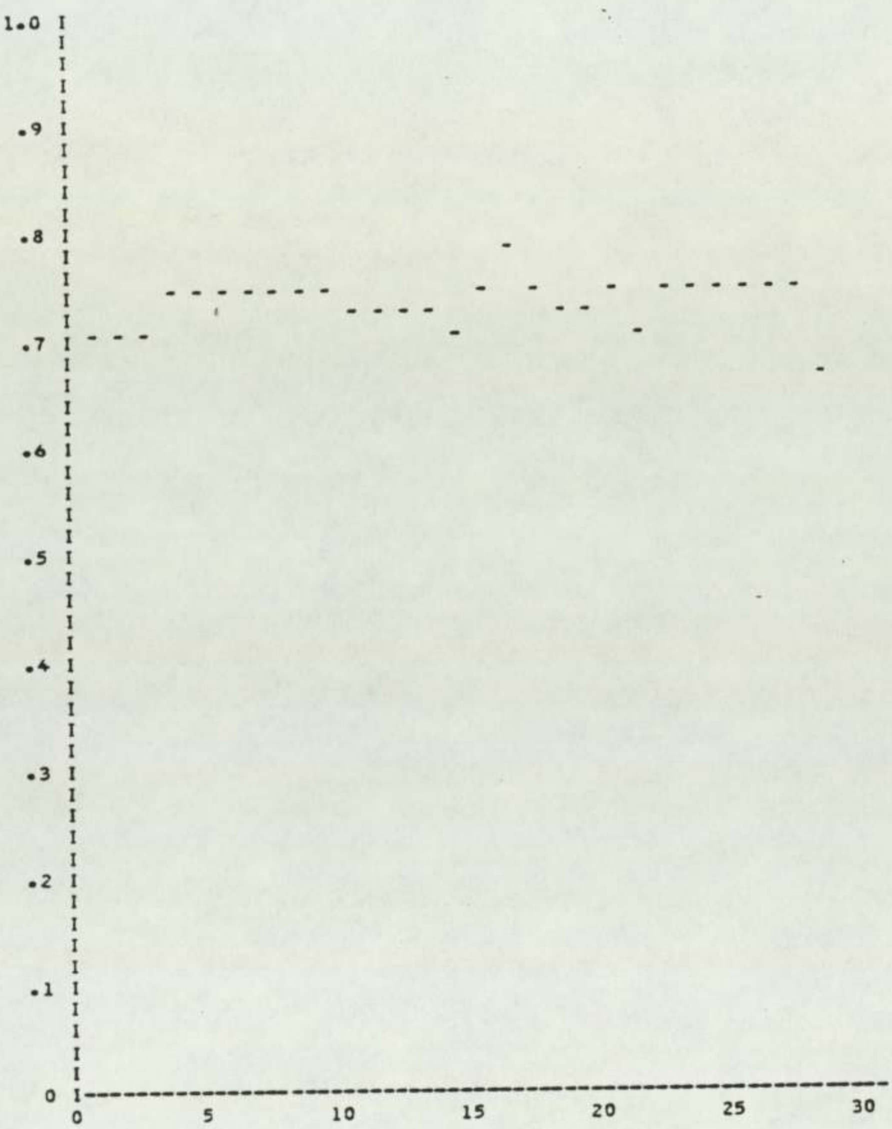


DIAGRAM 6.22

PRODUCTION FIGURES FOR FIDELITY LINING

Reference Number	Date	Production Level SMV	Productivity Index
1	17/7	1107	0.72
2	18/7	1065	0.69
3	19/7	1319	0.86
4	20/7	1269	0.83
5	F 21/7	792	0.75
6	24/7	1185	0.77
7	25/7	1247	0.81
8	26/7	1057	0.69
9	27/7	1044	0.68
10	F 28/7	625	0.59
11	31/7	979	0.64
12	1/8	1026	0.67
13	2/8	907	0.59
14	3/8	1237	0.81
15	F 4/8	683	0.85
16	7/8	1399	0.91
17	8/8	943	0.61
18	9/8	960	0.62
19	10/8	1104	0.72
20	F 11/8	899	0.85
21	14/8	827	0.54
22	15/8	1284	0.84
23	16/8	1082	0.70
24	17/8	1038	0.68
25	F 18/8	708	0.67
26	21/8	1182	0.77
27	22/8	982	0.64
28	23/8	754	0.49
29	24/8	755	0.49

Capability Basis : highest performance achieved =145%
Capability for two shifts : 1392 SM
Capability plus 10% contingency : 1532 SM
Capability Fridays only : 1053 SM

F = Fridays

LINING PRODUCTION AND FORECAST DATA   Diagram 6.23

ALPHA = 0.20
FORECAST = 0.70
TYPE = N
LIMIT =   25 %

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.72	0.00	0.64	
2	0.70	0.69	0.00	0.25	
3	0.70	0.86	0.00	0.84	
4	0.74	0.83	0.01	0.90	
5	0.76	0.75	0.00	0.85	
6	0.75	0.77	0.00	0.86	
7	0.76	0.81	0.00	0.90	
8	0.77	0.69	0.00	0.30	
9	0.75	0.68	0.01	-.05	
10	0.74	0.59	0.01	-.42	E
11	0.71	0.64	0.01	-.53	
12	0.70	0.67	0.01	-.57	
13	0.69	0.59	0.01	-.69	
14	0.67	0.81	0.01	-.11	
15	0.70	0.85	0.02	0.25	
16	0.73	0.91	0.03	0.51	
17	0.77	0.61	0.03	0.14	E
18	0.74	0.62	0.03	-.08	
19	0.72	0.72	0.02	-.08	
20	0.72	0.85	0.02	0.20	
21	0.75	0.54	0.03	-.17	E
22	0.71	0.84	0.03	0.08	
23	0.74	0.70	0.02	0.01	
24	0.73	0.68	0.02	-.09	
25	0.72	0.67	0.02	-.19	
26	0.71	0.77	0.01	-.02	
27	0.72	0.64	0.01	-.21	
28	0.71	0.49	0.02	-.50	E
29	0.67	0.49	0.03	-.64	E

DIAGRAM 6.24

FIDELITY KNITTING PRODUCTIVITIES AND FORECASTS

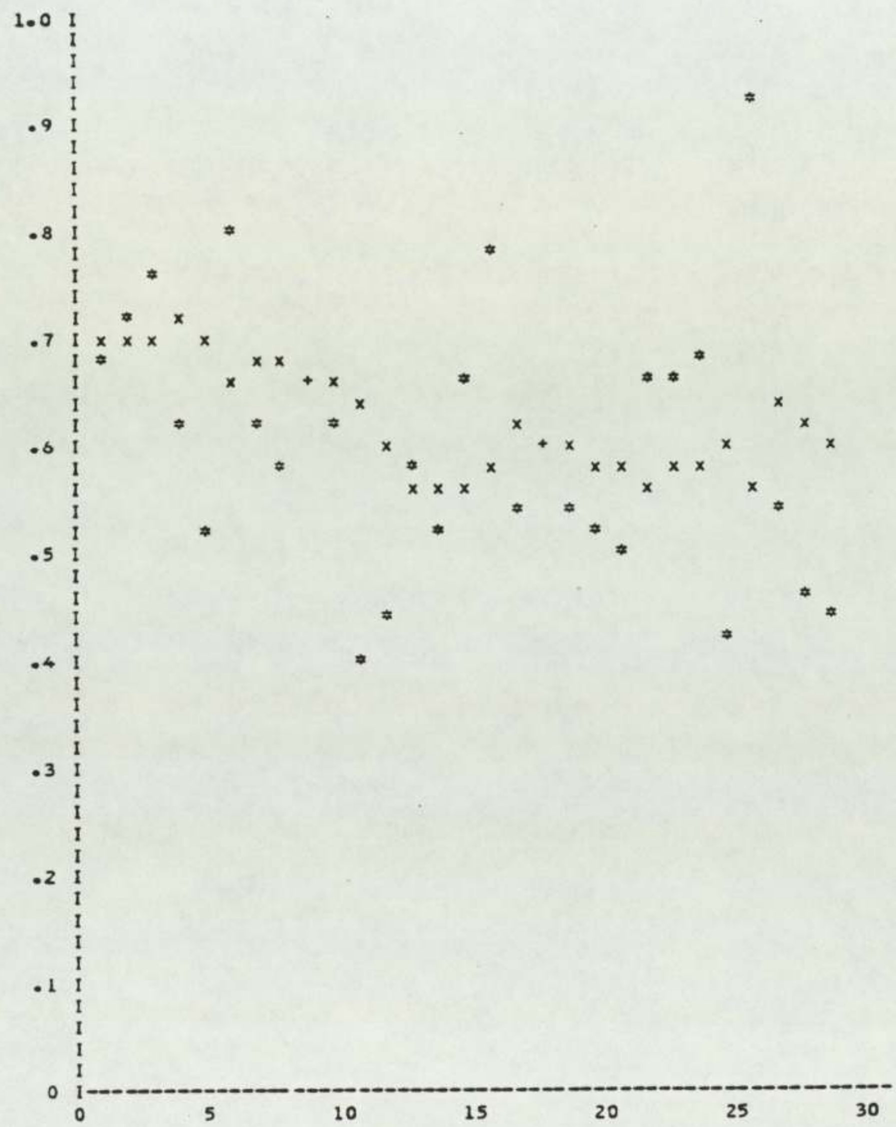


DIAGRAM 6.25

FIDELITY KNITTING MEAN PRODUCTIVITIES

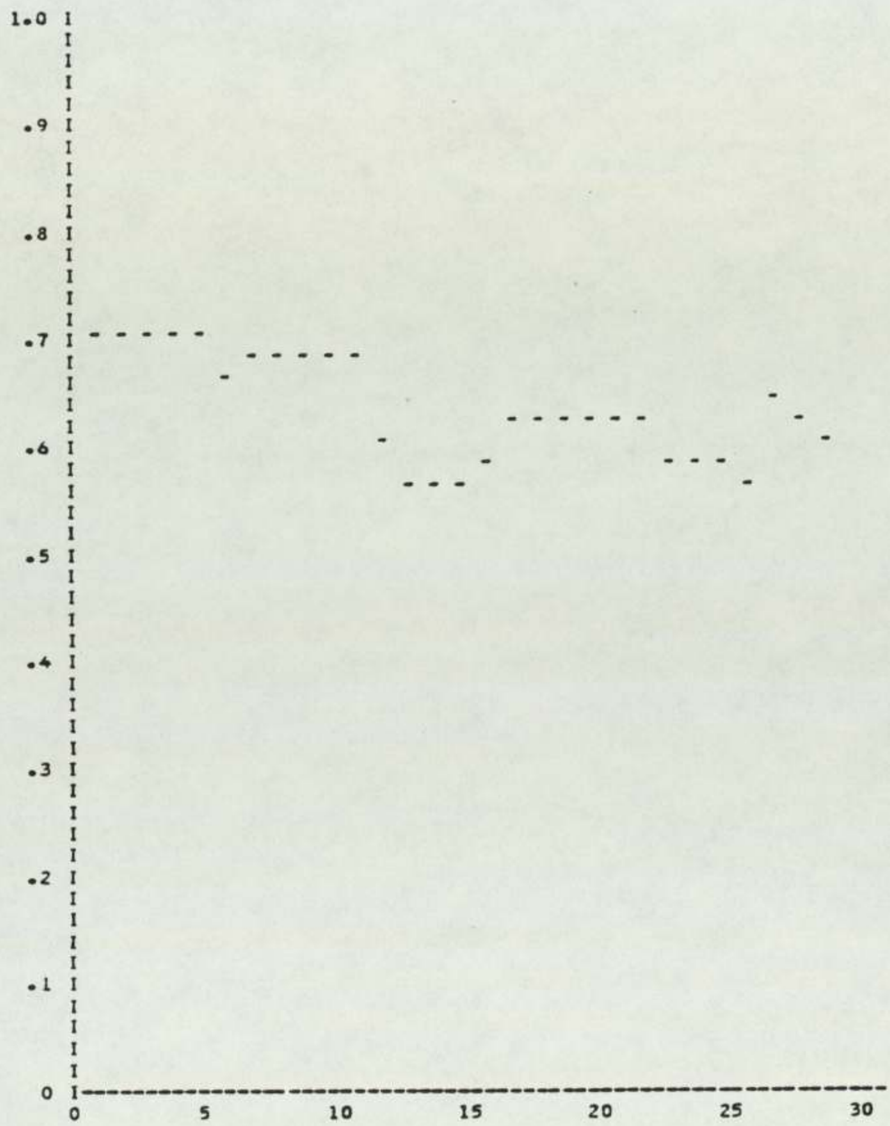


DIAGRAM 6.26

PRODUCTION FIGURES FOR FIDELITY KNITTING

Reference Number		Date	Production Level SMV	Productivity Index
1		17/7	1780	0.67
2		18/7	1899	0.71
3		19/7	2018	0.76
4		20/7	1605	0.61
5	F	21/7	933	0.51
6		24/7	2133	0.80
7		25/7	1621	0.61
8		26/7	1547	0.58
9		27/7	1710	0.65
10	F	28/7	1126	0.62
11		31/7	1039	0.39
12		1/8	1154	0.43
13		2/8	1551	0.58
14		3/8	1366	0.51
15	F	4/8	1200	0.66
16		7/8	2042	0.77
17		8/8	1423	0.54
18		9/8	1565	0.59
19		10/8	1413	0.53
20	F	11/8	930	0.51
21		14/8	1298	0.49
22		15/8	1727	0.65
23		16/8	1732	0.65
24		17/8	1818	0.67
25	F	18/8	761	0.42
26		21/8	2411	0.91
27		22/8	1437	0.54
28		23/8	1225	0.46
29		24/8	1150	0.43

Capability Basis : highest performance of 167 %
Capability three shifts : 2405 SM
Capability including 10% contingency : 2645 SM
Capability Fridays only : 1819 SM

FIDELITY KNITTING PRODUCTION AND FORECAST DATA   DIAGRAM 6.27

ALPHA = 0.20
FORECAST = 0.70
TYPE = N
LIMIT = 25 %

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.67	0.00	-.81	
2	0.69	0.71	0.00	-.39	
3	0.70	0.76	0.00	0.36	
4	0.71	0.61	0.00	-.32	
5	0.69	0.51	0.01	-.68	E
6	0.66	0.80	0.01	-.06	
7	0.69	0.61	0.01	-.24	
8	0.67	0.58	0.01	-.40	
9	0.65	0.65	0.01	-.41	
10	0.65	0.62	0.01	-.47	
11	0.65	0.39	0.02	-.74	E
12	0.60	0.43	0.02	-.81	E
13	0.56	0.58	0.01	-.75	
14	0.57	0.51	0.01	-.78	
15	0.56	0.66	0.01	-.36	
16	0.58	0.77	0.02	0.13	E
17	0.62	0.54	0.02	-.04	
18	0.60	0.59	0.01	-.06	
19	0.60	0.53	0.01	-.22	
20	0.59	0.51	0.01	-.36	
21	0.57	0.49	0.01	-.49	
22	0.55	0.65	0.01	-.15	
23	0.57	0.65	0.01	0.06	
24	0.59	0.67	0.01	0.25	
25	0.61	0.42	0.02	-.20	E
26	0.57	0.91	0.04	0.40	E
27	0.65	0.54	0.04	0.20	
28	0.63	0.46	0.04	-.06	E
29	0.59	0.43	0.04	-.26	E

DIAGRAM 6.28

FIDELITY COVERING PRODUCTIVIES AND FORECASTS

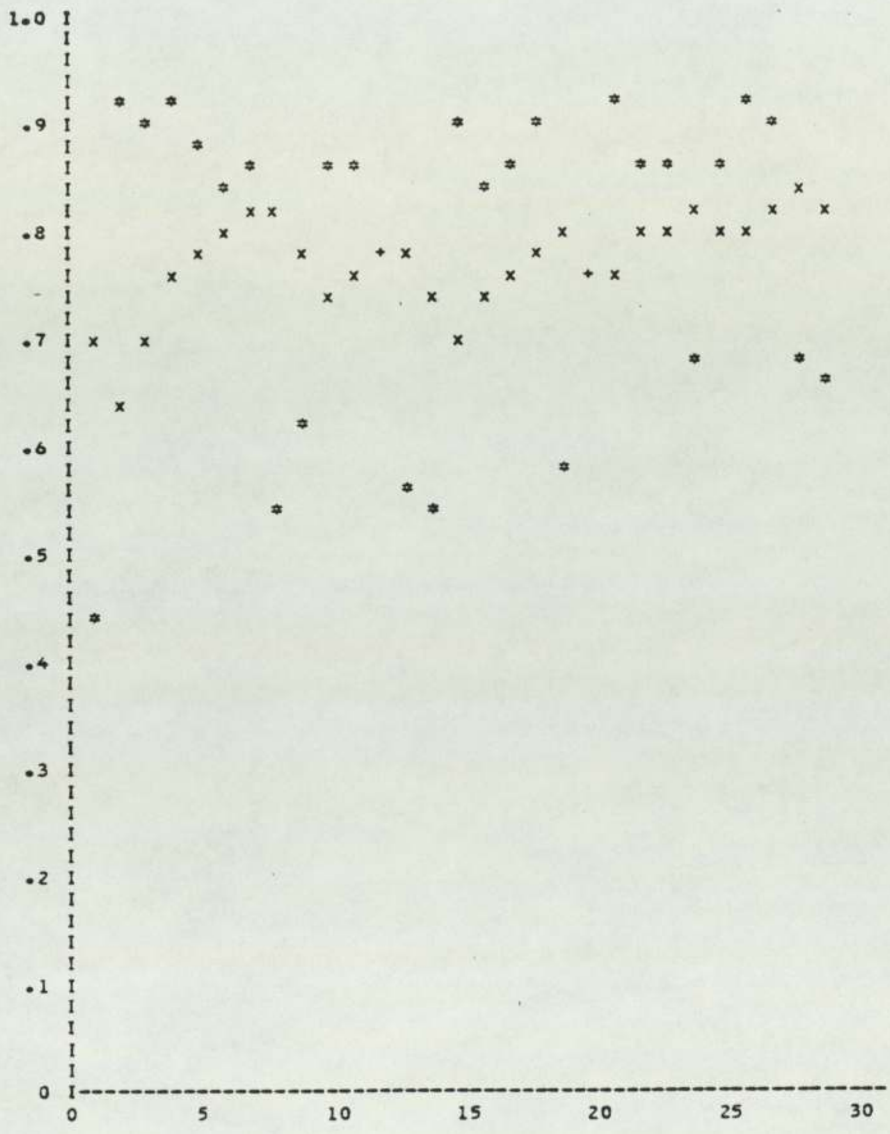


DIAGRAM 6.29

FIDELITY COVERING MEAN PRODUCTIVIES

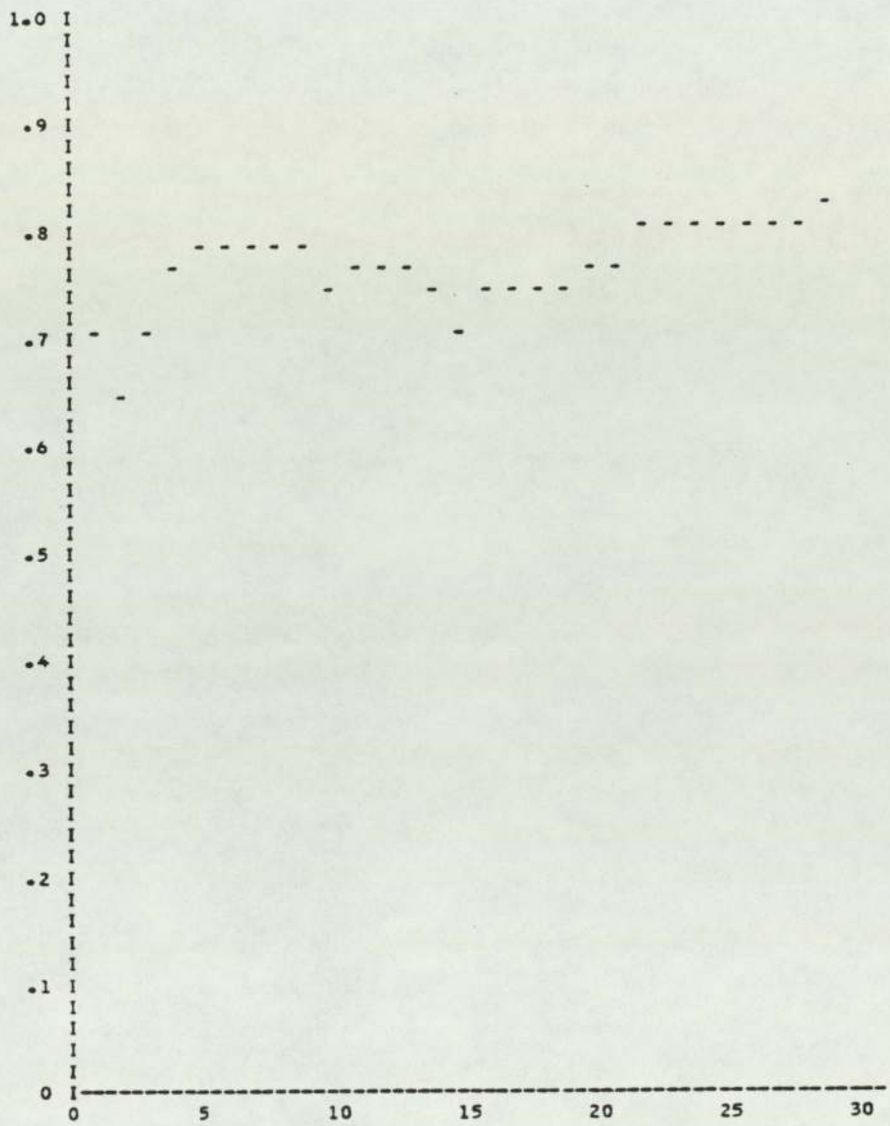


DIAGRAM 6.30

PRODUCTION FIGURES FOR FIDELITY COVERING

Reference Number		Date	Production Level SMV	Productivity Index
1		17/7	730	0.43
2		18/7	1533	0.91
3		19/7	1518	0.90
4		20/7	1532	0.91
5	F	21/7	1021	0.88
6		24/7	1405	0.83
7		25/7	1447	0.86
8		26/7	913	0.54
9		27/7	1041	0.62
10	F	28/7	1003	0.86
11		31/7	1437	0.85
12		1/8	1297	0.77
13		2/8	936	0.55
14		3/8	895	0.53
15	F	4/8	1041	0.89
16		7/8	1426	0.84
17		8/8	1455	0.86
18		9/8	1500	0.89
19		10/8	966	0.57
20	F	11/8	875	0.75
21		14/8	1537	0.91
22		15/8	1430	0.85
23		16/8	1460	0.86
24		17/8	1127	0.67
25	F	18/8	982	0.85
26		21/8	1538	0.91
27		22/8	1517	0.90
28		23/8	1150	0.68
29		24/8	1099	0.65

Capability Basis : highest performance of 160 %
Capability for two shifts : 1536 SM
Capability including 10% contingency : 1690 SM
Capability Fridays only : 1162 SM

DIAGRAM 6.30 continued

PRODUCTION FIGURES FOR FIDELITY COVERING

Reference Number	Date	Production Level SMV	Latency Index	Performance Index
1	17/7	730	0.67	0.29
2	18/7	1533	0.67	0.60
3	19/7	1518	0.67	0.60
4	20/7	1532	0.67	0.60
5	F 21/7	1021	0.46	0.40
6	24/7	1405	0.67	0.55
7	25/7	1447	0.67	0.57
8	26/7	913	0.67	0.36
9	27/7	1041	0.67	0.41
10	F 28/7	1003	0.46	0.40
11	31/7	1437	0.67	0.57
12	1/8	1297	0.67	0.51
13	2/8	936	0.67	0.37
14	3/8	895	0.67	0.35
15	F 4/8	1041	0.46	0.41
16	7/8	1426	0.67	0.56
17	8/8	1455	0.67	0.57
18	9/8	1500	0.67	0.59
19	10/8	966	0.67	0.38
20	F 11/8	875	0.46	0.34
21	14/8	1537	0.67	0.61
22	15/8	1430	0.67	0.56
23	16/8	1460	0.67	0.58
24	17/8	1127	0.67	0.44
25	F 18/8	982	0.46	0.39
26	21/8	1538	0.67	0.61
27	22/8	1517	0.67	0.60
28	23/8	1150	0.67	0.45
29	24/8	1099	0.67	0.43

Potentiality Basis : highest performance of 160 %
Potentiality for three shifts : 2304 SM
Potentiality including 10% contingency : 2534 SM

FIDELITY COVERING PRODUCTION AND FORECAST DATA   DIAGRAM 6.31

ALPHA = 0.20
FORECAST = 0.70
TYPE = N
LIMIT =   25 %

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.43	0.01	-1.57	E
2	0.65	0.91	0.02	-.12	E
3	0.71	0.90	0.03	0.27	
4	0.75	0.91	0.04	0.47	
5	0.79	0.88	0.03	0.56	
6	0.81	0.83	0.02	0.58	
7	0.81	0.86	0.02	0.62	
8	0.82	0.54	0.04	-.04	E
9	0.77	0.62	0.04	-.25	
10	0.74	0.86	0.04	-.01	
11	0.77	0.85	0.03	0.14	
12	0.79	0.77	0.02	0.10	
13	0.78	0.55	0.03	-.28	E
14	0.74	0.53	0.04	-.48	E
15	0.70	0.89	0.05	-.08	
16	0.74	0.84	0.04	0.08	
17	0.76	0.86	0.04	0.22	
18	0.79	0.89	0.04	0.37	
19	0.81	0.57	0.05	-.04	E
20	0.77	0.75	0.03	-.06	
21	0.76	0.91	0.04	0.21	
22	0.80	0.85	0.03	0.29	
23	0.81	0.86	0.02	0.37	
24	0.82	0.67	0.03	0.02	
25	0.79	0.85	0.02	0.15	
26	0.80	0.91	0.03	0.35	
27	0.83	0.90	0.02	0.46	
28	0.84	0.68	0.03	0.05	
29	0.81	0.65	0.03	-.21	E

DIAGRAM 6.32

FIDELITY LINING ATTENDANCE PRODUCTIVITIES

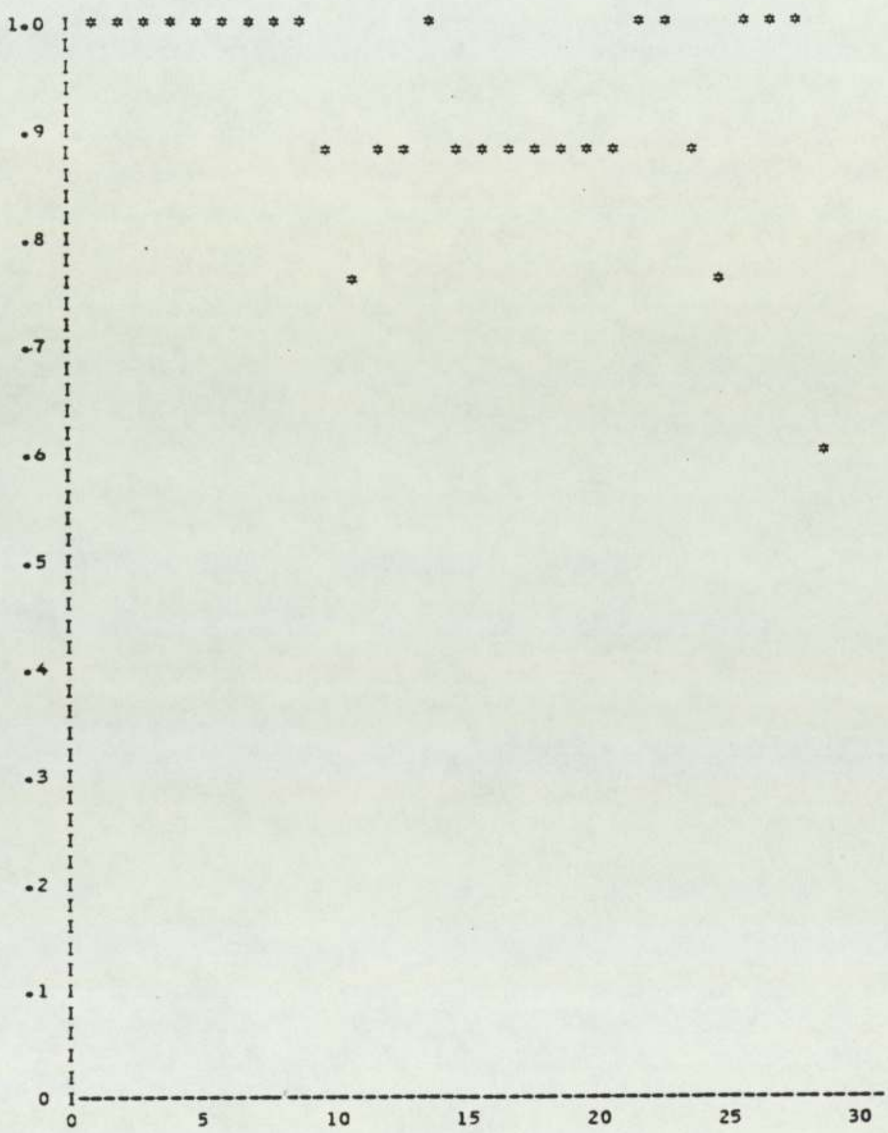
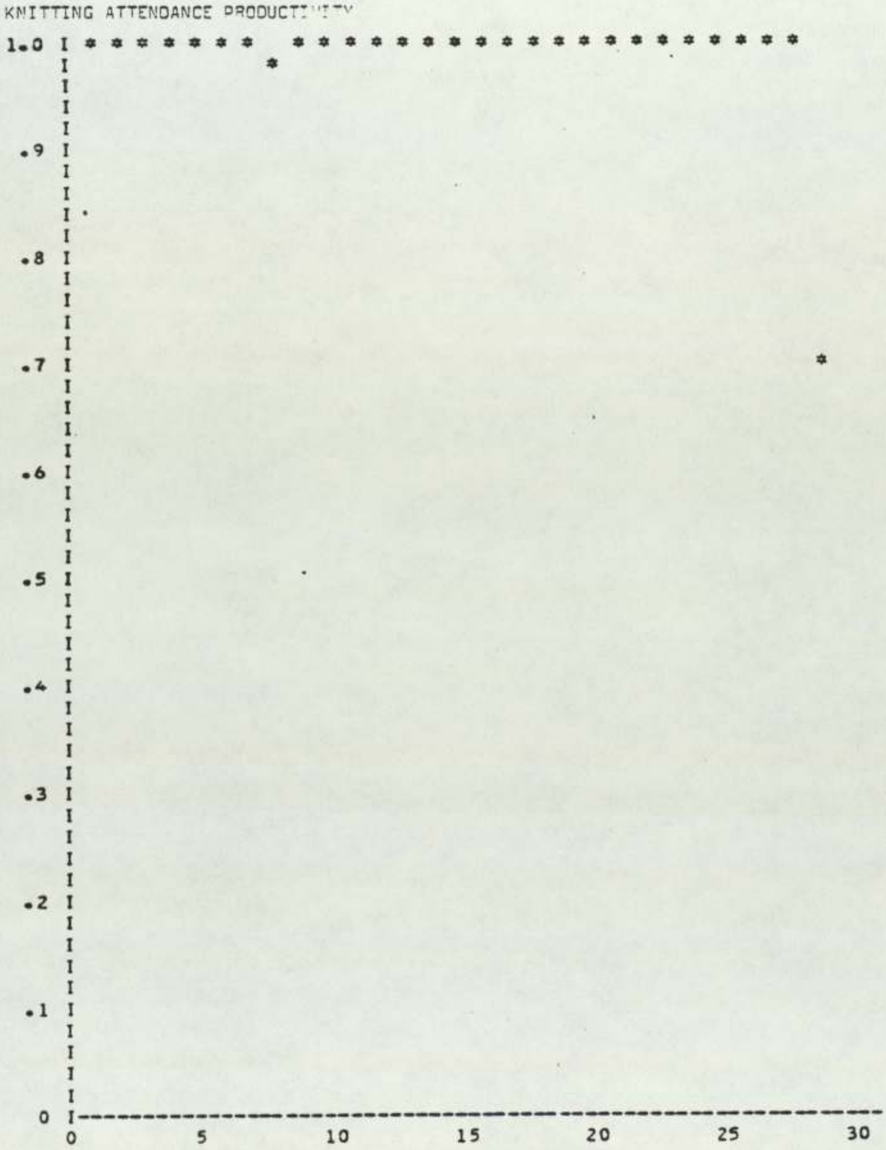
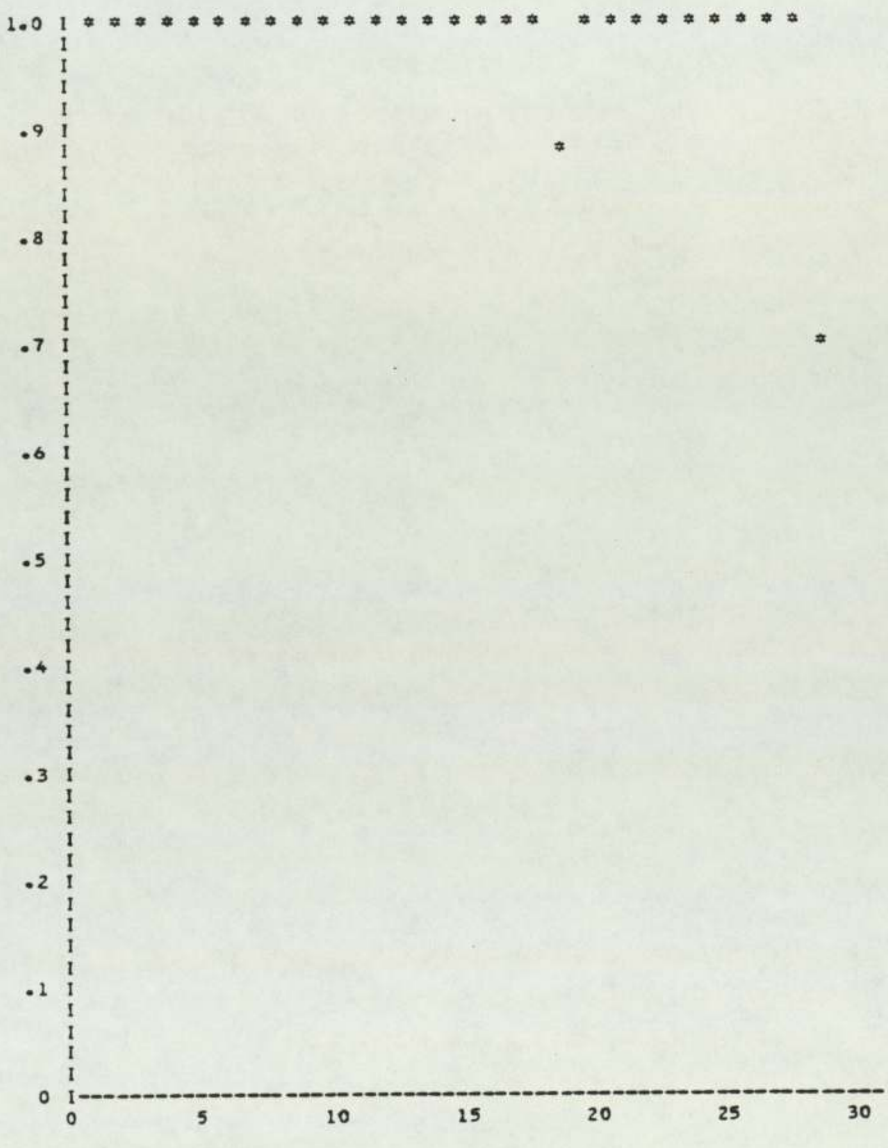


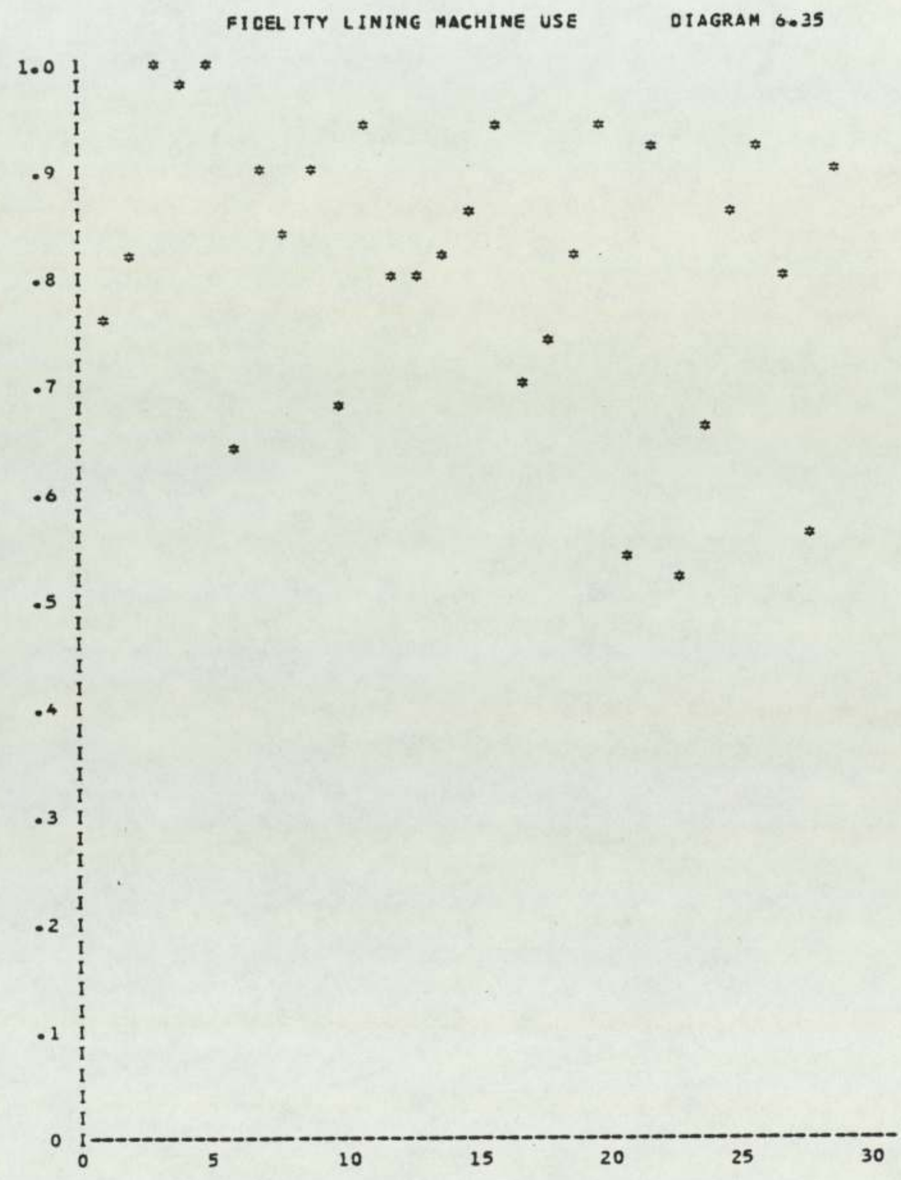
DIAGRAM 6.[illegible]

KNITTING ATTENDANCE PRODUCTIVITY

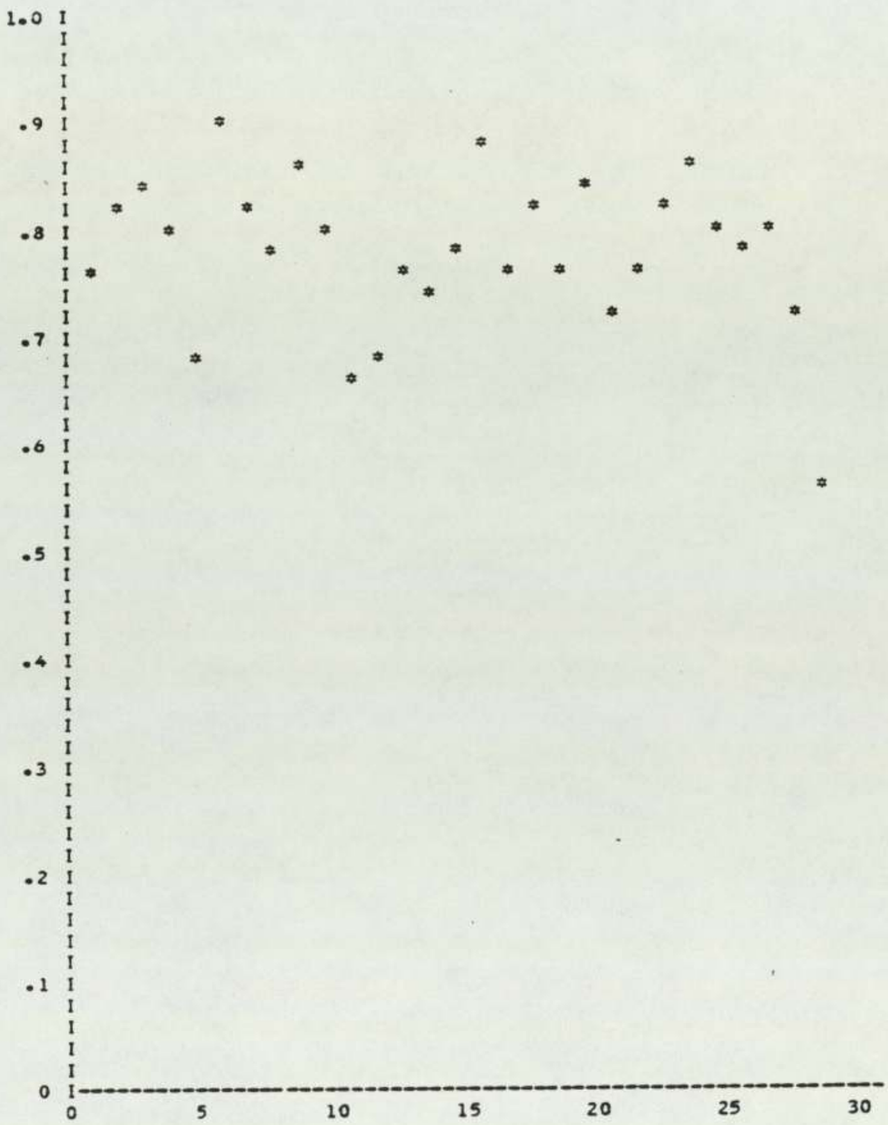


FIDELITY COVERING ATTENDANCE PRODUCTIVITIES DIAGRAM 6.34




FIDELITY LINING MACHINE USE
DIAGRAM 6.35
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
5
10
15
20
25
30

FIDELITY KNITTING MACHINE USE DIAGRAM 6.36



FIDELITY COVERING MACHINE USE DIAGRAM 6.37

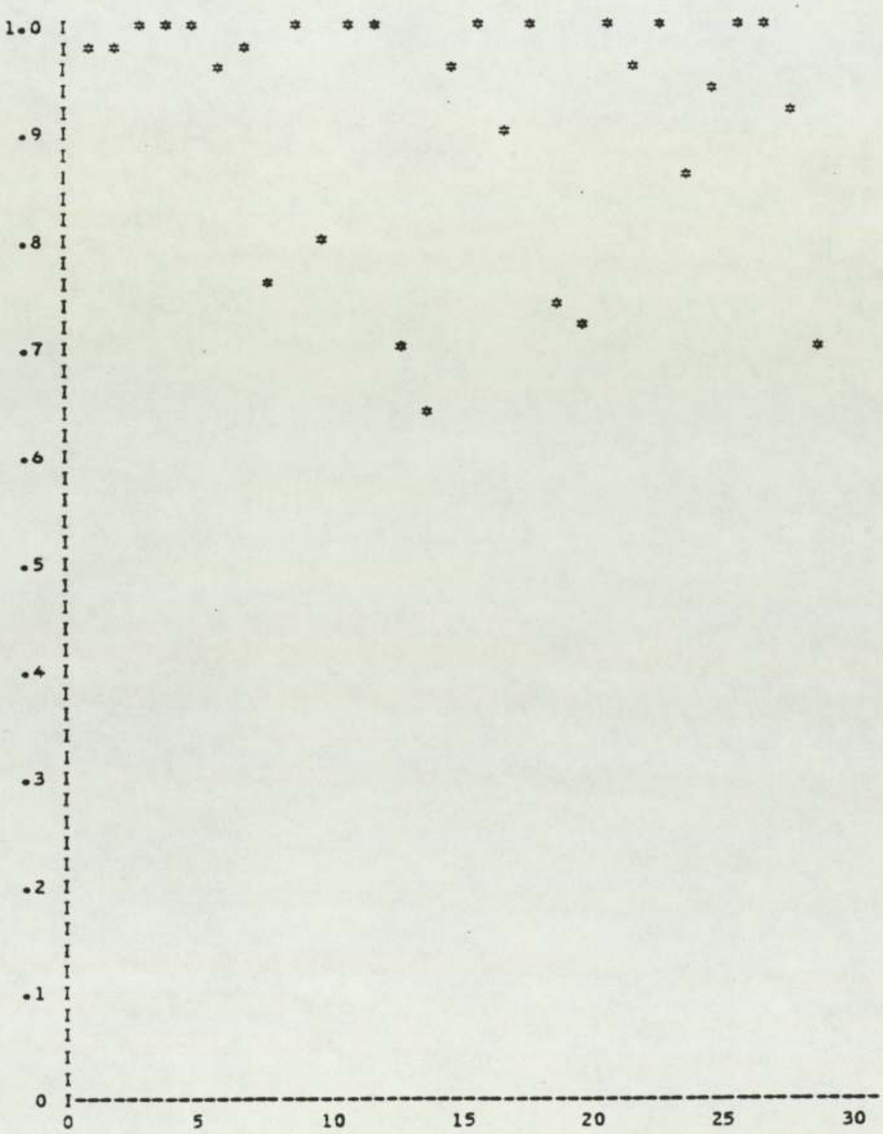


DIAGRAM 6.38

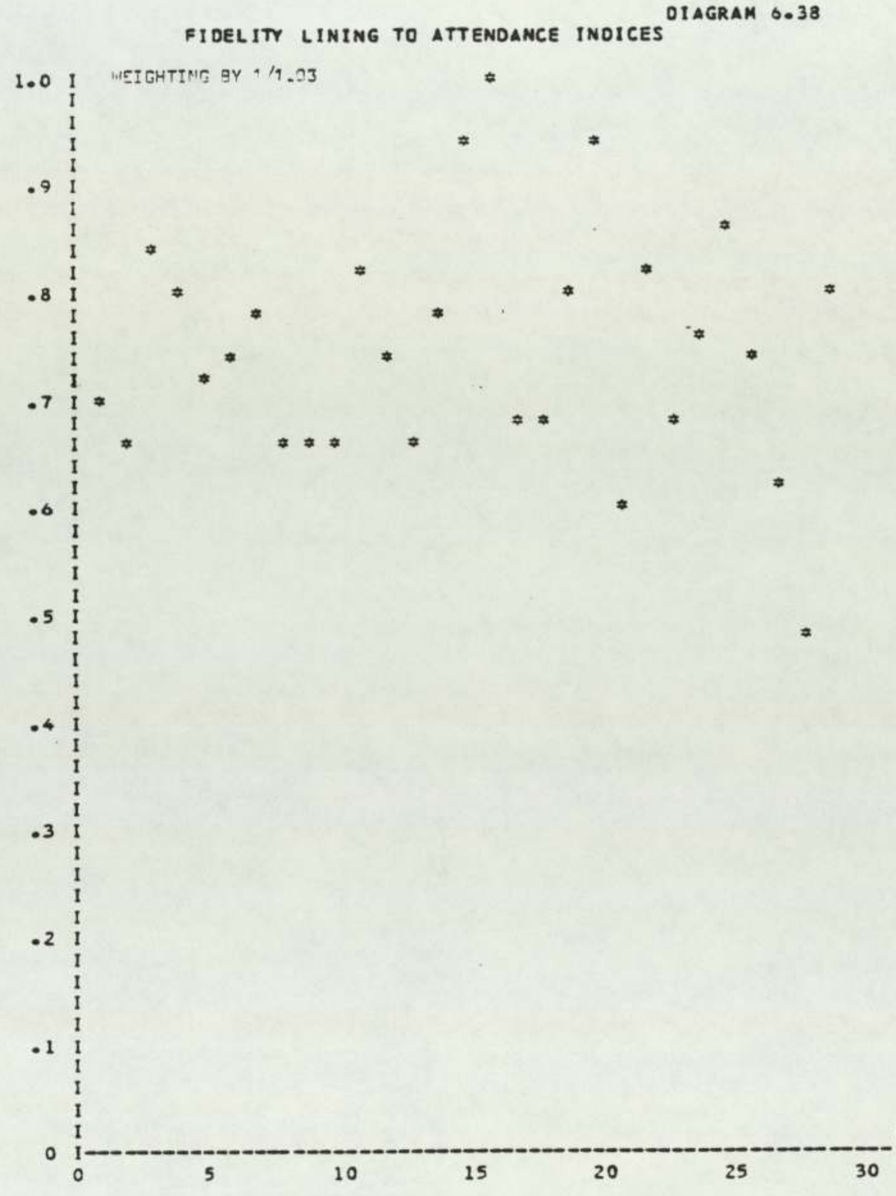

FIDELITY LINING TO ATTENDANCE INDICES
WEIGHTING BY 1/1.03
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
5
10
15
20
25
30

DIAGRAM 6.39

FIDELITY KNITTING PRODUCTION TO ATTENDANCE INDICES

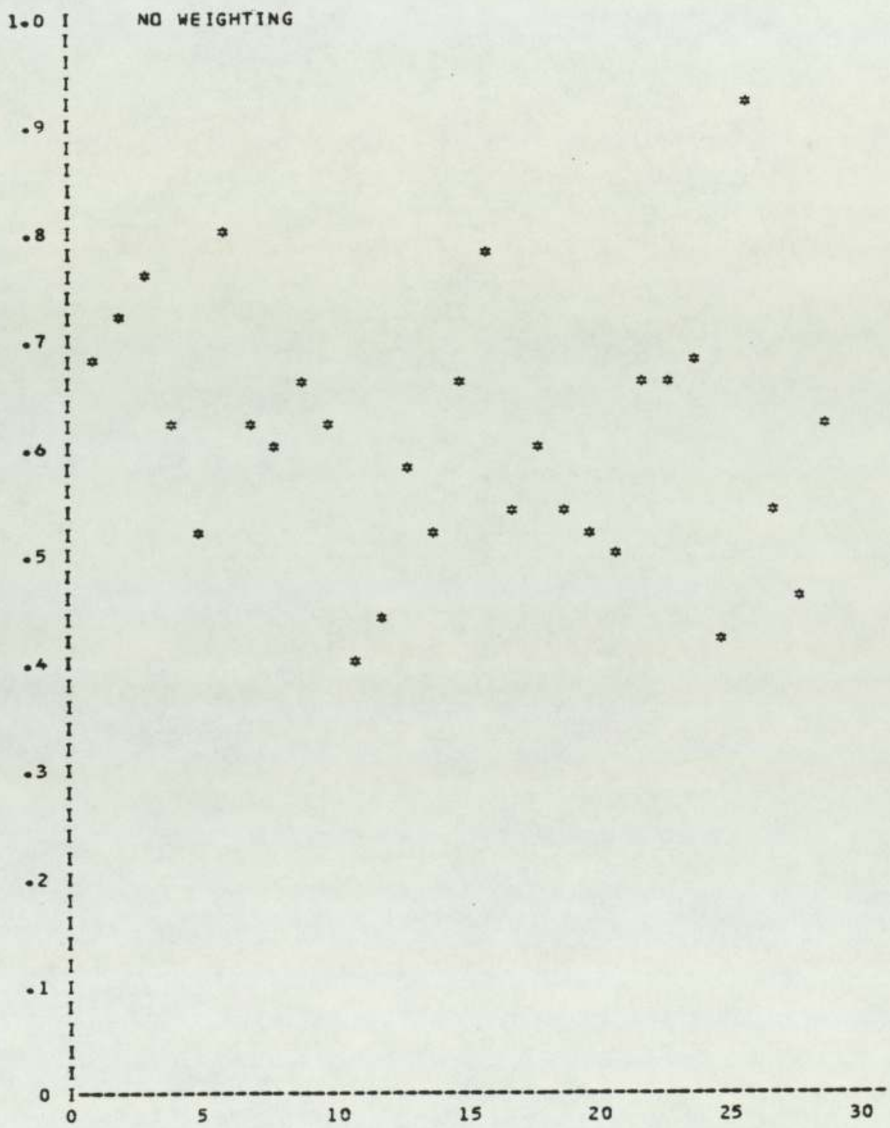


DIAGRAM 6.40

FIDELITY COVERING PRODUCTION TO ATTENDANCE INDICES

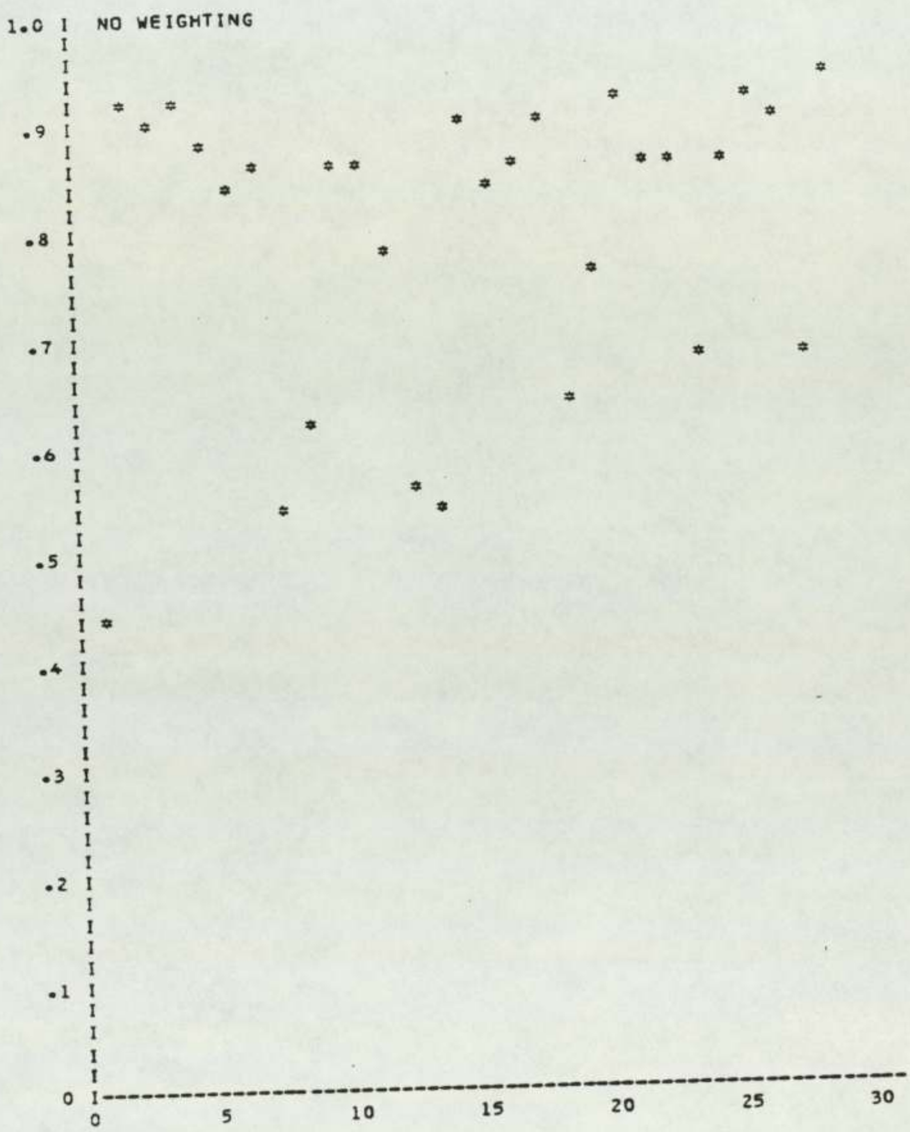
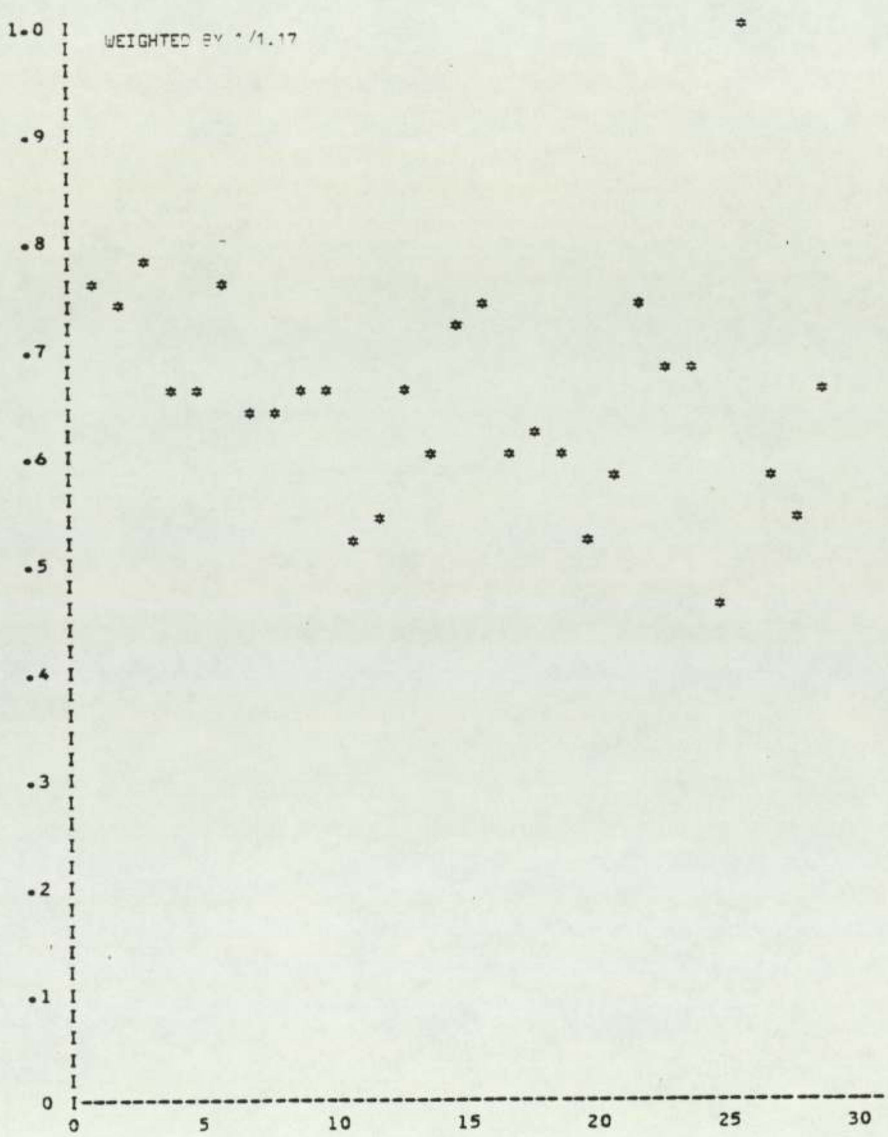


DIAGRAM 6.41

FIDELITY KNITTING PRODUCTION TO MACHINE USE INDICES



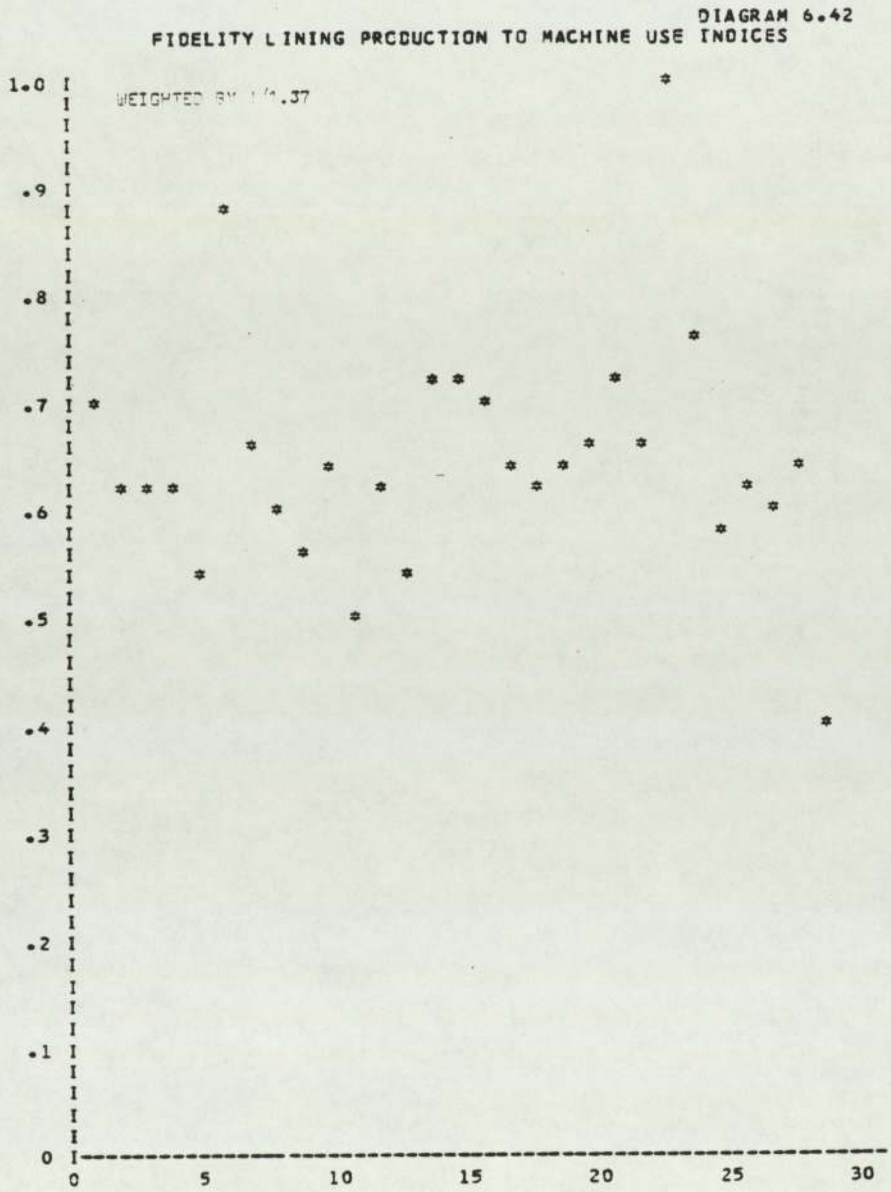


DIAGRAM 6.42
FIDELITY LINING PRODUCTION TO MACHINE USE INDICES
WEIGHTED BY
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
5
10
15
20
25
30

DIAGRAM 6.43

FIDELITY COVERING PRODUCTION TO MACHINE USE INDICES

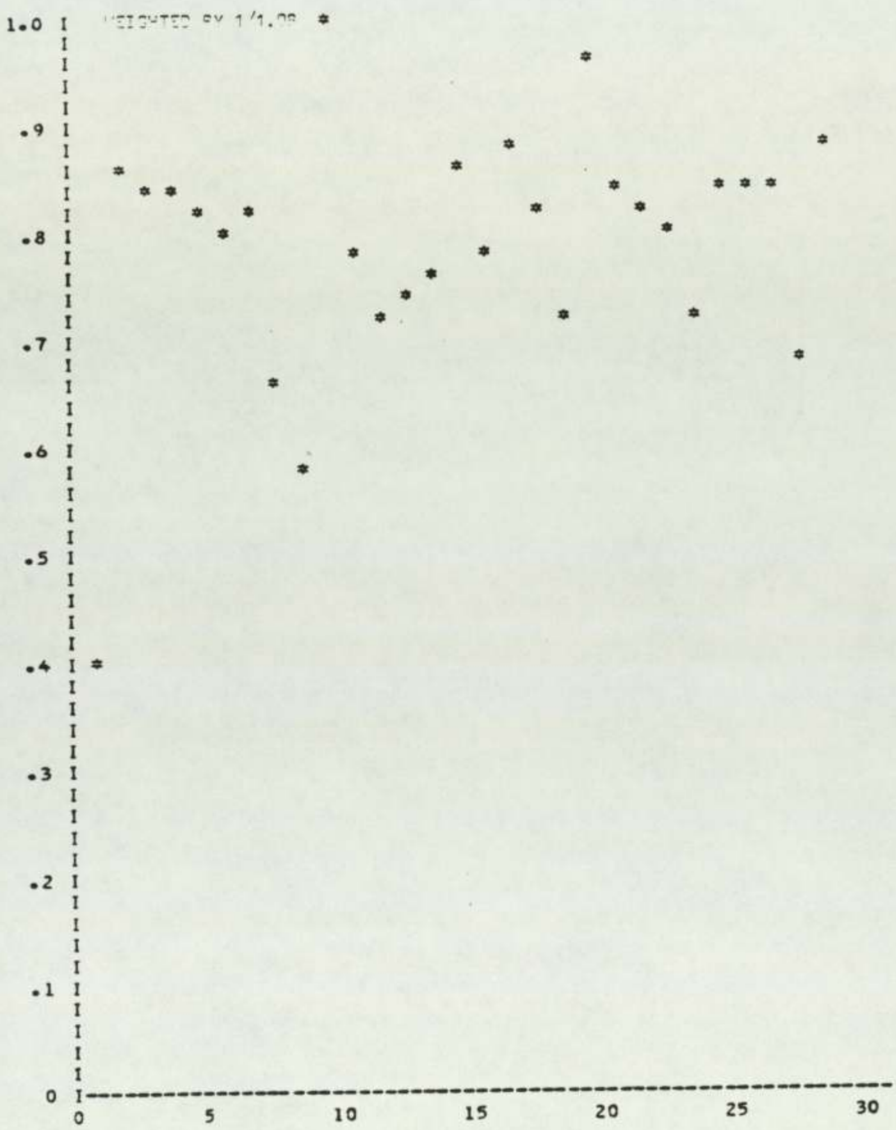


DIAGRAM 6.44

FIDELITY LINING PRODUCTION PRODUCTIVITIES AND FORECASTS

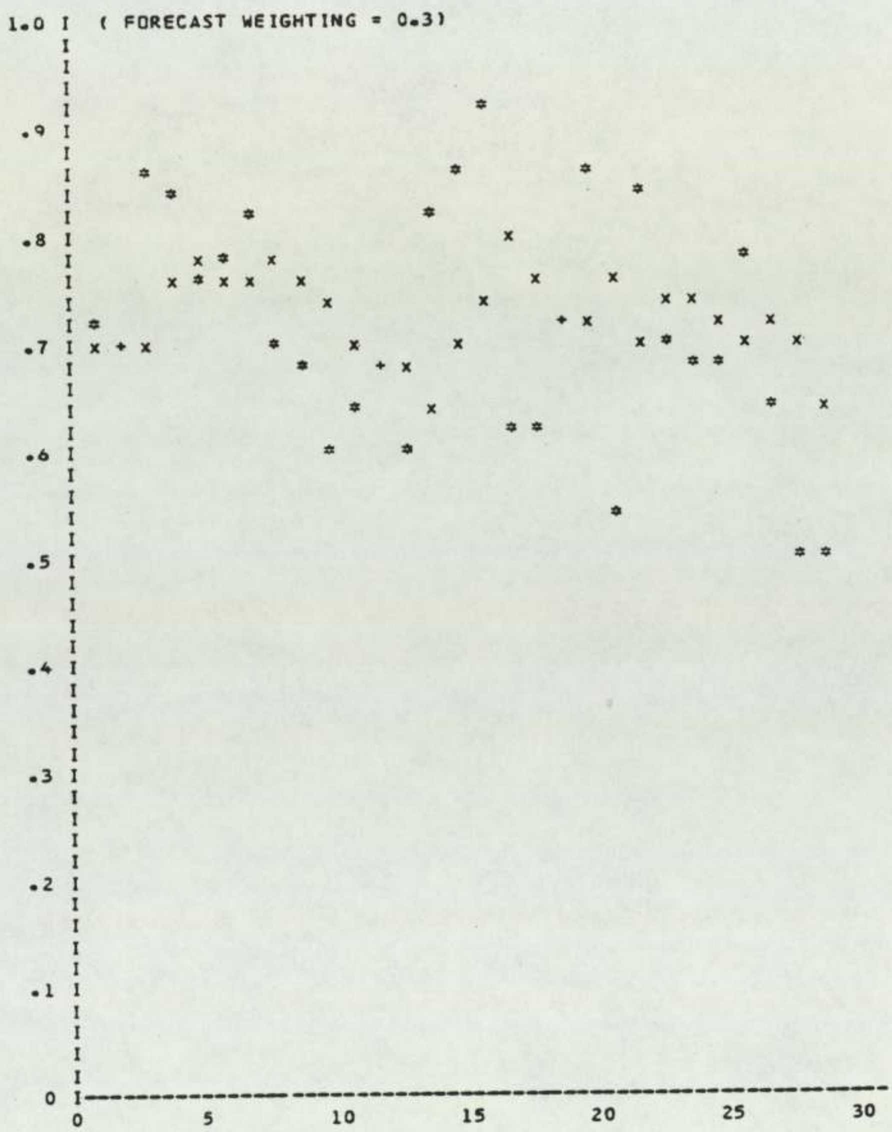
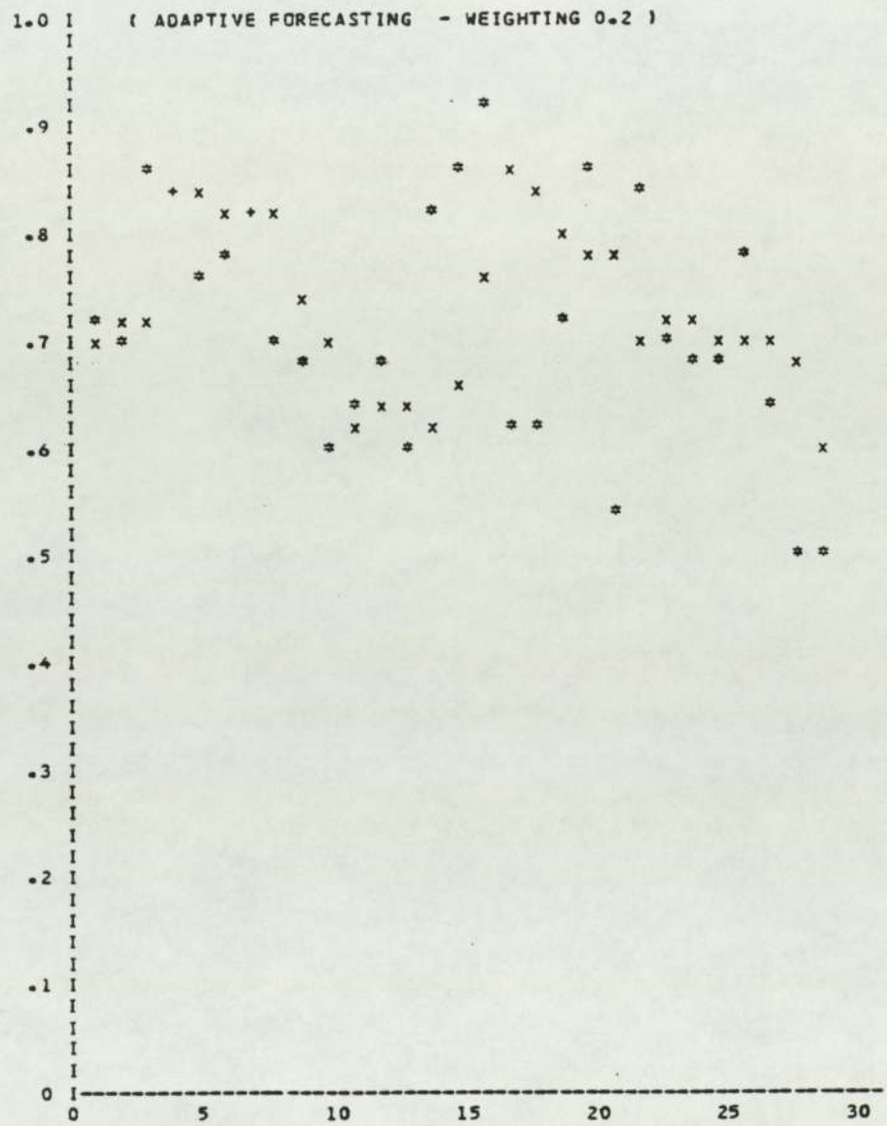


DIAGRAM 6.45

FIDELITY LINING PRODUCTION PRODUCTIVITIES AND FORECASTS



CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.0 Conclusions and Recommendations

The Action Research presented in the preceeding chapters was initiated with vague descriptions of problems to be solved in the Autohose Group. Using these as the basis for further analysis and discussion with managers, the true source of the problems was found to be the lack of suitable management information. In conjunction with the Autohose Managers the objectives for this research were developed into the provision of a Management Information System, its presentation and implementation.

Using the Cybernetic Model as the basis for analysis (Chapter Four) a Management Information System, based on Productivity (and other) Indices, was designed (Chapter Five).

Attempting to introduce the information system on the shop floor presented two major problems; firstly, the lack of any suitable measures and secondly, the lack of co-operation by operatives. Both of these problems could be overcome by changes in management policy and the introduction of suitable measures.

The way in which information could be presented, with suitable measures available, is described in the second part of Chapter Six.

The design of the M.I.S. presented here should be implemented in four phases. Firstly, the introduction of suitable, accurate measures within the factory. Secondly, stronger definition of the roles of production areas (Chapter Five). Thirdly the initial assessment of Capability and Potentiality values, based on the new measures (initial assessments would evolve with the development of the information system). Fourthly the introduction of a computer based system using the designs and techniques described in Chapter Five and Six, to provide the information for management.

The provision of information to the levels described in Chapter Five, would help solve the problems as they were defined initially, not by directly solving the stated problems, but by providing information to enable the best methods to be used to relieve the causes of the problems at the most salient times. A summary of the problems brought to light during this investigation is presented in Diagram 7.1. In this summary, solutions other than the provision of information are also suggested where appropriate.

The use of an M.I.S. such as the one presented here has many attributes, but it also has a few drawbacks: Firstly, the Information System is dependant on the collection of an accurate, and accessible database before it could be reliable. Secondly it would require a setup or "tuning" period in which precise information requirements and adjustments could be made.

Thirdly, the system designed here could not provide detail on individual hose batches and their progress through the factory. Such detail could only be supplied by a Production Control System based on individual hose part numbers. Such a system would also be compatible with this design.

The Management Information System presented here would be compatible with an Order Processing System such as that developed for the Metalastik Group. The principles used for this M.I.S. design could readily be made available for Order Processing data to provide similar information, for example on customer demand, to the relevant managers. This would be an area for further development of the basic system designed here.

In addition the techniques used, in Chapter Six, were simplistic in their approach. The development of more refined methods (such as the Bayesian Forecasting Model), and the detailed computational requirements for the M.I.S. would be the subjects for further research.

A Summary of Problems and Recommended Solutions in the Autohose Factory

PROBLEMS	REFERENCES	CONCLUSIONS/RECOMMENDATIONS
Lack of information relating to capacity for new orders	3.1, 3.2.1 3.2.4	The M.I.S. will provide accurate productivity levels
Little information on costs as the basis for establishing prices	3.1, 3.2.3 4.2.5 4.3.4	The Finance Productivity indices in the M.I.S. will provide costing information
Laborious and time consuming methods for recording customers requirements and allocating stock	3.1, 3.2.2	The Order Processing System being introduced will provide this information
Unreliable methods for order vetting (for customer over ordering)	3.1, 3.2.1 4.3.1	Establishment of an accessible data base will enable "norms" to be judged
Delays in order communication	3.1, 3.2.1 4.3.1	Computer generation of production programmes

PROBLEMS	REFERENCES	CONCLUSIONS/RECOMMENDATIONS
No priority definition for stock allocation	3.1, 3.2.1	From the Order Processing System. First come first served
Poor response to customer enquiries	3.1, 4.4.2	An accessible database will provide information of this kind
Inaccurate information from production areas	3.1, 3.2.4	Productivity Indices will show "in process" productivity
Lack of information on availability of raw materials (compound)	3.1, 3.2.4 4.2.2	Advance ordering of materials based on customer orders
Late feedback of information on production levels	3.1, 3.2.4	Use of M.I.S. will ensure direct feedback for production areas
Lack of information on product scrap	3.1, 3.2.5 4.3.3	Use of M.I.S. and in particular the use of defined "Index Centres"
Poor definition of "Scrap areas"	3.1, 4.2.3 4.3.3	Use of M.I.S. and in particular the use of defined "Index Centres"

PROBLEMS	REFERENCES	CONCLUSIONS/RECOMMENDATIONS
Inconsistent policy of "autonomy" for departments	3.1, 3.2.5 4.3.2 4.4.1	The division of departments to increase productivity. Use of M.I.S. will highlight the problem areas
Lack of routing information	3.1, 3.2.5 4.2.1	The automatic generation of dockets with routing information, part numbers
Transcription errors on dockets	3.1, 3.2.5 3.2.6	and quantities pre-printed on the dockets
Poor bin labelling and lack of priority	3.1, 3.2.5 4.2.5	Use of labels on the outside of tins. Dockets colour coded for priorities
Little information in-process stock	3.1, 3.2.5	The use of the Productivity indices in the M.I.S. will reflect in process stock
Duplicate warehouse filing systems	3.1, 3.2.6	Introduction of centralised stock records to correspond with the Order Processing System
Lack of warehouse space	3.1, 3.2.6	Introduction of priorities with better order communication will help

PROBLEMS	REFERENCES	CONCLUSIONS/RECOMMENDATIONS
		solve the problem of
Poor stock control system	3.1, 3.2.6	"Stagnant" stock
Dual stocking system - one for original equipment and one for spare parts	3.1, 3.2.6	Introduction of centralised stock records
In-process stock bottle-necks	3.2.5	Introduction of M.I.S. will highlight areas of probable bottle-necks before they can become serious problems
"Seat of the pants" basis for control	4.2.1	Introduction of suitable accurate measures and the use of indices to show "norms"
Poor integrity of basic measures Lack of availability of measures for production control	4.2.1, 4.2.2, 4.3.2 4.4.1	Introduction of suitable accurate measures and the use of indices to show "norms"

PROBLEMS	REFERENCES	CONCLUSIONS/RECOMMENDATIONS
Poor customer satisfaction	4.4.2	The introduction of the M.I.S. as described in Chapters Five and Six will enable lead times to be defined and adhered to. When orders are met on time and are of sufficient quality, the customers will be satisfied. An index of customer orders met on time should be introduced in the Order Processing System, similar to the Productivities designed in the M.I.S.
Lack of "cost consciousness"	3.1, 3.2.5	Use of the Finance Productivity Indices
High priority given to the curing process with lack of consideration for other processes	3.1, 3.2.1	Installation of Productivity Indices will enable balancing to be achieved

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APPENDICES

DUNLOP LIMITED

POLYMER ENGINEERING DIVISION
AUTOMOTIVE HOSE GROUP
Evington Valley Road
PO Box 98 Leicester LE5 5LY
Phone 0533 730281 Telex 34397
Telegrams Polyeng Leicester

TERMS OF REFERENCE

1/ To examine the receipt of customers orders and schedules.

2/ The analysis of these.

3/ The planning of the production of the base material and subsequent individual hoses.

4/ The method of containerisation and transfer to the Warehouse.

5/ The storage of hose in transit and the ultimate despatch to the customer.

6/ Make recommendations for improving the whole system in the light of current demands.

7/ Examine the planning and manufacture of small quantity orders and determine their profitability.

POINTS RAISED AT MEETING AT DUNLOP P.E.D., LEICESTER (3.11.77)

In attendance were :

Mr. R. Booth

Mr. M. Belcher

Mr. R. Espejo

Mr. J. Jaffe

AIMS :

The first topic to be discussed was the general aim of the project. Mr. Booth clarified the terms of reference which implicate a revised project title, namely "Improvement of the efficiency and profitability of coolant hose by the development of information systems". This covers not only information supplied via order processing to the Shop Floor Planning Office, but also information to management for decision purposes.

Mr. Booth recognises and states that there is something very wrong within the Autohose Group but can't pinpoint it. It is the locating and correcting of these problem areas that is the main purpose of this project.

It was implied by Mr. Booth that the Management Services facilities were not being used because, in the past, Divisional services' facilities have proven to be more expensive and less productive than services provided by specifically engaged personnel. However, at my meeting with Management Services (26.9.77), it was quite categorically stated that they wanted me to work along the lines of a systems design similar to that already used by the Metalastik Group. It therefore appears that my project is to by-pass the use of Management Services.

PROBLEMS

The lack, at present, of any useful management information service was shown by the trouble incurred when customers enquire about missing orders :

As the situation is at the moment, the first hint of anything being wrong in this area usually occurs when a customer telephones to enquire about the missing orders.
Mr. Booth would like to see the situation where he has immediate access to relevant information that will tell him in advance which orders are in arrears and need attention.

Likewise, Mr. Belcher identified the problem the Shop Floor Planning Office has with obtaining relevant information (from customer schedules) in time. Delays at the moment are attributed to the time taken by sequential processing (transcription and calculation) of customer schedules.
This was exemplified by the situation, now, where a customer is quoted a lead time of at least twelve weeks, even for a slight modification to an existing hose design.

Priority treatment is given to 'critical' customers (that is, the ones who would cease production if P.E.D. did not supply hose on time), at the expense of spare-part customers, which has led to bad relations and reputation.

Mr. Booth also stressed that he would like the costing of hose production, especially small orders, (as outlined in the terms of reference) looked at, paying particular attention to customer liaison.

The project is only concerned with the waterhose aspect of the Autohose Group, and not the brake-hose.

Mr. Espejo suggested that in looking at the problems at the factory, the following general courses of action to be taken :

1. To generally observe factory operations to define, more specifically, objectives of the project.
2. To identify and define (by cross-reference) communications within the company (group).
3. To identify functional areas (sub-systems) within the company (group).
4. To model the present system.
5. To develop alternative solutions/designs.
6. To formulate a model(s) of the alternatives.
7. To apply quantitative data to test the model(s) and cost it (them).
8. Presentation of recommendations.
9. Implementation of the chosen alternative.

MINUTES OF MEETING -9TH DECEMBER 1977

IN ATTENDANCE WERE:

MR.R.E.Booth

Mr.H.Bryans.

Mr.R.Espejo.

Mr.J.D.Jaffe.

It was agreed that Mr.Bryans would take over as the main Industrial Supervisor to the I.H.D. Project and that the aims of the project should remain as agreed at the last supervisory meeting.That is ," To Effect Control of the Planning of Production and Provide Suitable Management Information Systems".

Throughout,the project should be concerned with practical solutions to problems as they surface and they should be implemented concurrently.

Problems incurred with the Shop-floor Planning Office will be approached after Easter.Working in the office itself,for a period,was agreed to b e the best solution.This will also serve to show the staff in this office that the project is aimed at reducing their workload.

It was also agreed that,after an initial period in the Autohose Group,comparison with the computer systems used by the Metalastik Group would be a valuable excercise.

MEETING 3/3/78

In attendance were:

Mr.M.Hill Mr. K. Beaumont
Mr.R.Espejo Mr. P. Stevens
Mr.J.Jaffe

The basic topic of discussion was the volume and the uninformative "information" produced by the computer on printouts to the Metalastik Production Control Department.The printouts concerned show , in progressive detail the balance of orders,stock and work-in-progress.But they don't show up any trends,that would be useful for management decisions. That is there are no reference values shown for decisions to be related to.

Mr.Espejo suggested that there is basically a problem of assimilating information.It is impossible to realise,for such a large volume of products,the correct values (in absolute terms) that either product price,volume or turn-over should be.

By using indices of appropriate values (i.e. normalising to a nominal value of 1 and relating everything as a proportion of this) a much more accurate and quicker assessment of what is normal or abnormal can be made.In producing these indices measurements of:

1) Actuality
2) Capability
3) Potentiality,have to be made.

Measurement of these indices accurately is critical - what is a true value for these parameters?

However once these values have been collected the indices derived from them can be used very effectively for management information.They may be grouped to give progressively broader indices for higher levels of management.

Although useful in assessing at a glance trends or the state of an area of performance,this type of indexing doesn't show "real" values which may,in themselves,be important for certain managerial decisions.

Knowledge of the state of stock held by major customers was cited as being very important in ascertaining the validity of their demands.. With this information readily available,on a regular basis,priorities can be accurately assessed.

Patterns were shown by Mr. Hill as being a very effective method of identifying trends from which decisions may be made. Different groupings of data show up different trends and it is the unique ability of the computer to do this that is not being utilised fully.

B

CUST. PART No.	INTERNAL PART No.	CUSTOMER/DELIVERY POINT	ORDER No.	DATE	W.O.F. No.	QUANTITY
205 1744	–	Chrysler Parts.	SC 105411	6/2/70	AUT/1/2737	OPEN.

WEEK No	WEEK ENDING	DESPATCHES							DELIVERIES		REQUIREMENTS	
		MON.	TUES.	WED.	THURS.	FRIDAY	SAT	TOTAL	CUMULATIVE	ORDER BALANCE	SCHEDULE	CUMULATIVE
	16.10.	–				PED 40.		40.	1171.			

⇐ Re scheduling ⇒ \\\\\\\\ = cancelled schedules.
– written as – eg. 17/24/9. 17+24 (weeks ending on) of September.
Item no. required. Subsequent orders. eg 100 oct 100/week.

E.E. POLYMER ENGINEERING DIVISION OF THE DUNLOP COMPANY LTD. Δ L.21700-RR

C

ISSUE NO. .....3........

DATE OF ISSUE .6.9.77....

SHEET ...1..... OF ..6...

HOSE PROCEDURE NO. ....HC 1........

OPERATION ...Enquiry and Works Order Form System..............................

INITIAL CONDITIONS ...Enquiry Ford Ref. 2022..................................

DEPARTMENTS RESPONSIBLE ...Sales, Technical, Works Study, Cost Office..........

PROCEDURE

Sales Department

Raise Enquiry Form Ref. 2022 (3 copies), attach customers drawing and forward to Technical Department.

Technical Department

Technical Estimator shall enter the following details on the Enquiry Form:

Cure
Reject level (2½% minimum)
Product Code
Construction data
Cut length
Mandrel Type and trim length details
Trimming Method
Stamping requirement
Inspection level
Deviations from Customers Specification (for onward (eg tolerances) transmission to the customer via Sales Department)

The enquiry number is entered into a register which should show dates of booking in and out. Enquiries are then passed to Technical Drawing Office.

In the case of hoses which require a non-routine method of production the enquiry shall be referred to the Production Manager for discussion. This also applies to enquiries with a call off in excess of 1,000 per week.

Technical Drawing Office

Enter estimated cost of :- Pattern
Cast or Wrought Aluminium / Mild Steel Mandrels
Cutting Jig - Indicate if wood or metal
Drilling Jig
Wood Plane Gauge or Built up Gauge
Stamp for Part Number
Any other special equipment.

Where cutting jigs and inspection gauges are not ordered (SPO's) the fact that such items are not required must be stated. When a WOF is raised this fact must also be recorded on the WOF and a print from the mandrel/hose drawing attached (for eventual use by Inspection Department).

When ordering inspection gauges the type should be noted. In the case of gauges for Ford the Engineering Release number must be included on the gauge as well as the part number.

C

DATE OF ISSUE ..6.9.77...

HOSE PROCEDURE NO. ...HC 1.....   SHEET ...2.... OF ..6....

OPERATION ..Enquiry and Works Order Form System..........

INITIAL CONDITIONS ...Enquiry Form Ref. 2022 ....

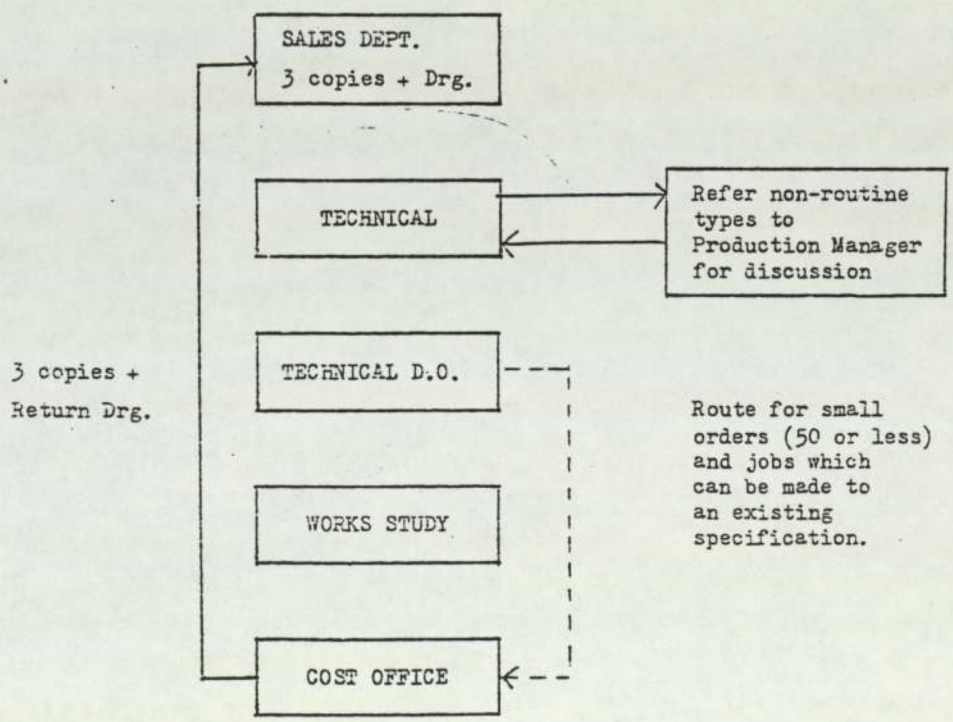
The enquiry (3 copies) and drawing are then forwarded to Works Study. In the case of small orders (50 parts or less) and jobs which can be made to existing specifications the Enquiry should be routed direct to Cost Office.

Works Study

Enter rates against the appropriate operation. Forward enquiry (3 copies) and drawing to Cost Office.

Cost Office.

Carry out costing and return all copies plus drawing to Sales.



DATE OF ISSUE ..6.9.77...

HOSE PROCEDURE NO. ..HP.1.....

SHEET ..3.... OF ..6....

OPERATION ....Enquiry and Works Order Form System....

INITIAL CONDITIONS ..Enquiry Form Ref. 2022/Pink Sheet Ref. 3082/WOF Ref. 183......

PROCEDURE

Sales Department

Will raise all WOFs, one set for tooling and parts combined. Any special delivery promise should also be quoted.

Bottom copies (cards) shall be sent to Planning Dept. Top copies shall be attached to the drawing and a copy of the enquiry and forwarded to the Technical Estimator.

Technical Department

The Technical Estimator will examine the technical content, modify or record details as shown on page 1 and transcribe those details both onto the WOF and onto the sample sheet (Ref. 3082). All paperwork shall then be forwarded to Technical Services for checking.

For orders in excess of 1500 per week TC.1 shall be informed so that Purchase Dept. can be notified well in advance of the extra material requirements.

After checking (and requesting drawing changes from the customer where applicable) the pink sheet shall be signed and all data forwarded by the following routes:-

1) Where tooling is required:- all paperwork to Tech. D.O. (flow chart page 5)

2) No extra tooling required:- all paperwork to QC. Planning Engr. (flow chart page 6)

Technical Drawing Office

The necessary drawings will be prepared and the WOFs, Enquiries and Tooling Drawings containing all purchasing information will be forwarded to the Purchase Dept.

The draughtsman will ensure that full tooling details are entered on the sample sheet, including the PED Mandrel Drawing Number. The Pink Sheet and customer drawing are then forwarded to the Quality Engineer (Quality Planning).

Purchase Dept.

Purchase Dept. shall raise the orders for tooling as specified.

Initially only one mandrel or battery of mandrels will be ordered to enable the design and process to be approved. Once approval has been received the remainder of the mandrels shall be ordered.. Only in special circumstances where commercial pressure demands will all the tooling be ordered immediately. This will be authorised by TC.1 in liaison with the Sales Dept.

PROCEDURE

Quality Planning

Examine drawing content against customers quality requirements and requisition test slabs, material reports and test reports as necessary from the Senior Hose Technologist.

It is essential that the pink sample sheets shall indicate the number of samples required by the customer together with the extra number required internally. These are as follows:-

a) One marked out sample for order trim jig and gauge when applicable (for Toolmaker)

b) One marked out sample for checking trim jig and gauge when applicable (retained by Tool Inspection)

c) Samples as requested for test purposes.

The pink sheet is then passed to Planning Dept. while the duplicate pink sheet and drawing are retained. WOF and Enquiry forwarded to Works Study and then to Cost Office.

Cost Office

WOFs will be retained for a minimum period to enable the necessary records and data for invoicing to be made.

Planning Dept.

Details shall be entered onto the Kardex System from the WOF yellow card sent direct from the Sales Department.

On receipt of the sample sheet Planning Progress Chaser shall order materials and pass to Technical Sampling Dept. He shall also enter details onto the Sample Plan Board.

On receipt of the WOF top copy the Planning Office Manager shall enter details in the Planning WOF register and pass to the Progress Chaser who after checking that the tooling records are correct will pass the WOF to Purchase Dept. Purchase Dept. will finally pass the WOF back to Planning Dept. for filing.

DATE OF ISSUE ...6.9.77.....

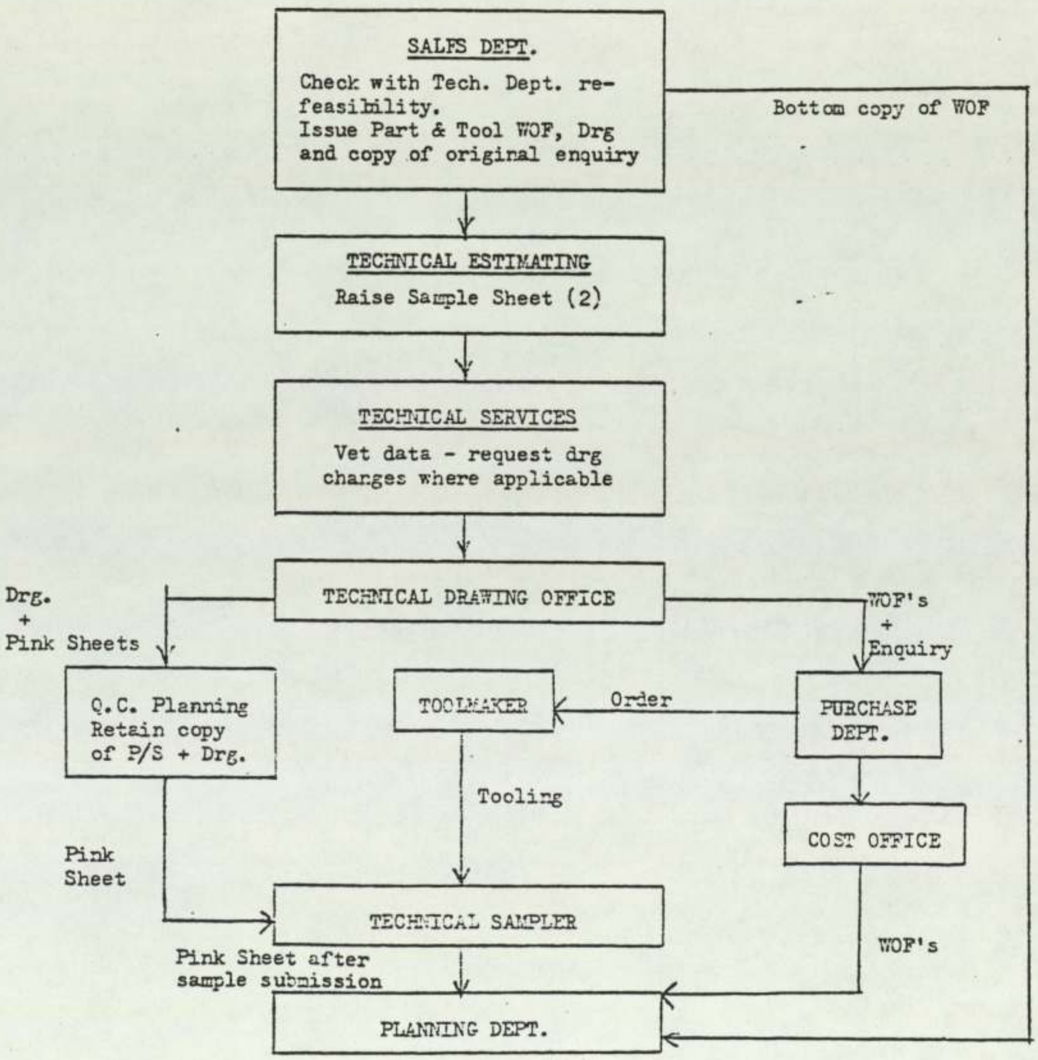
HOSE PROCEDURE NO. ..HC 1........ SHEET ...5.... OF ...6.....

OPERATION ....Enquiry and Works Order Form System....

REQUIREMENT ...Works Order Form Ref. 183....

PERSONNEL RESPONSIBLE....Sales, Technical, Cost Office, Planning....

WORKS ORDER RESULTING FROM ENQUIRY WHICH REQUIRE TOOLING



Direct Order WOFs

The same procedure is adopted as for WOFs resulting from an enquiry except the Technical Estimator shall enter all details direct onto the WOF.

Direct orders are quantity orders for which no quotation by P.E.D. has been made. Such orders may simultaneously be the subject of a cost exercise in order to establish the price.

DATE OF ISSUE ...6.9.77...

HOSE PROCEDURE NO. ...HC 1...

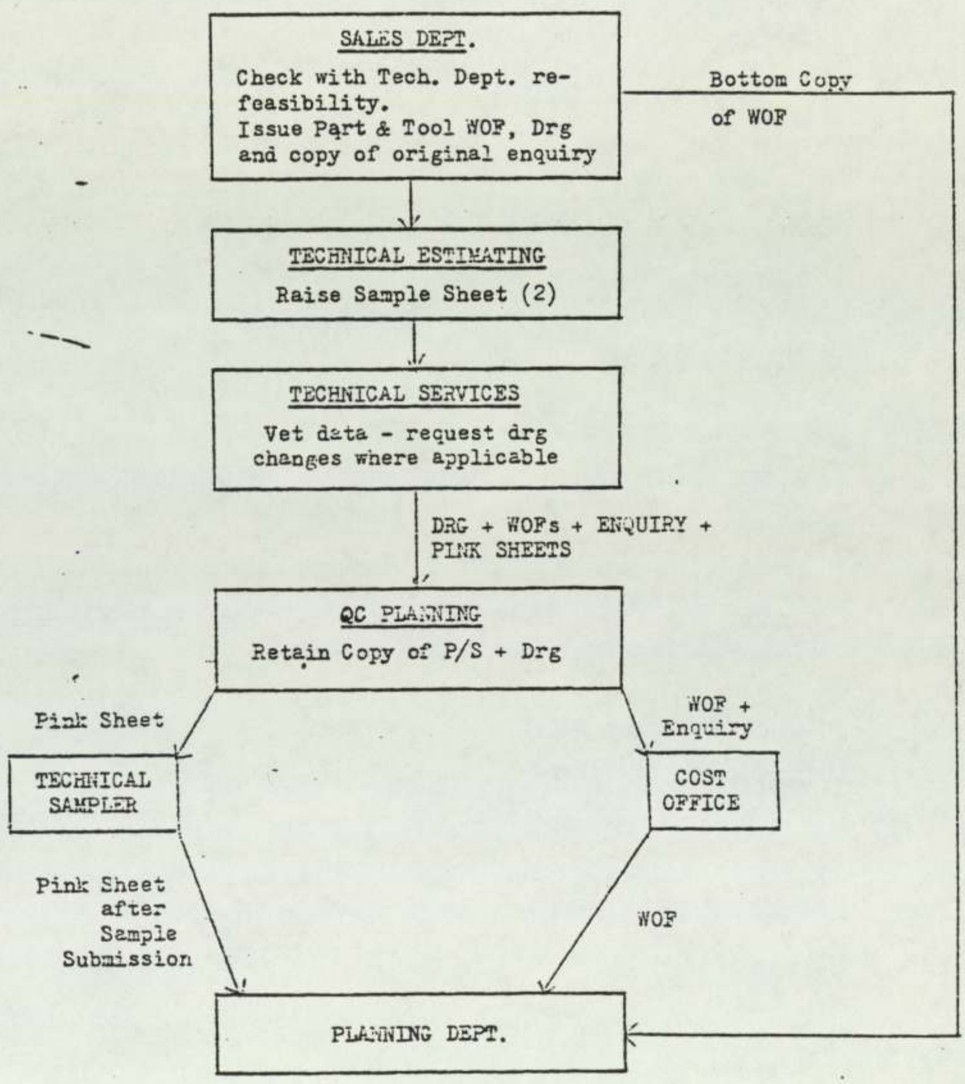
SHEET ...6... OF ...6...

OPERATION ...Enquiry and Works Order Form System...

REQUIREMENT Works Order Form Ref. 183...

PERSONNEL RESPONSIBLE ...Sales, Technical, Cost Office, Planning...

WORKS ORDER RESULTING FROM ENQUIRY WHICH REQUIRES NO TOOLING



D

REF. 183

Hose Group Works Order No.

CUSTOMER			DELIVERY ADDRESS	
ORDER No.		DATE	ACCOUNT No.	P.E.D REFERENCE
QUANTITY	PART No.		DESCRIPTION	
DELIVERY REQUIREMENT			REMARKS	
PRICE				

E No. E.			Sign:		
TOOLING	No.	Drg. No.	P.	O/No.	Manu.
Fixture(s)					
Mandrel(s)					
Pattern					
Mandrel(s)					
Plate(s)					
Fitting(s)					
T. Jig/Man.					
D. Jig(s)					
B. U. Gauge					
W.P.G.					
Inserts					
Conv. Eq.					
Stamp					
1 off Int.					

P. = Please Order

CIRCULATION

DEPT.	INITIAL	DATE
SALES		
TECHNICAL DEPT.		
TECHNICAL D.O.		
QUALITY [illegible]		
COST OFFICE		
[illegible]		
PURCHASING		
PLANNING		

SEPARATE SHEETS FOR
DIFFERENT CONSTRUCTION TYPES

SCHEDULE AT 24.9.77.

		OCTOBER				NOVEMBER					DECEMBER				JAN
	ARRS.	1/10	[illegible]	15/10	22/10	29/10	5/11	12/11	19/11	26/11	3/12	10/12	17/12	[illegible]	[illegible]

PRODUCTION REQUIRED FROM W/H DEL. 24.9.77.

	PRIORITY 1	2	3	OCTOBER				NOVEMBER				DECEMBER			
	ARRS.	ASAP	ASAP	1/10	8/10	15/10	22/10	29/10	5/11	12/11	19/11	26/11	3/12	10/12	17/12
CUSTOMER + HOSE NUMBER.															

F

Wilkes SNAP-AWAY Multiset

DESPATCH RECORD

D. 032747

DATE	DESPATCH No.	ORDER No.

DESCRIPTION	QUANTITY THIS DELIVERY	

PACKED IN: ROUTE:

TYPED BY:

G

№ 11434

①

PLANNING

CUSTOMER J-Bull

PART No. ½x4FT

DATE ______ TYPE AR-CONV

ORIGINAL QUANTITY 20

WAREHOUSE QUANTITY ______

INSPECTOR ______ REJECTS ______

DETAIL

½x4 1301

②

№ 11434

WAREHOUSE

CUSTOMER J Bull

PART No. ½x4FT

DATE ______

QUANTITY ______

LOCATION ______

③

№ 11434

CUSTOMER J-Bull

PART No. ½x4FT

DATE	IN	OUT	STOCK

REF. 776

№ 11434

④

WASH-SORT-COUNT

CUSTOMER ______

PART No. ______

QUANTITY ______ CLOCK No. ______

⑤

№ 11434

JIG CUT/LATHE TRIM

CUSTOMER ______

PART No. ______

QUANTITY ______ CLOCK No. ______

⑥

№ 11434

BLOW ON DRILL SOLUTION/CUT FABRIC & RUBBER

CUSTOMER ______

PART No. ______

QUANTITY ______ CLOCK No. ______

⑦

№ 11434

BUFF/MAKE UP/BUILD

CUSTOMER ______

PART No. ______

QUANTITY ______ CLOCK No. ______

⑧

№ 11434

VULCANISE/BLOW OFF/WRAP

CUSTOMER ______

PART No. ______

QUANTITY ______ CLOCK No. ______

⑨

№ 11434

STAMP

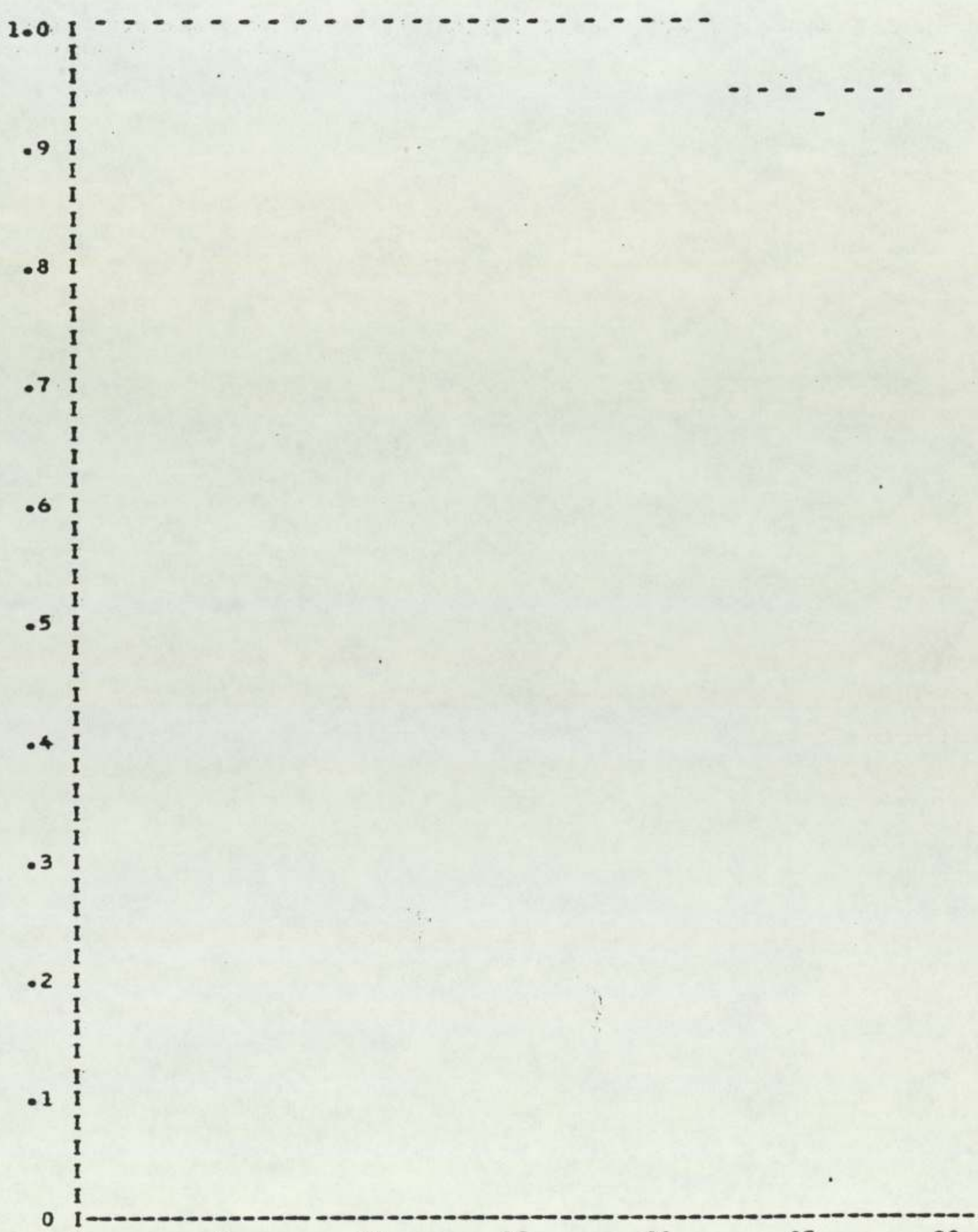
CUSTOMER ______

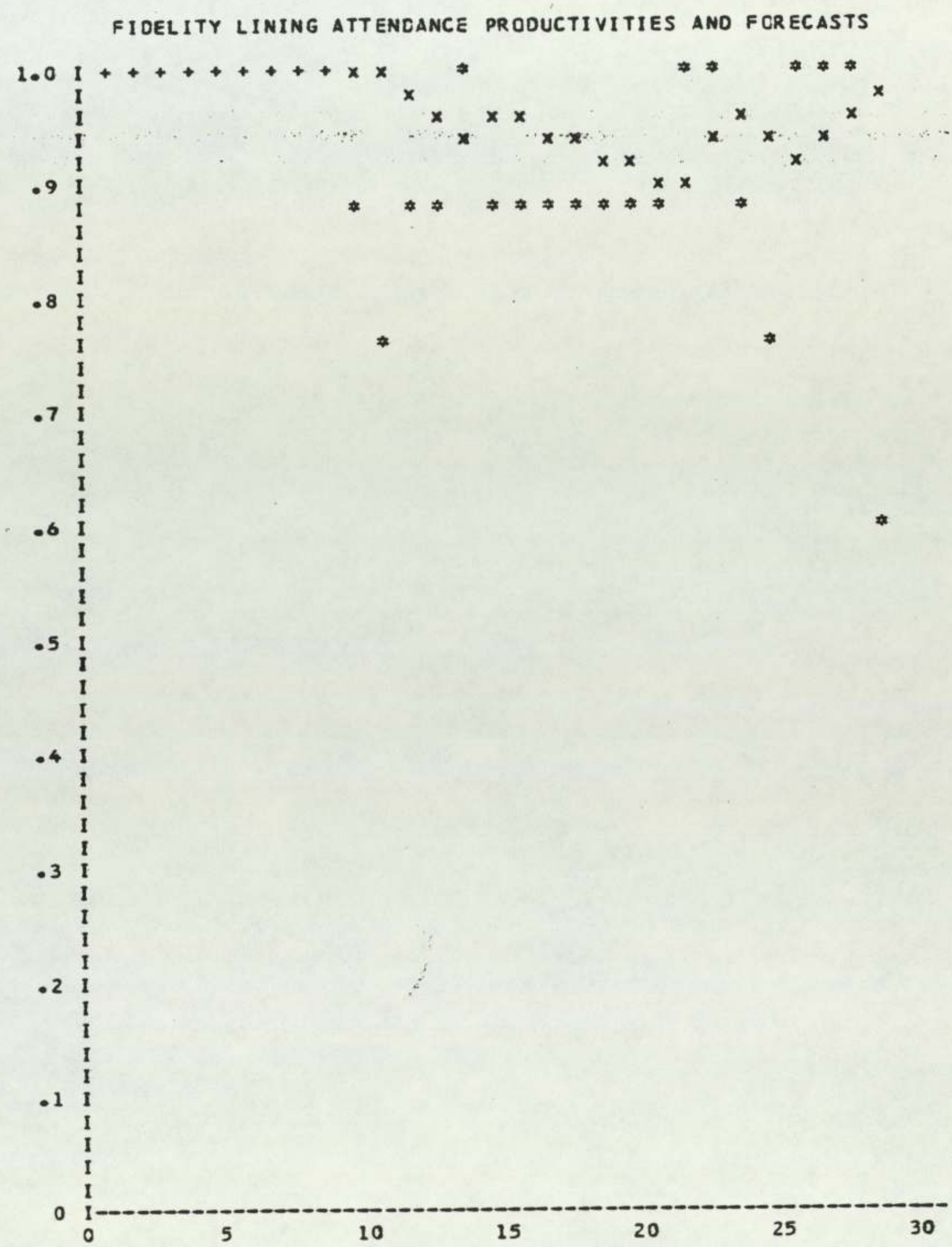
PART No. ______

QUANTITY ______ CLOCK No. ______

APPENDIX H

FIDELITY LINING ATTENDANCE MEAN PRODUCTIVITIES



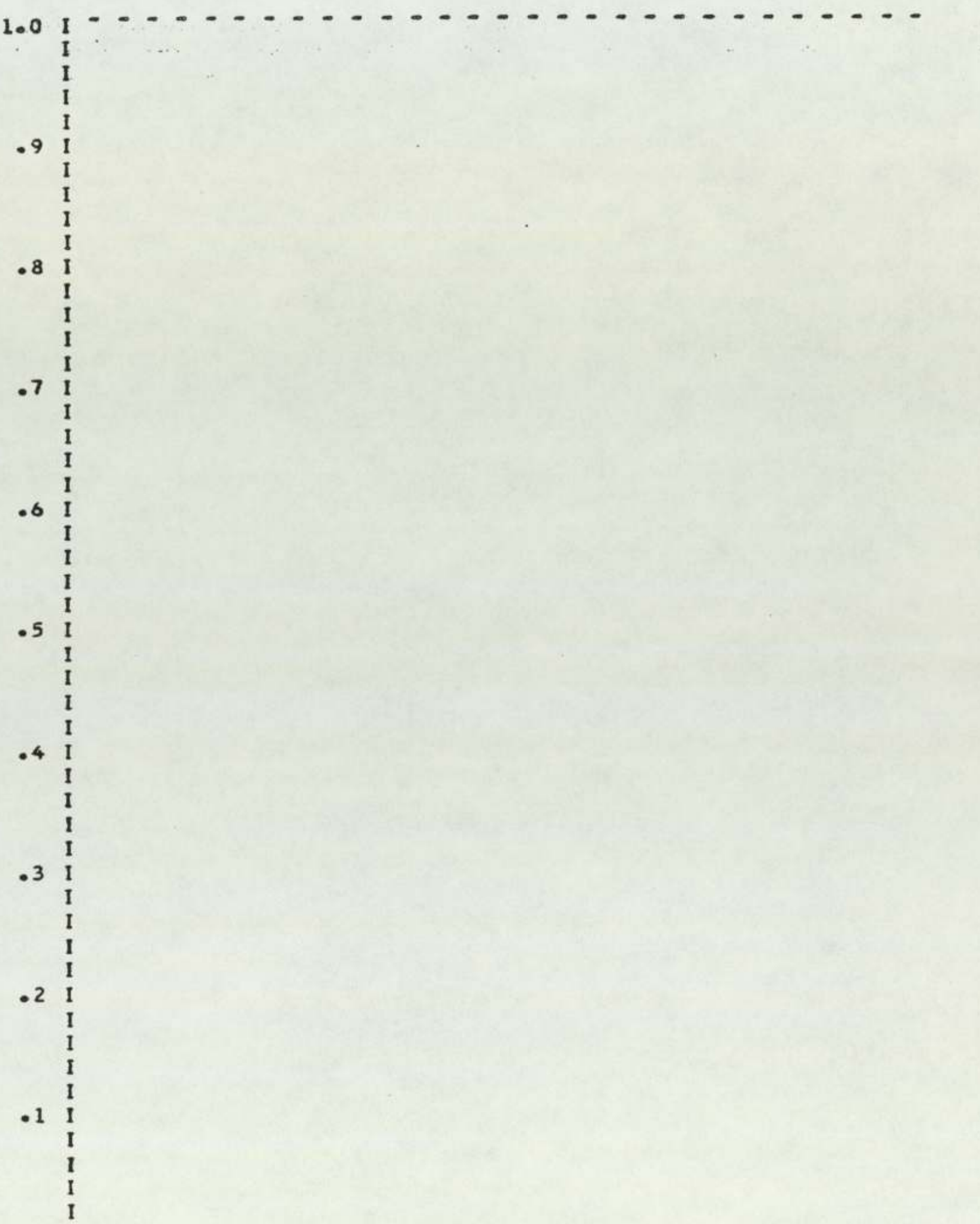

FIDELITY LINING ATTENDANCE PRODUCTIVITIES AND FORECASTS
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
5
10
15
20
25
30

ATTENDANCE FIGURES FOR FIDELITY LINING

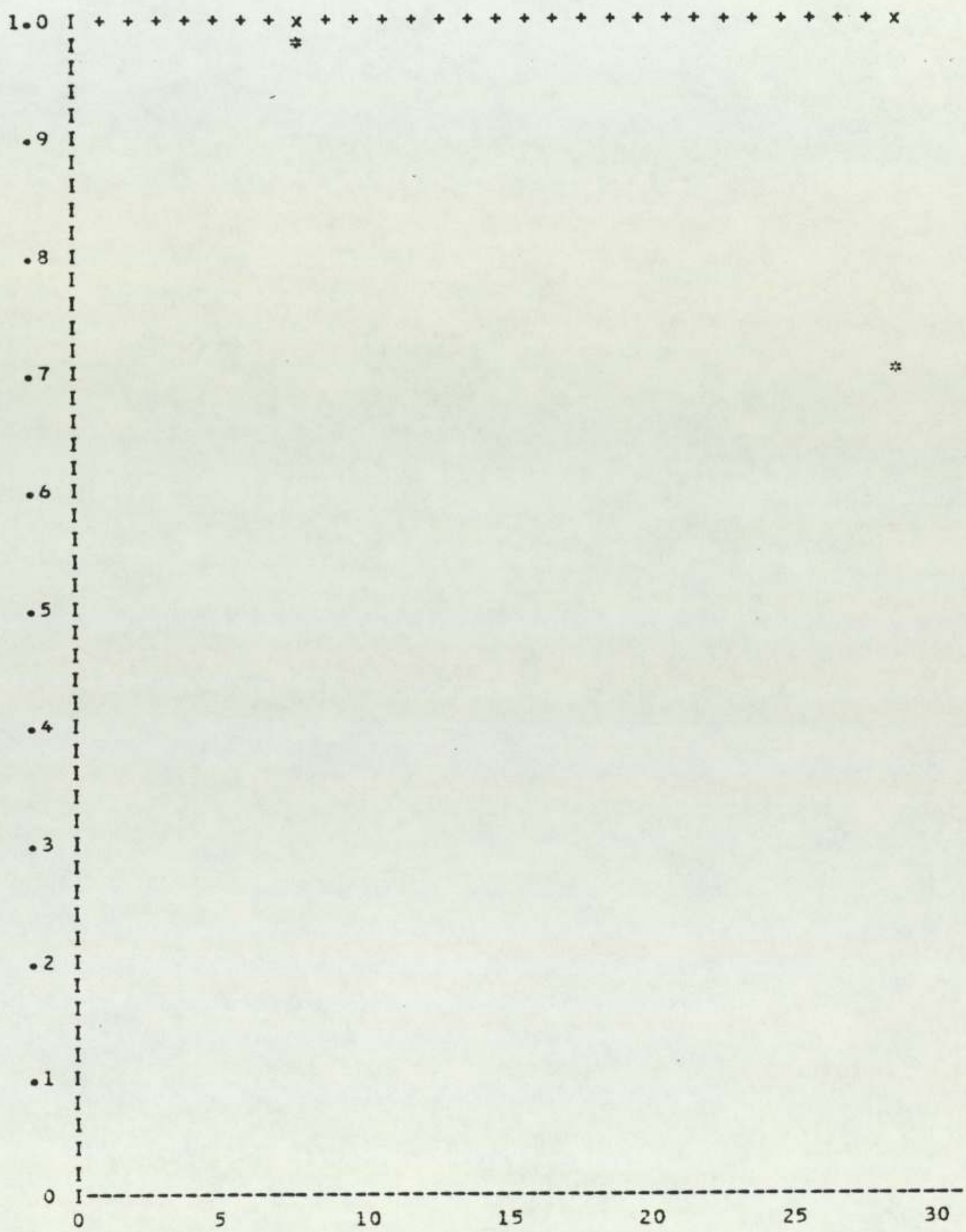
Reference Number		Date	Attendance Level Hours	Productivity Index
1		17/7	64	1
2		18/7	64	1
3		19/7	64	1
4		20/7	64	1
5	F	21/7	44	1
6		24/7	64	1
7		25/7	64	1
8		26/7	64	1
9		27/7	64	1
10	F	28/7	38.5	.88
11		31/7	48	.75
12		1/8	56	.88
13		2/8	56	.88
14		3/8	64	1
15	F	4/8	38.5	.88
16		7/8	56	.88
17		8/8	56	.88
18		9/8	56	.88
19		10/8	64	.88
20	F	11/8	38.5	.88
21		14/8	56	.88
22		15/8	56	1
23		16/8	56	1
24		17/8	56	.88
25	F	18/8	38.5	.75
26		21/8	56	1
27		22/8	64	1
28		23/8	56	1
29		24/8	44	.60

Capability Basis : four operatives for two shifts

FIDELITY KNITTING ATTENDANCE MEAN PRODUCTIVITIES



FIDELITY KNITTING ATTENDANCE PRODUCTIVITIES AND FORECASTS

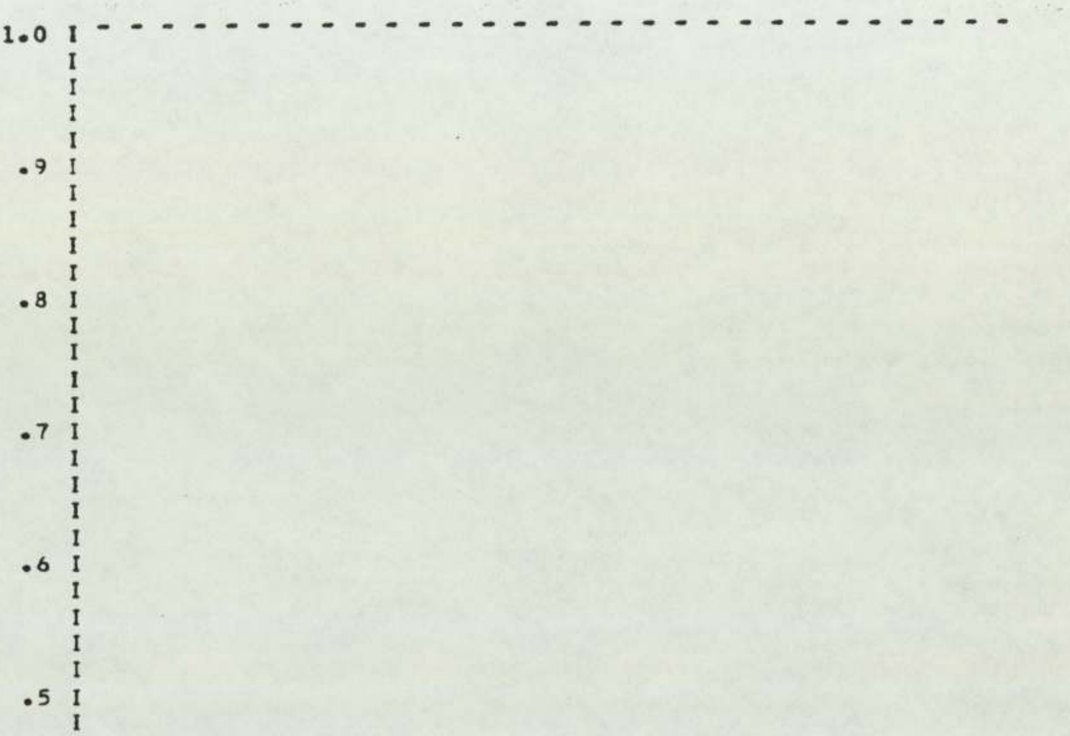


ATTENDANCE FIGURES FOR FIDELITY KNITTING

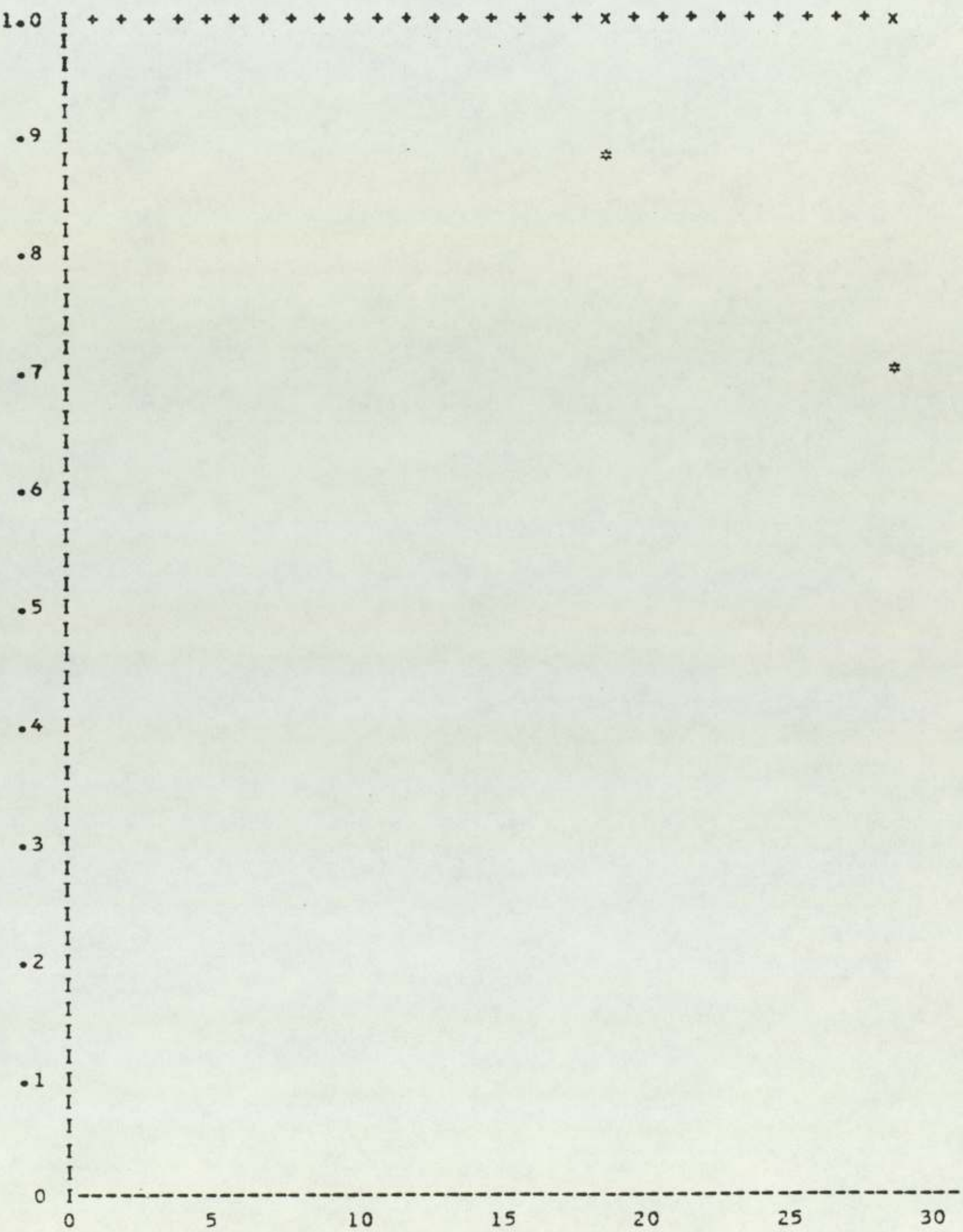
Reference Number		Date	Attendance Level Hours	Productivity Index
1		17/7	24	1
2		18/7	24	1
3		19/7	24	1
4		20/7	24	1
5	F	21/7	16.5	1
6		24/7	24	1
7		25/7	24	1
8		26/7	23.25	.97
9		27/7	24	1
10	F	28/7	16.5	1
11		31/7	24	1
12		1/8	24	1
13		2/8	24	1
14		3/8	24	1
15	F	4/8	16.5	1
16		7/8	24	1
17		8/8	24	1
18		9/8	24	1
19		10/8	24	1
20	F	11/8	16.5	1
21		14/8	24	1
22		15/8	24	1
23		16/8	24	1
24		17/8	24	1
25	F	18/8	24	1
26		21/8	24	1
27		22/8	24	1
28		23/8	24	1
29		24/8	16.5	.69

Capability Basis : one operative for three shifts

FIDELITY COVERING ATTENDANCE MEAN PRODUCTIVITIES



FIDELITY COVERING ATTENDANCE PRODUCTIVITIES AND FORECASTS

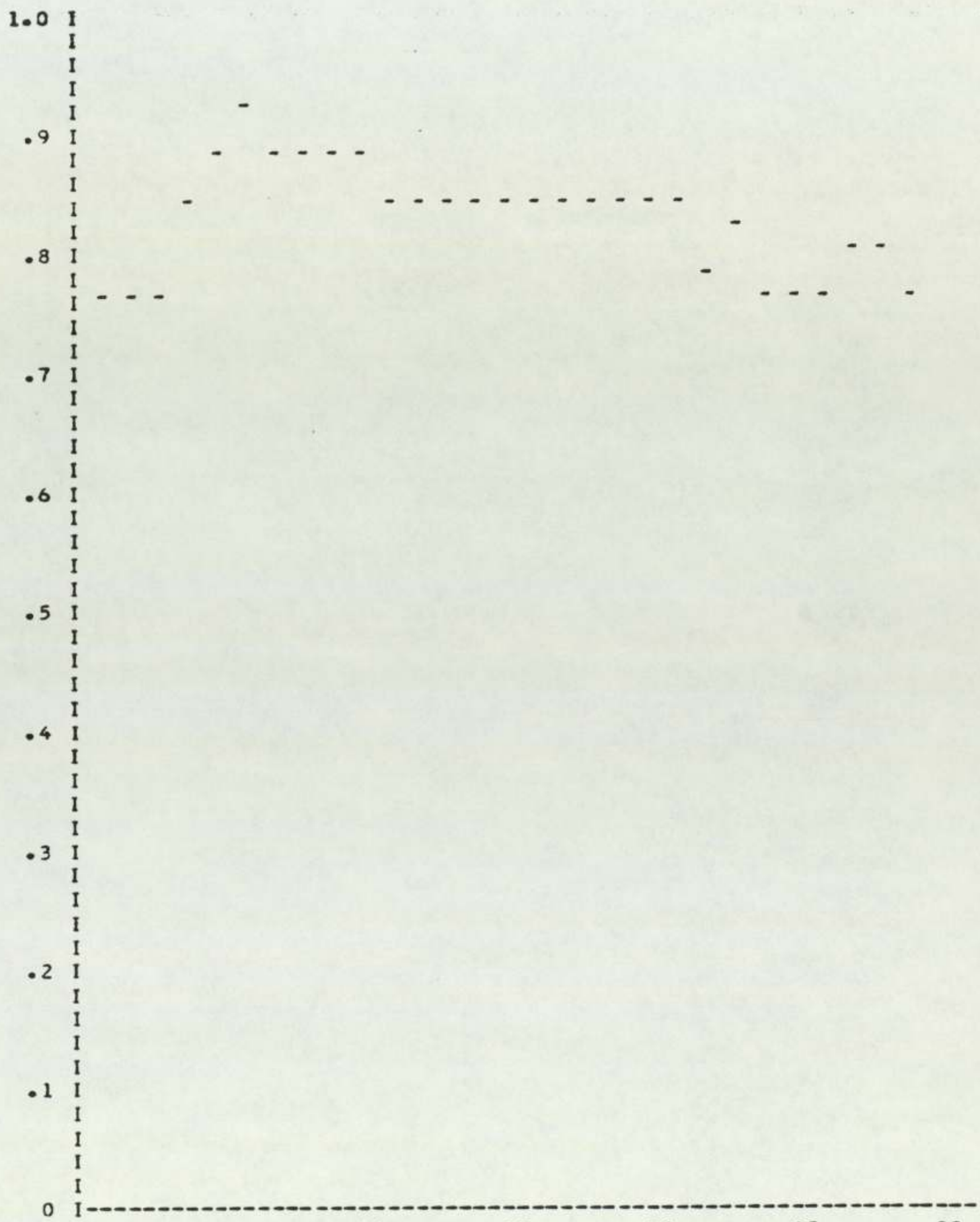


ATTENDANCE FIGURES FOR FIDELITY COVERING

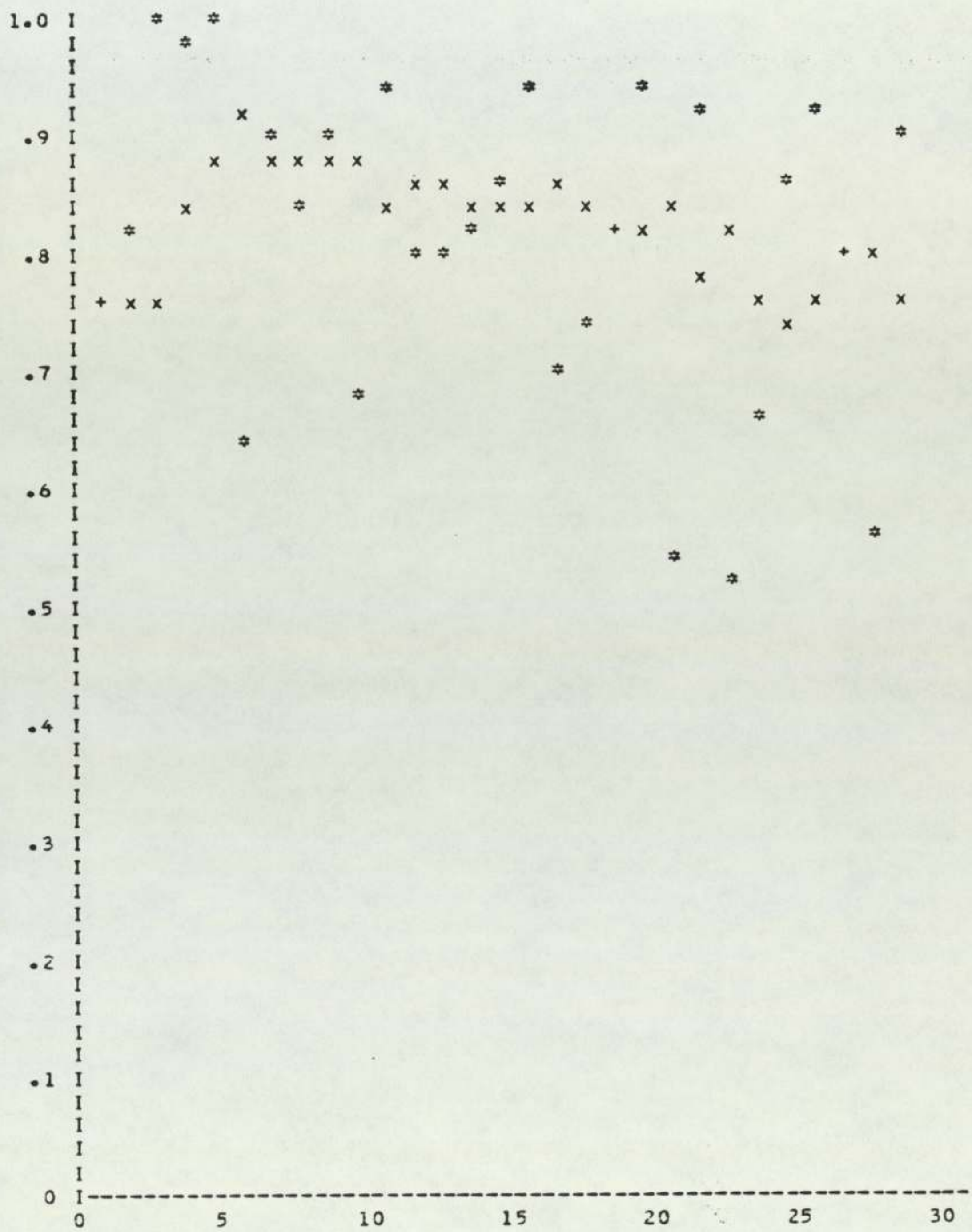
Reference Number	Date	Attendance Level Hours	Productivity Index
1	17/7	64	1
2	18/7	64	1
3	19/7	64	1
4	20/7	64	1
5	F 21/7	44	1
6	24/7	64	1
7	25/7	64	1
8	26/7	64	1
9	27/7	64	1
10	F 28/7	44	1
11	31/7	64	1
12	1/8	64	1
13	2/8	64	1
14	3/8	64	1
15	F 4/8	44	1
16	7/8	64	1
17	8/8	64	1
18	9/8	64	1
19	10/8	56	.88
20	F 11/8	44	1
21	14/8	64	1
22	15/8	64	1
23	16/8	64	1
24	17/8	64	1
25	F 18/8	44	1
26	21/8	64	1
27	22/8	64	1
28	23/8	64	1
29	24/8	44	.69

Capability Basis : four operatives for two shifts

FICELITY LINING MACHINE USE MEAN PROCUCTIVITIES



FIDELITY LINING MACHINE USE PRODUCTIVITIES AND FORECASTS

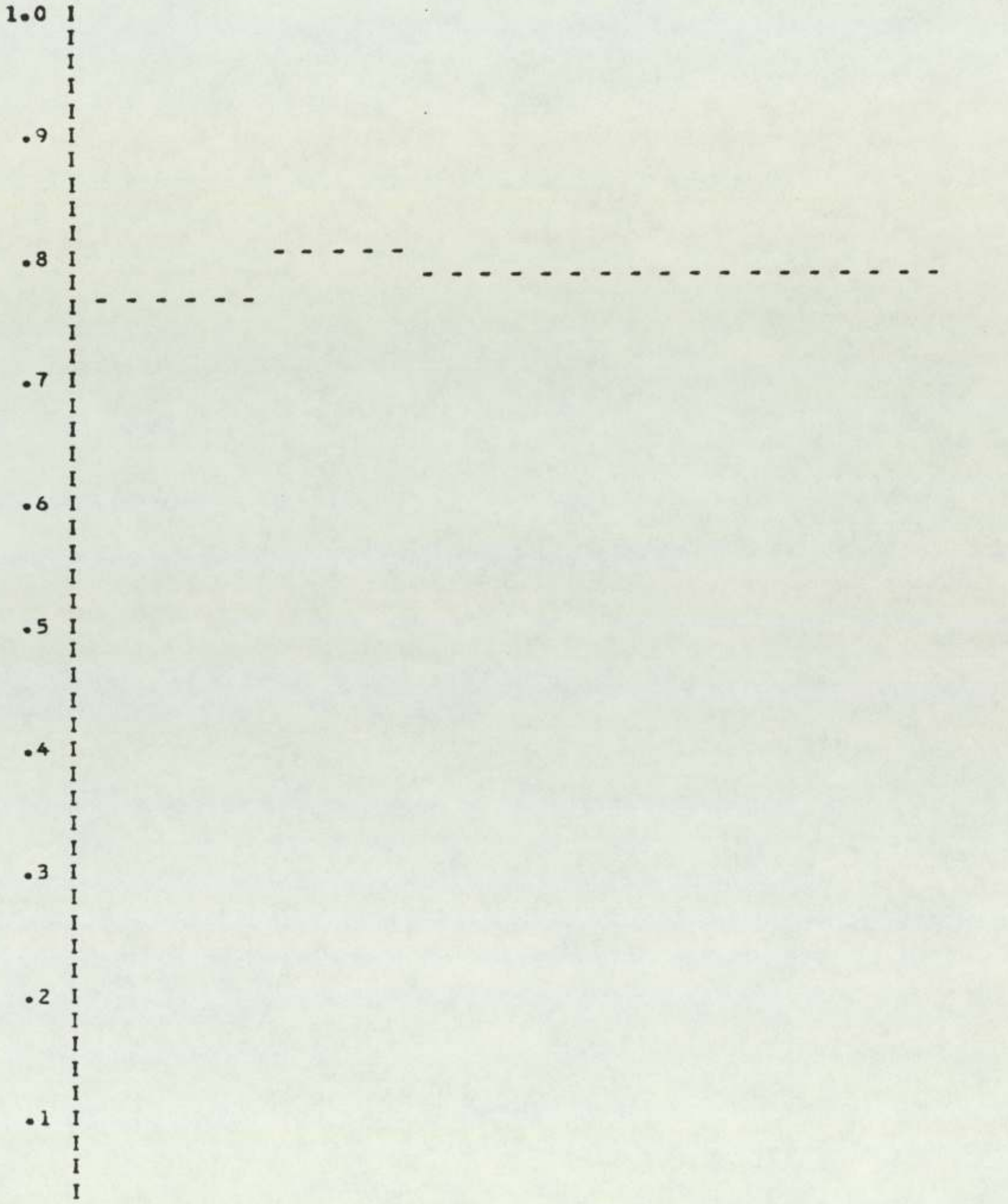


MACHINE USE FIGURES FOR FIDELITY LINING

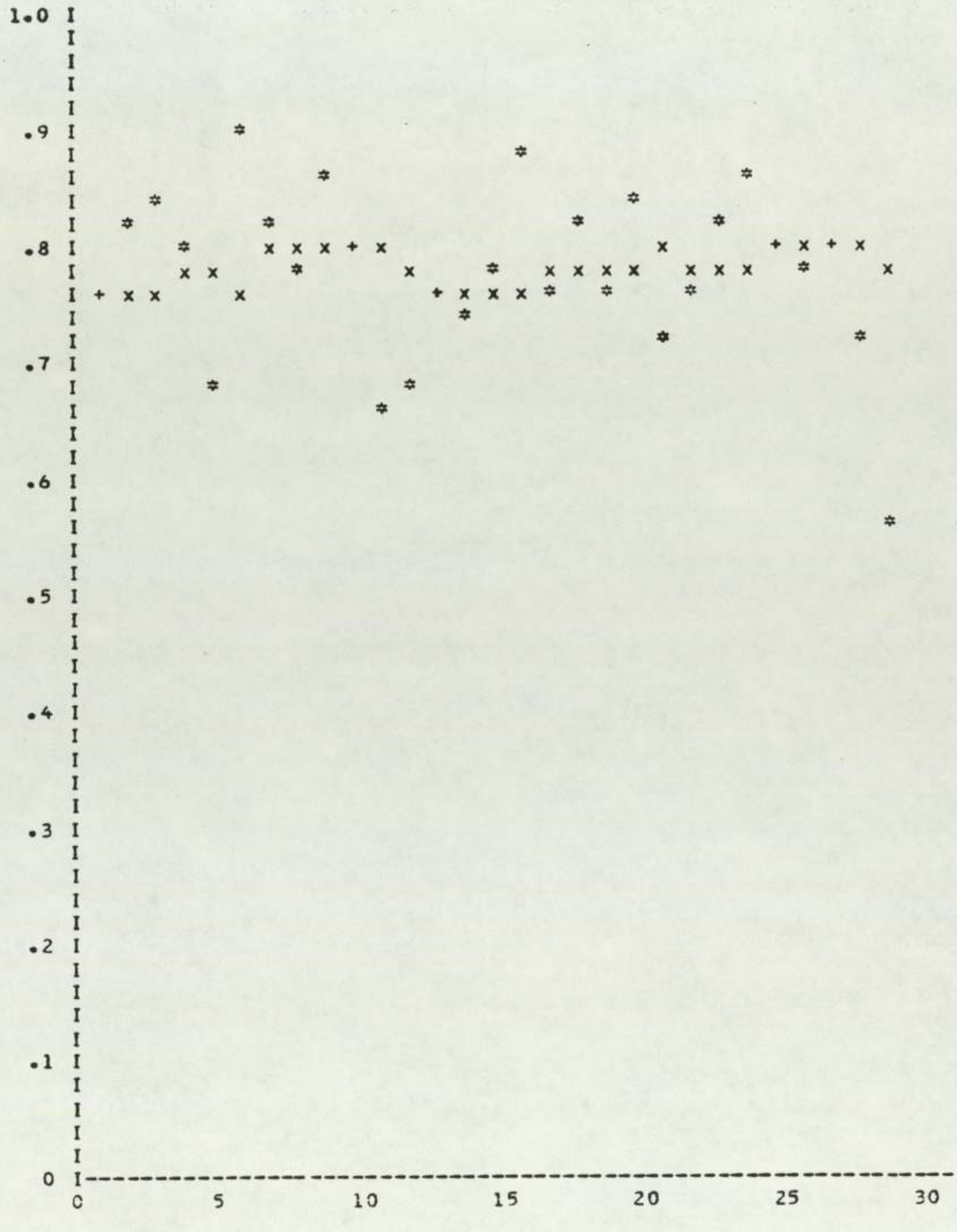
Reference Number		Date	Machine Use Minutes	Productivity Index
1		17/7	730	0.76
2		18/7	775	0.81
3		19/7	960	1
4		20/7	940	0.98
5	F	21/7	660	1
6		24/7	615	0.64
7		25/7	870	0.90
8		26/7	795	0.83
9		27/7	855	0.89
10	F	28/7	450	0.68
11		31/7	900	0.94
12		1/8	765	0.80
13		2/8	760	0.79
14		3/8	785	0.82
15	F	4/8	570	0.86
16		7/8	900	0.94
17		8/8	660	0.69
18		9/8	700	0.73
19		10/8	775	0.81
20	F	11/8	615	0.93
21		14/8	518	0.54
22		15/8	880	0.92
23		16/8	490	0.51
24		17/8	630	0.66
25	F	18/8	560	0.85
26		21/8	870	0.91
27		22/8	760	0.79
28		23/8	536	0.56
29		24/8	590	0.89

Capability : 960 minutes (two shifts)
Capability Fridays : 660 minutes

FIDELITY KNITTING MACHINE USE MEAN PRODUCTIVITIES



FIDELITY KNITTING MACHINE USE PRODUCTIVITIES AND FORECASTS

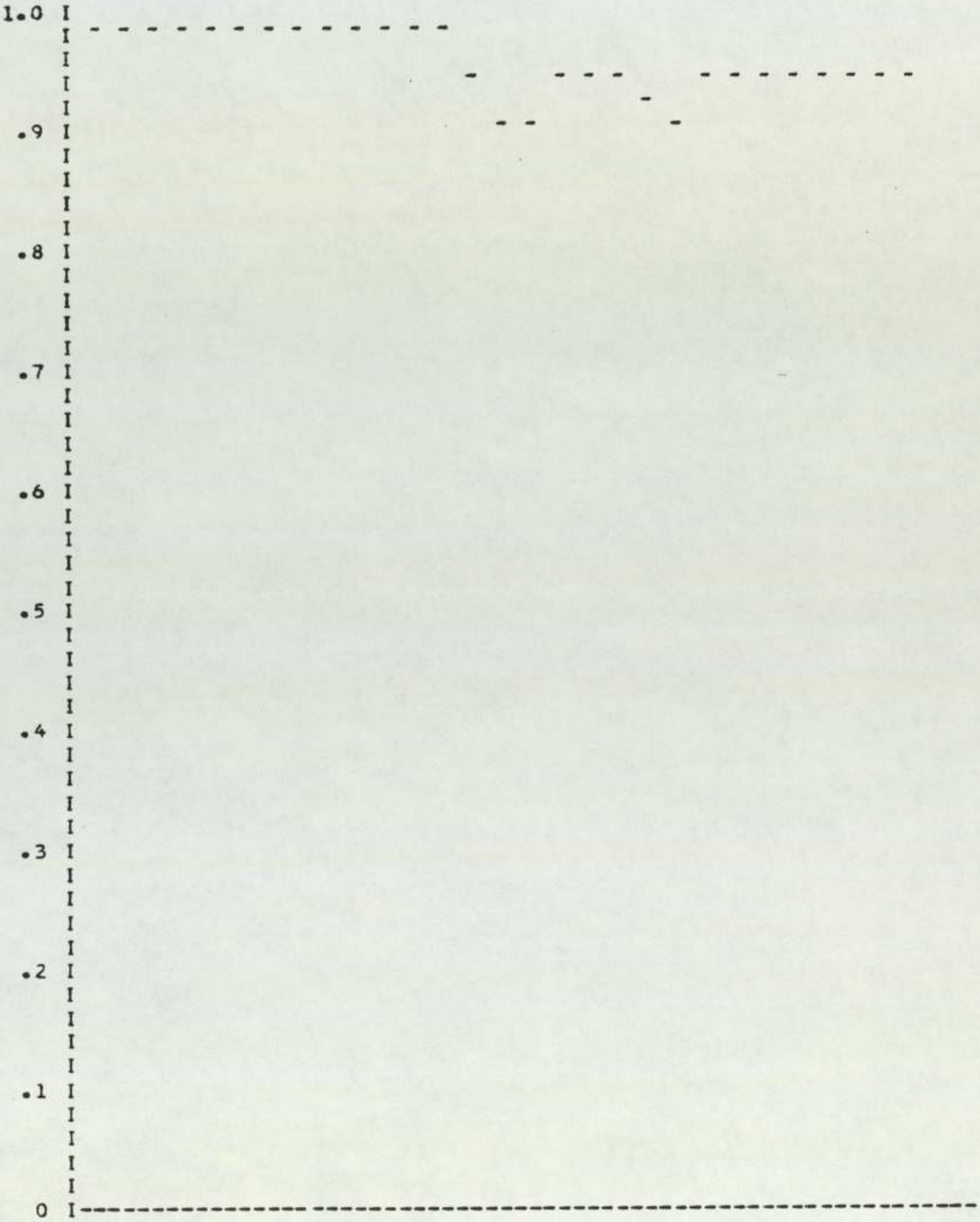


MACHINE USE FIGURES FOR FIDELITY KNITTING

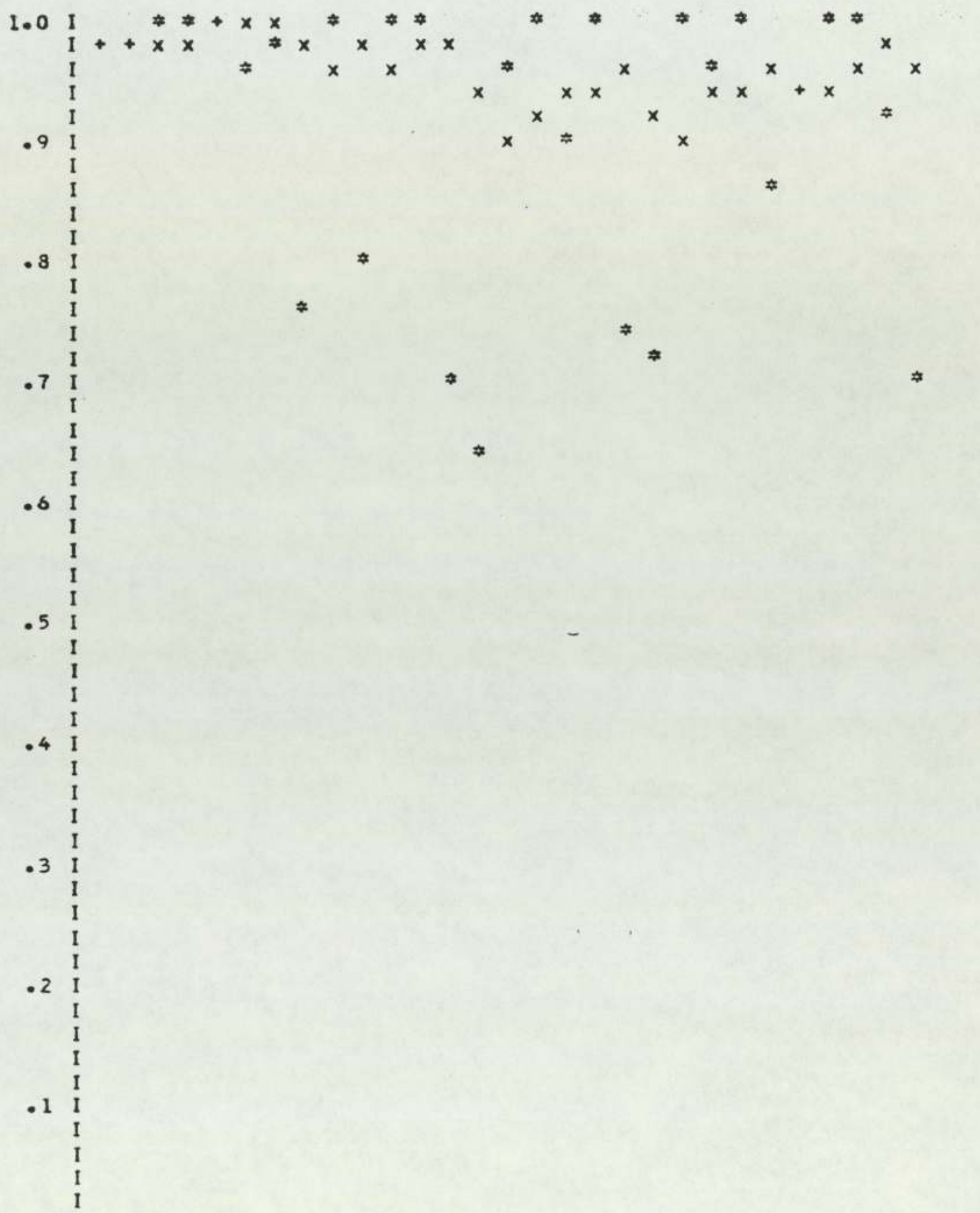
Reference Number		Date	Machine Use Minutes	Productivity Index
1		17/7	2200	0.76
2		18/7	2320	0.31
3		19/7	2410	0.84
4		20/7	2278	0.80
5	F	21/7	1330	0.67
6		24/7	2590	0.90
7		25/7	2350	0.82
8		26/7	2265	0.78
9		27/7	2444	0.85
10	F	28/7	1590	0.80
11		31/7	1872	0.65
12		1/8	1960	0.68
13		2/8	2165	0.75
14		3/8	2110	0.73
15	F	4/8	1550	0.78
16		7/8	2545	0.88
17		8/8	2177	0.76
18		9/8	2350	0.82
19		10/8	2180	0.76
20	F	11/8	1640	0.83
21		14/8	2047	0.71
22		15/8	2200	0.76
23		16/8	2360	0.82
24		17/8	2460	0.85
25	F	18/8	1565	0.79
26		21/8	2239	0.78
27		22/8	2282	0.79
28		23/8	2087	0.72
29		24/8	1578	0.55

Capability : two machines for three shifts = 2880 mins.
Capability Fridays : 1980 minutes

FIDELITY COVERING MACHINE USE MEAN PRODUCTIVITIES



FIDELITY COVERING MACHINE USE PRODUCTIVITIES AND FORECASTS

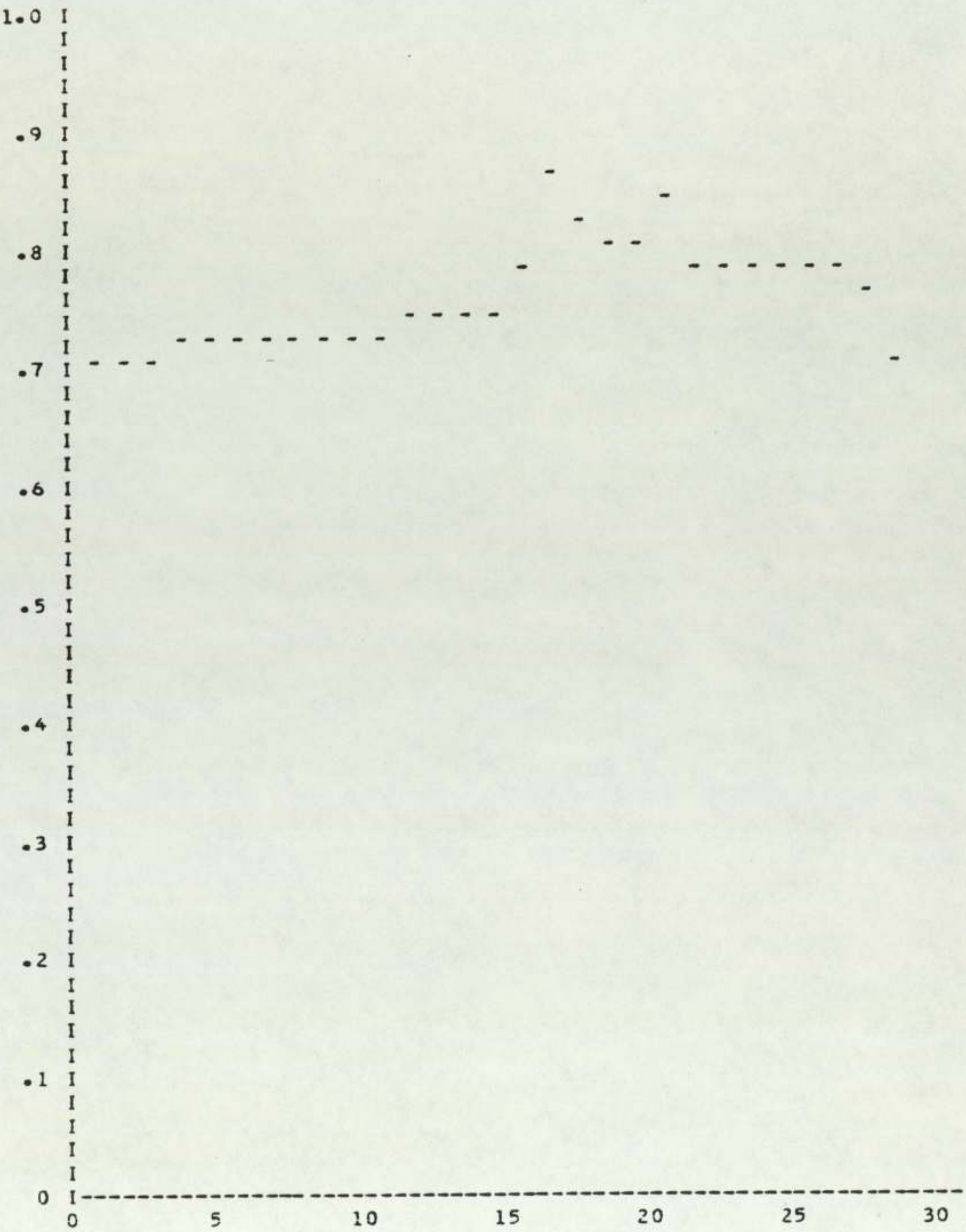


MACHINE USE FIGURES FOR FIDELITY COVERING

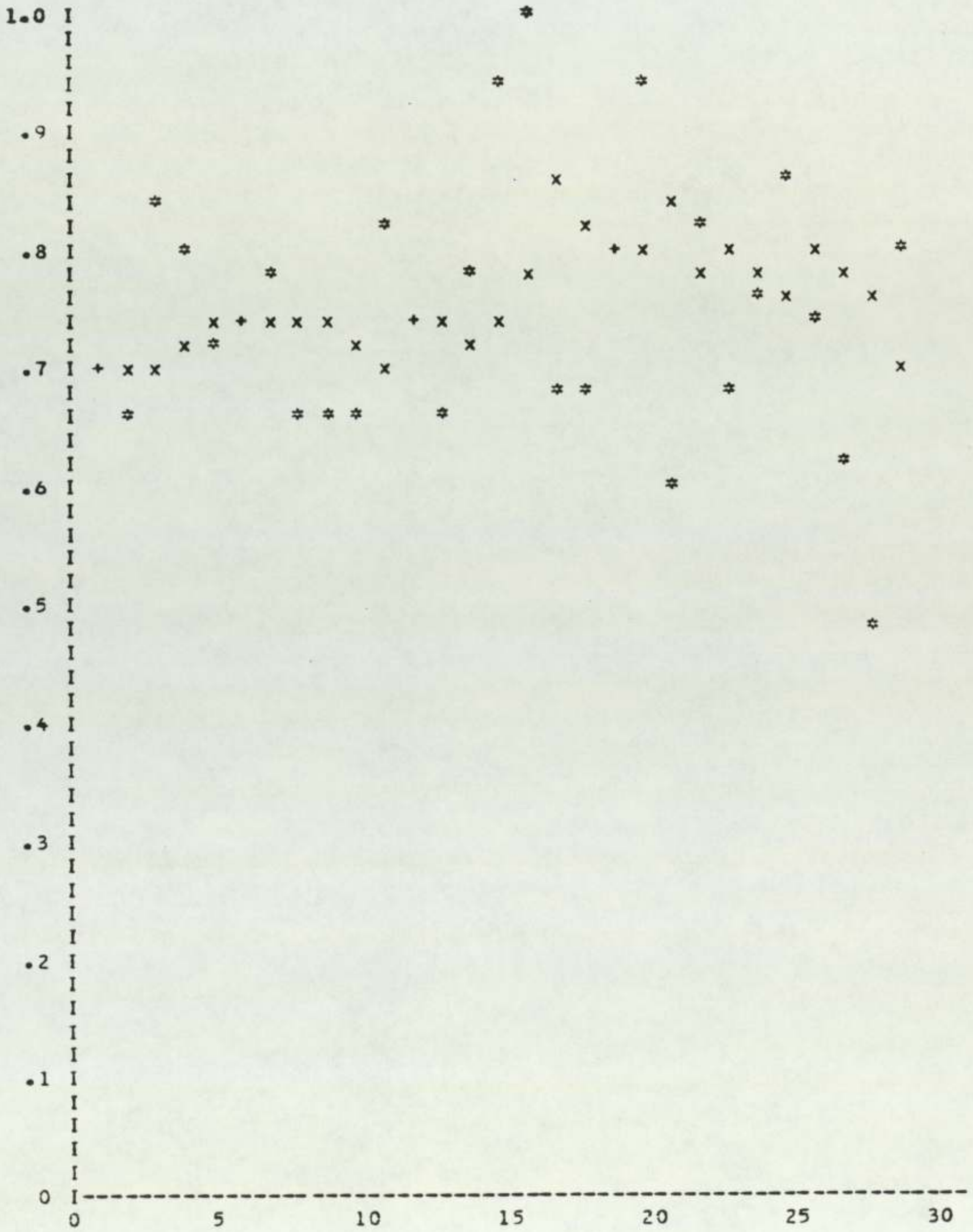
Reference Number		Date	Machine Use Minutes	Productivity Index
1		17/7	940	0.98
2		18/7	940	0.98
3		19/7	940	1
4		20/7	960	1
5	F	21/7	660	1
6		24/7	925	0.96
7		25/7	945	0.98
8		26/7	720	0.75
9		27/7	960	1
10	F	28/7	525	0.80
11		31/7	960	1
12		1/8	960	1
13		2/8	660	0.69
14		3/8	616	0.64
15	F	4/8	630	0.95
16		7/8	960	1
17		8/8	870	0.9
18		9/8	960	1
19		10/8	700	0.73
20	F	11/8	475	0.72
21		14/8	960	1
22		15/8	915	0.95
23		16/8	960	1
24		17/8	850	0.86
25	F	18/8	620	0.94
26		21/8	960	1
27		22/8	960	1
28		23/8	884	0.92
29		24/8	660	0.69

Capability : 960 minute (two shifts)
Capability Fridays : 660 minutes

FIDELITY LINING TO ATTENDANCE INDICES
MEAN PRODUCTIVITIES



FIDELITY LINING TO ATTENDANCE INDICES
PRODUCTIVITIES AND FORECASTS



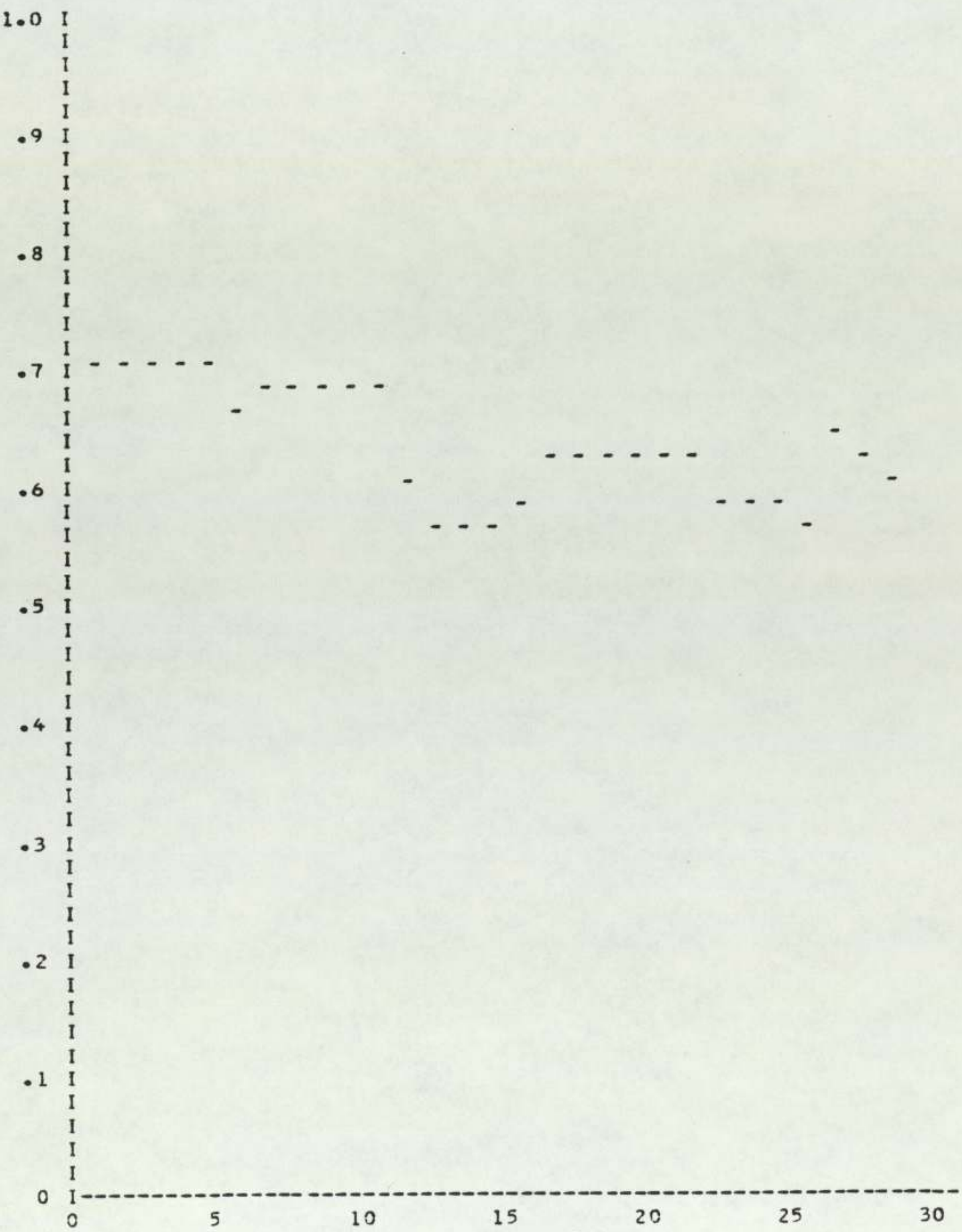
FIDELITY LINING TO ATTENDANCE DATA

DIVIDED BY 1.03

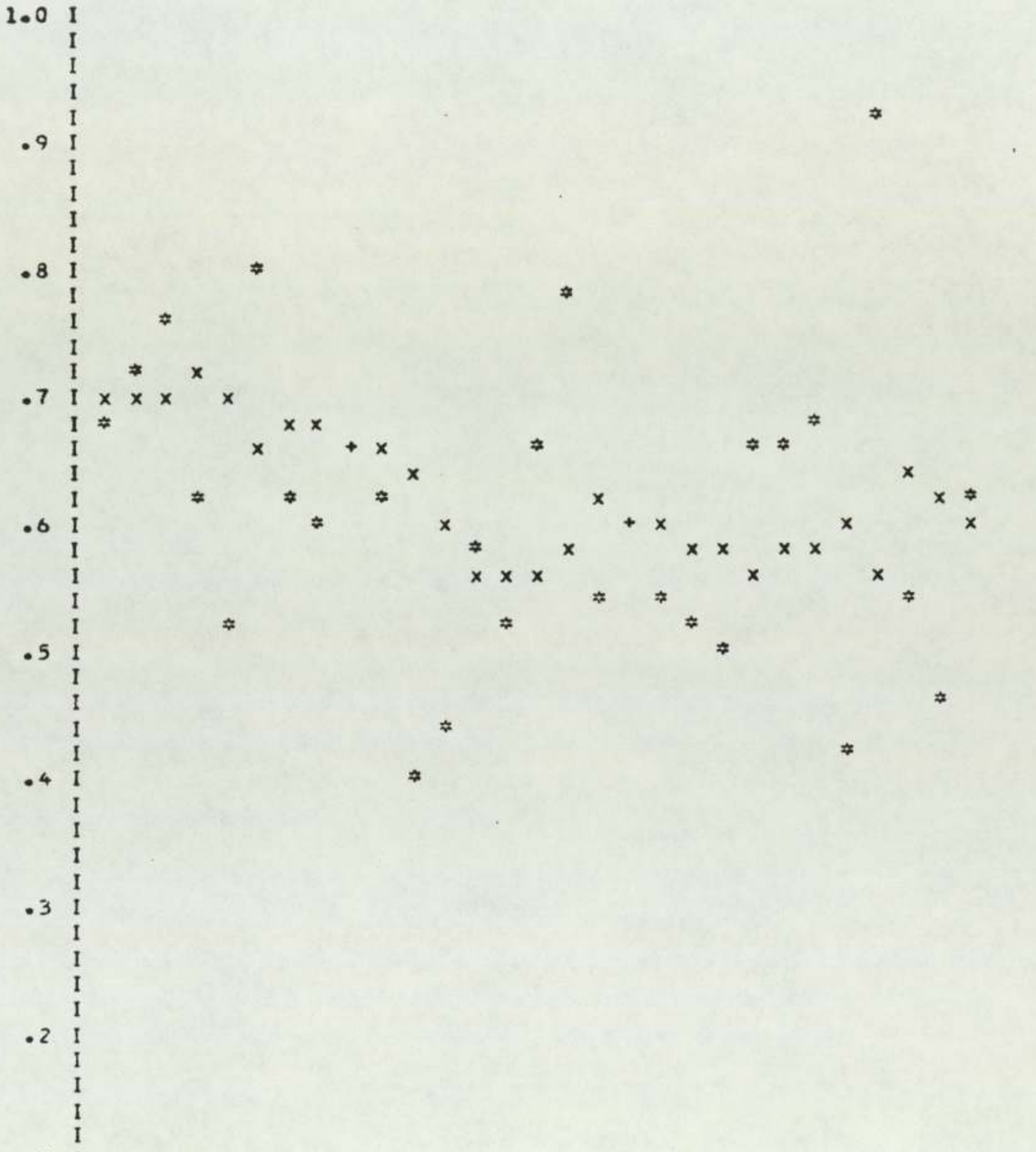
ALPHA = 0.20
FORECAST = 0.70
TYPE = N
LIMIT = 25 %

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.70	0.00	-.05	
2	0.70	0.67	0.00	-.52	
3	0.69	0.83	0.00	0.64	
4	0.72	0.81	0.00	0.77	
5	0.74	0.73	0.00	0.65	
6	0.74	0.75	0.00	0.67	
7	0.74	0.79	0.00	0.76	
8	0.75	0.67	0.00	0.15	
9	0.73	0.66	0.01	-.17	
10	0.72	0.65	0.01	-.38	
11	0.71	0.83	0.01	0.14	
12	0.73	0.74	0.01	0.16	
13	0.73	0.65	0.01	-.14	
14	0.72	0.79	0.01	0.11	
15	0.73	0.94	0.02	0.56	
16	0.78	1.00	0.05	0.79	
17	0.86	0.67	0.06	0.38	E
18	0.82	0.68	0.05	0.14	
19	0.80	0.79	0.04	0.14	
20	0.80	0.94	0.04	0.36	
21	0.83	0.60	0.05	-.03	E
22	0.79	0.82	0.04	0.01	
23	0.79	0.68	0.03	-.16	
24	0.77	0.75	0.02	-.20	
25	0.77	0.87	0.02	0.05	
26	0.79	0.75	0.02	-.05	
27	0.78	0.62	0.02	-.32	E
28	0.75	0.48	0.04	-.57	E
29	0.70	0.79	0.03	-.34	

FIDELITY KNITTING PRODUCTION TO ATTENDANCE INDICES
MEAN PRODUCTIVITIES



FIDELITY KNITTING PRODUCTION TO ATTENDANCE INDICES
PRODUCTIVITIES AND FORECASTS

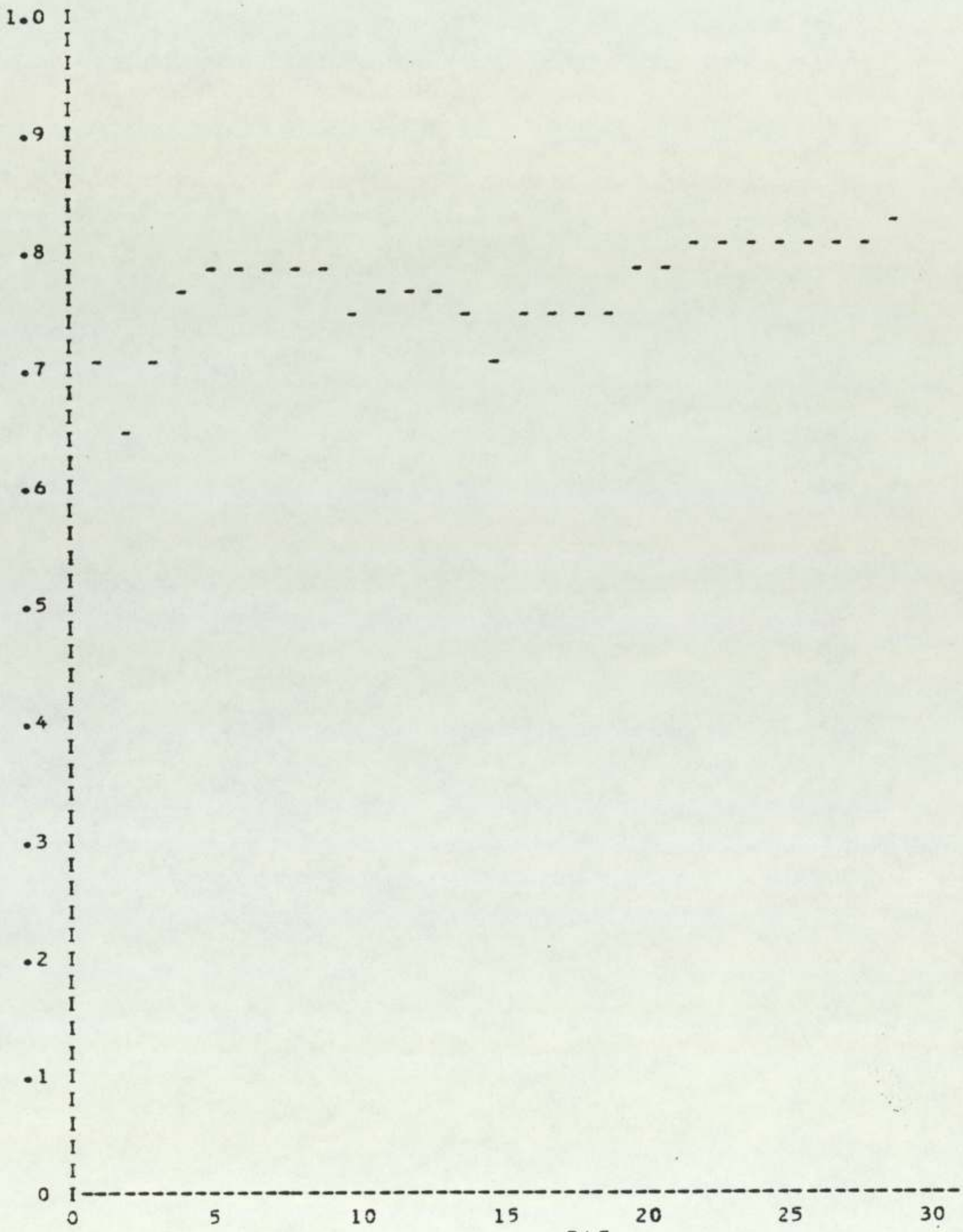


FIDELITY KNITTING TO ATTENDANCE DATA

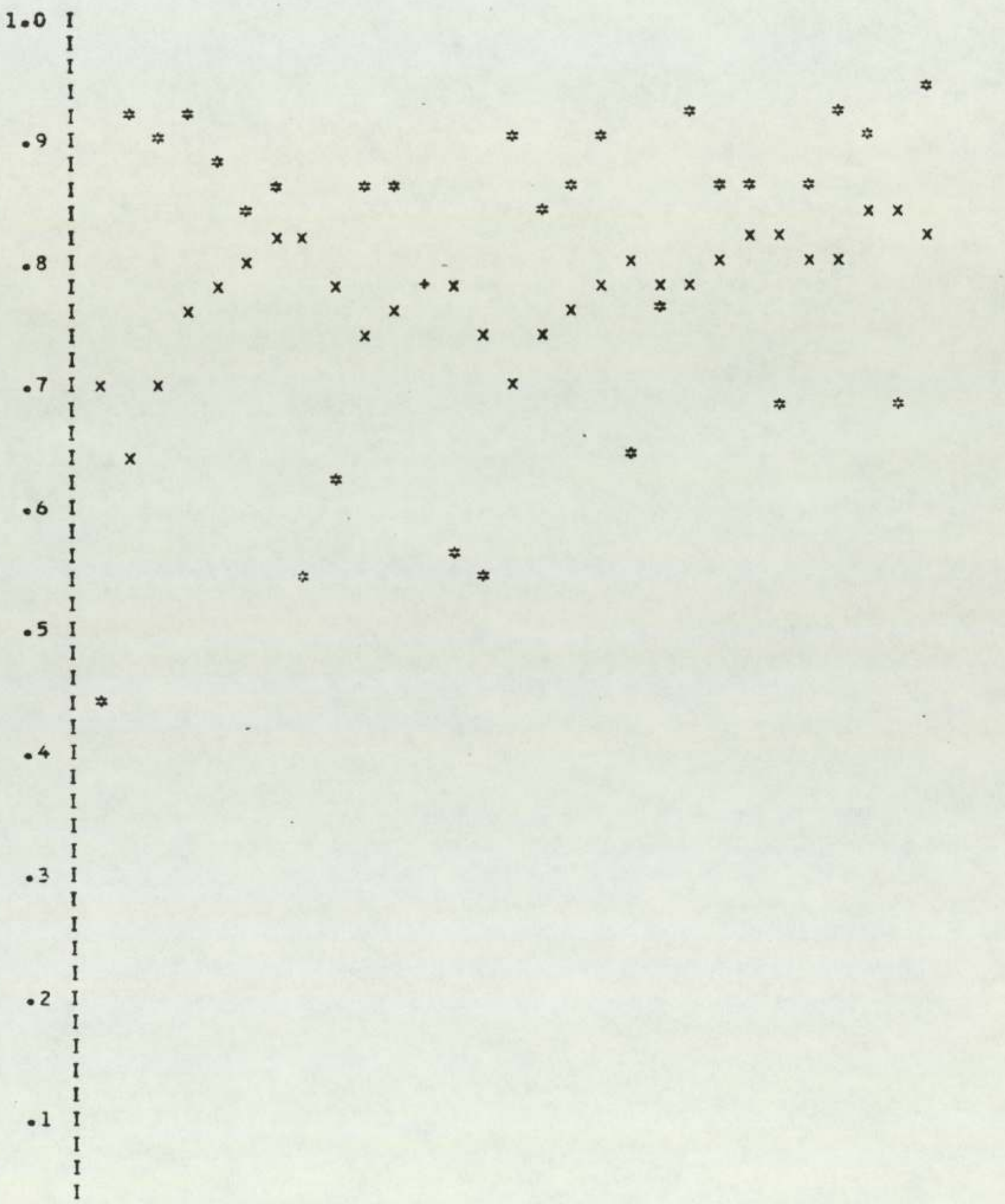
ALPHA = 0.20
FORECAST = 0.70
TYPE = N
LIMIT = 25 %   NO WEIGHTING

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.67	0.00	-.81	
2	0.69	0.71	0.00	-.39	
3	0.70	0.76	0.00	0.36	
4	0.71	0.61	0.00	-.32	
5	0.69	0.51	0.01	-.68	E
6	0.66	0.80	0.01	-.06	
7	0.69	0.61	0.01	-.24	
8	0.67	0.60	0.01	-.37	
9	0.66	0.65	0.01	-.39	
10	0.66	0.62	0.01	-.46	
11	0.65	0.39	0.02	-.73	E
12	0.60	0.43	0.02	-.81	E
13	0.56	0.58	0.01	-.75	
14	0.57	0.51	0.01	-.79	
15	0.56	0.66	0.01	-.37	
16	0.58	0.77	0.02	0.12	E
17	0.62	0.54	0.02	-.04	
18	0.60	0.59	0.01	-.07	
19	0.60	0.53	0.01	-.22	
20	0.59	0.51	0.01	-.37	
21	0.57	0.49	0.01	-.49	
22	0.55	0.65	0.01	-.15	
23	0.57	0.65	0.01	0.06	
24	0.59	0.67	0.01	0.25	
25	0.61	0.42	0.02	-.20	E
26	0.57	0.91	0.04	0.40	E
27	0.65	0.54	0.04	0.19	
28	0.63	0.46	0.04	-.06	E
29	0.59	0.62	0.03	-.01	

FIDELITY COVERING PRODUCTION TO ATTENDANCE INDICES
MEAN PRODUCTIVITIES



FIDELITY COVERING PRODUCTION TO ATTENDANCE INDICES
PRODUCTIVITIES AND FORECASTS

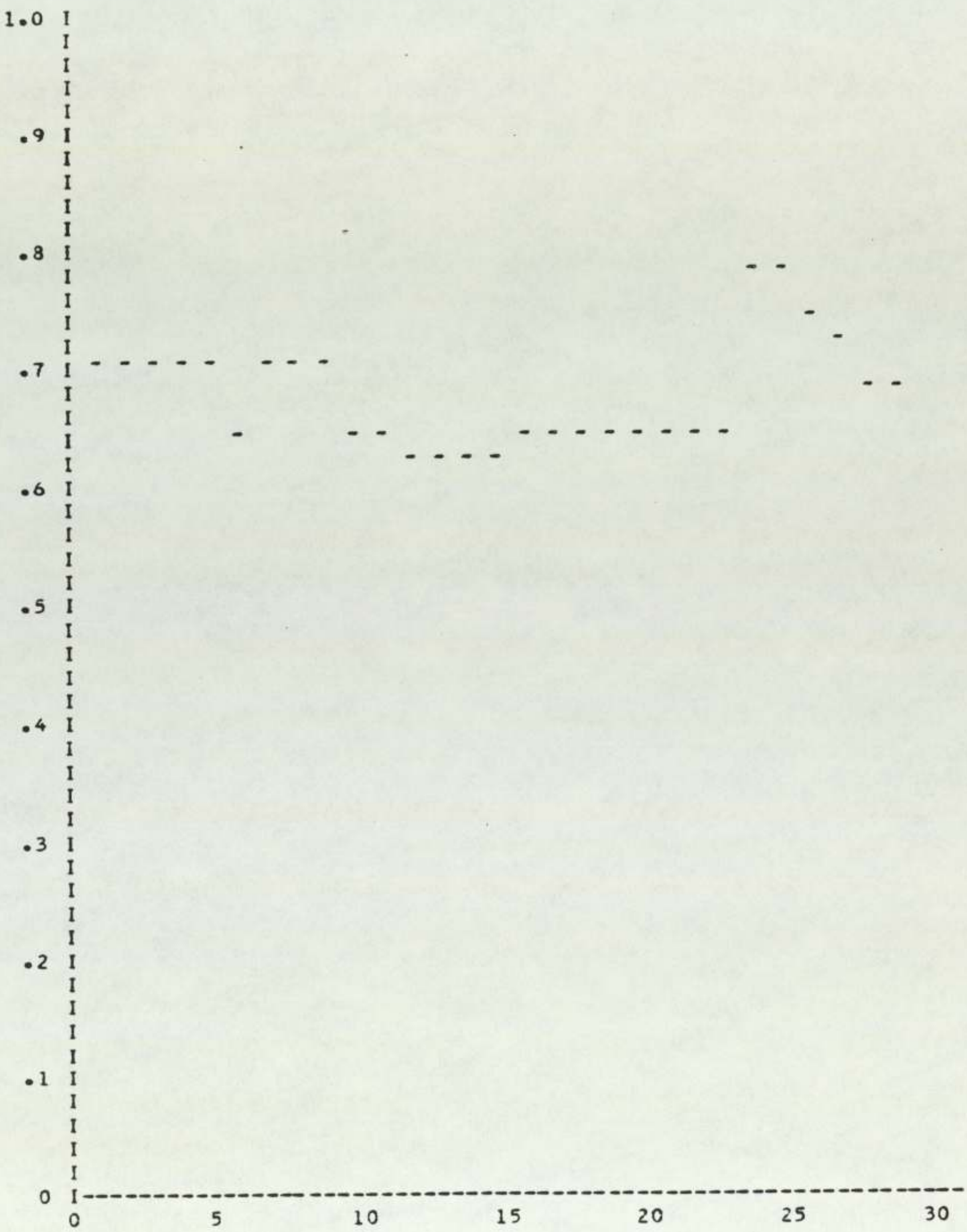


FIDELITY COVERING TO ATTENDANCE DATA

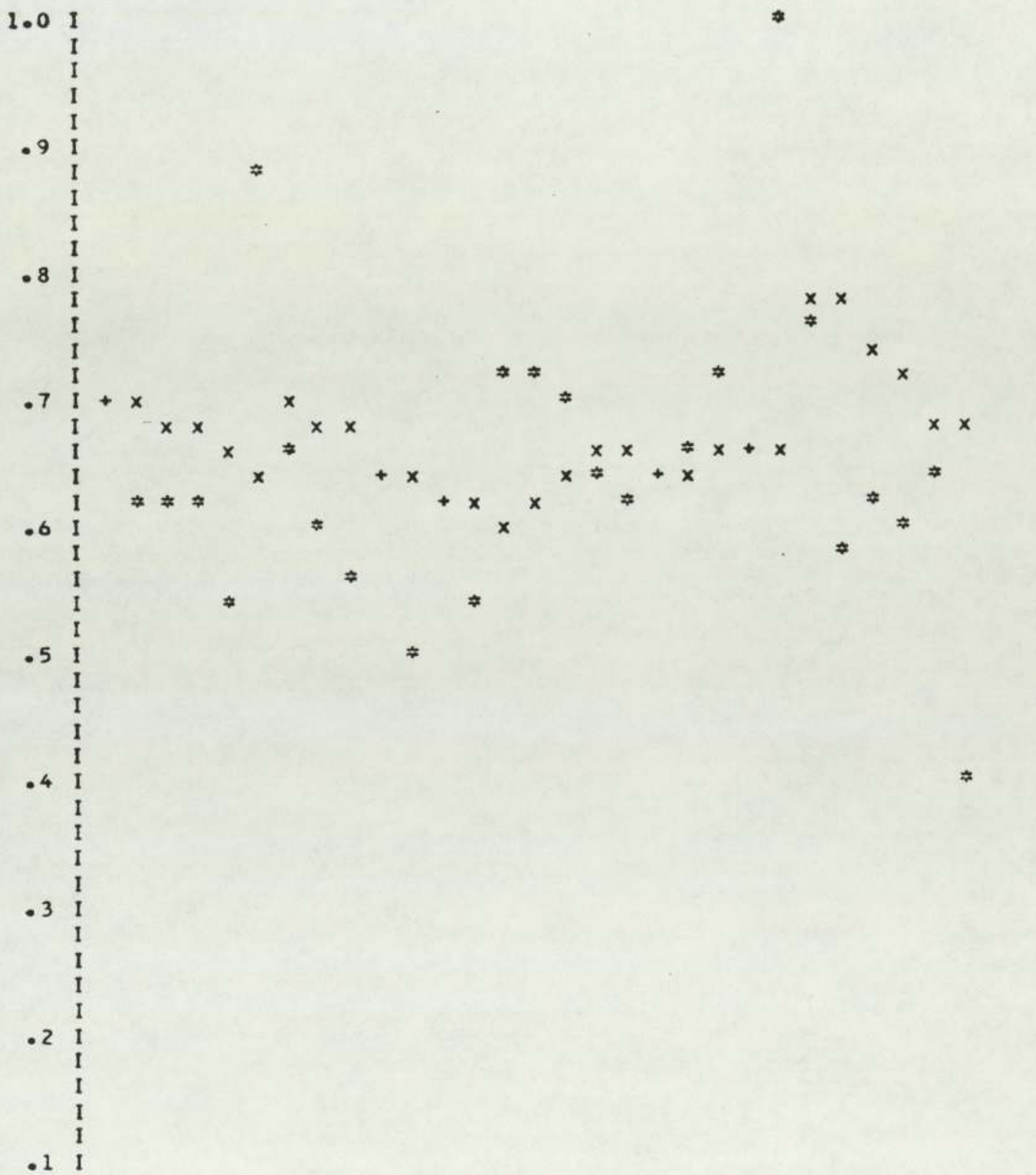
ALPHA = 0.20
FORECAST = 0.70
TYPE = N
LIMIT = 25 % NO WEIGHTING

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.43	0.01	-1.57	E
2	0.65	0.91	0.02	-.12	E
3	0.71	0.90	0.03	0.27	
4	0.75	0.91	0.04	0.47	
5	0.79	0.88	0.03	0.56	
6	0.81	0.83	0.02	0.58	
7	0.81	0.86	0.02	0.62	
8	0.82	0.54	0.04	-.04	E
9	0.77	0.62	0.04	-.25	
10	0.74	0.86	0.04	-.01	
11	0.77	0.85	0.03	0.14	
12	0.79	0.77	0.02	0.10	
13	0.78	0.55	0.03	-.28	E
14	0.74	0.53	0.04	-.48	E
15	0.70	0.89	0.05	-.08	
16	0.74	0.84	0.04	0.08	
17	0.76	0.86	0.04	0.22	
18	0.79	0.89	0.04	0.37	
19	0.81	0.65	0.04	0.06	
20	0.78	0.75	0.03	0.00	
21	0.77	0.91	0.03	0.26	
22	0.80	0.85	0.03	0.33	
23	0.81	0.86	0.02	0.41	
24	0.82	0.67	0.03	0.01	
25	0.80	0.85	0.02	0.14	
26	0.81	0.91	0.02	0.35	
27	0.83	0.90	0.02	0.46	
28	0.85	0.68	0.03	0.03	
29	0.82	0.94	0.03	0.29	

FIDELITY LINING PRODUCTION TO MACHINE USE INDICES
MEAN PRODUCTIVITIES



FIDELITY LINING PRODUCTION TO MACHINE USE INDICES AND FORECASTS

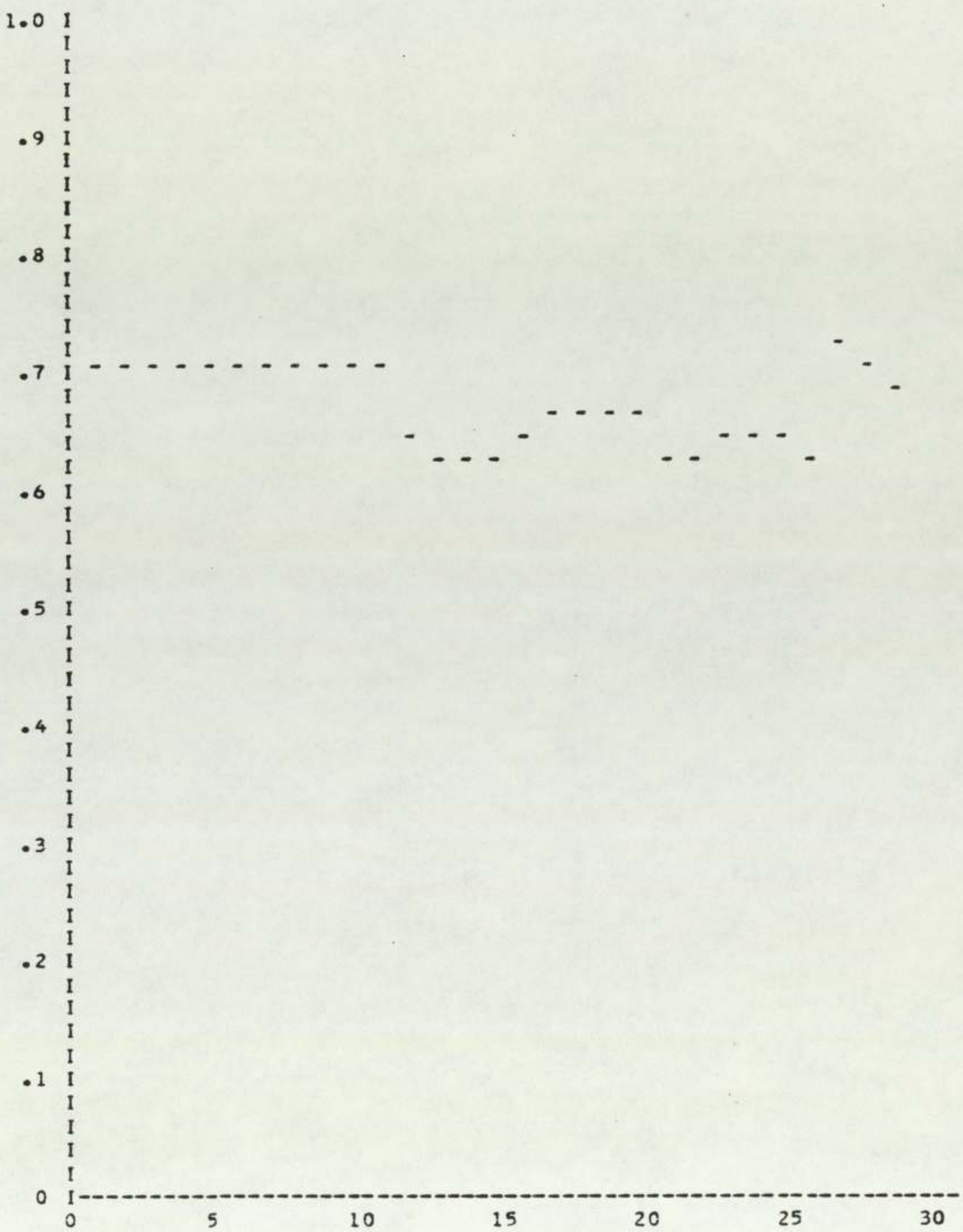


FIDELITY LINING PRODUCTION TO MACHINE USE DATA

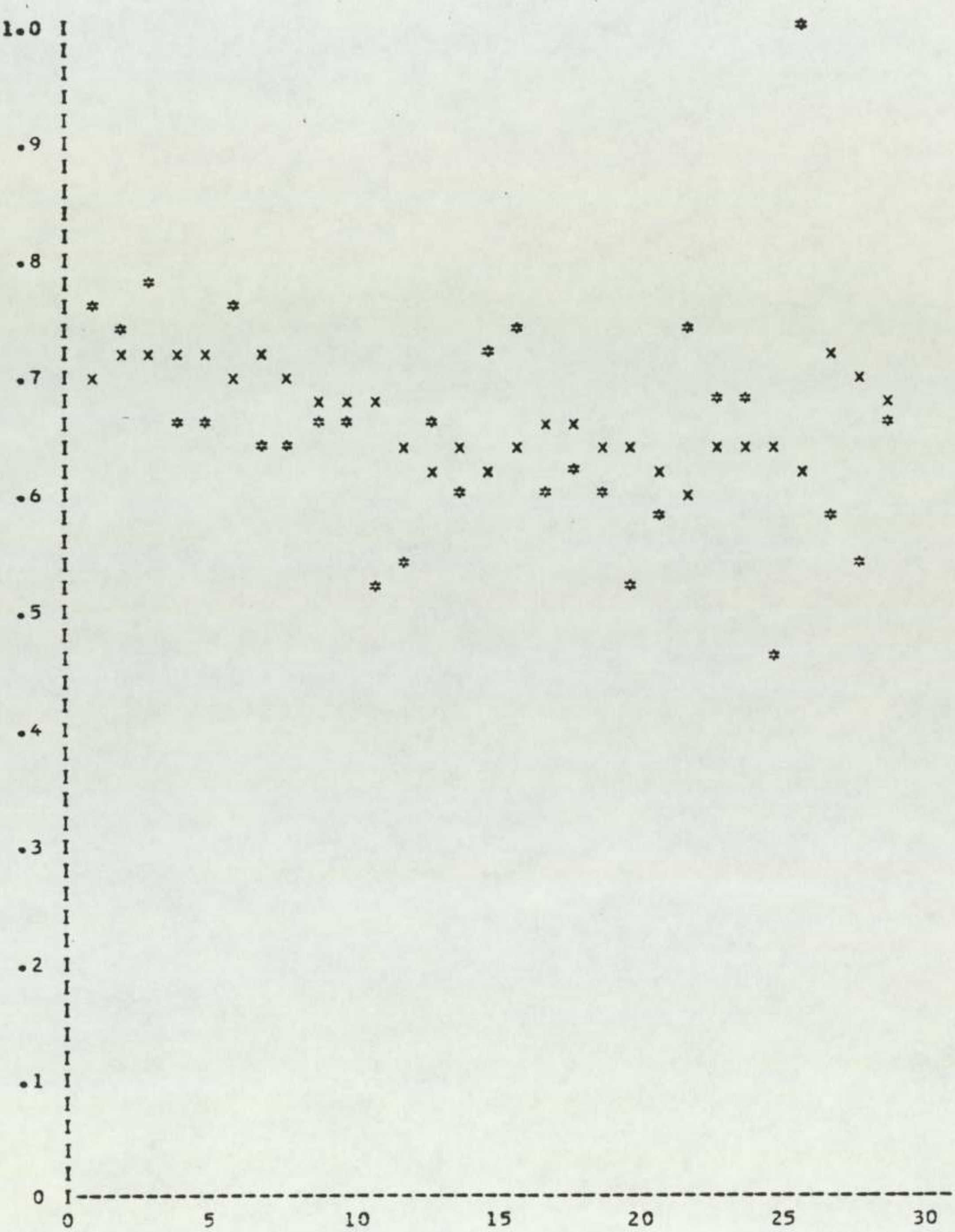
ALPHA = 0.20
FORECAST = 0.70
TYPE = N
LIMIT = 25 %
WEIGHTING = 1/1.37

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG	
1	0.70	0.69	0.00	-.34	
2	0.70	0.62	0.00	-.78	
3	0.68	0.63	0.00	-.87	
4	0.67	0.62	0.00	-.91	
5	0.66	0.55	0.00	-.95	
6	0.64	0.88	0.02	0.18	E
7	0.69	0.66	0.01	0.07	
8	0.69	0.61	0.01	-.13	
9	0.67	0.56	0.01	-.35	
10	0.65	0.63	0.01	-.38	
11	0.65	0.50	0.01	-.58	E
12	0.62	0.61	0.01	-.59	
13	0.62	0.55	0.01	-.67	
14	0.60	0.72	0.01	-.17	
15	0.63	0.72	0.01	0.10	
16	0.65	0.71	0.01	0.24	
17	0.66	0.65	0.01	0.19	
18	0.66	0.62	0.01	0.05	
19	0.65	0.65	0.00	0.05	
20	0.65	0.67	0.00	0.14	
21	0.65	0.73	0.00	0.42	
22	0.67	0.67	0.00	0.40	
23	0.67	1.00	0.04	0.87	E
24	0.78	0.75	0.03	0.79	
25	0.77	0.58	0.03	0.27	E
26	0.74	0.62	0.03	0.05	
27	0.71	0.59	0.03	-.15	
28	0.69	0.64	0.02	-.22	
29	0.68	0.40	0.04	-.50	E

FIDELITY KNITTING PRODUCTION TO MACHINE USE INDICES
MEAN PRODUCTIVITIES



FIDELITY KNITTING PRODUCTION TO MACHINE USE INDICES
AND FORECASTS

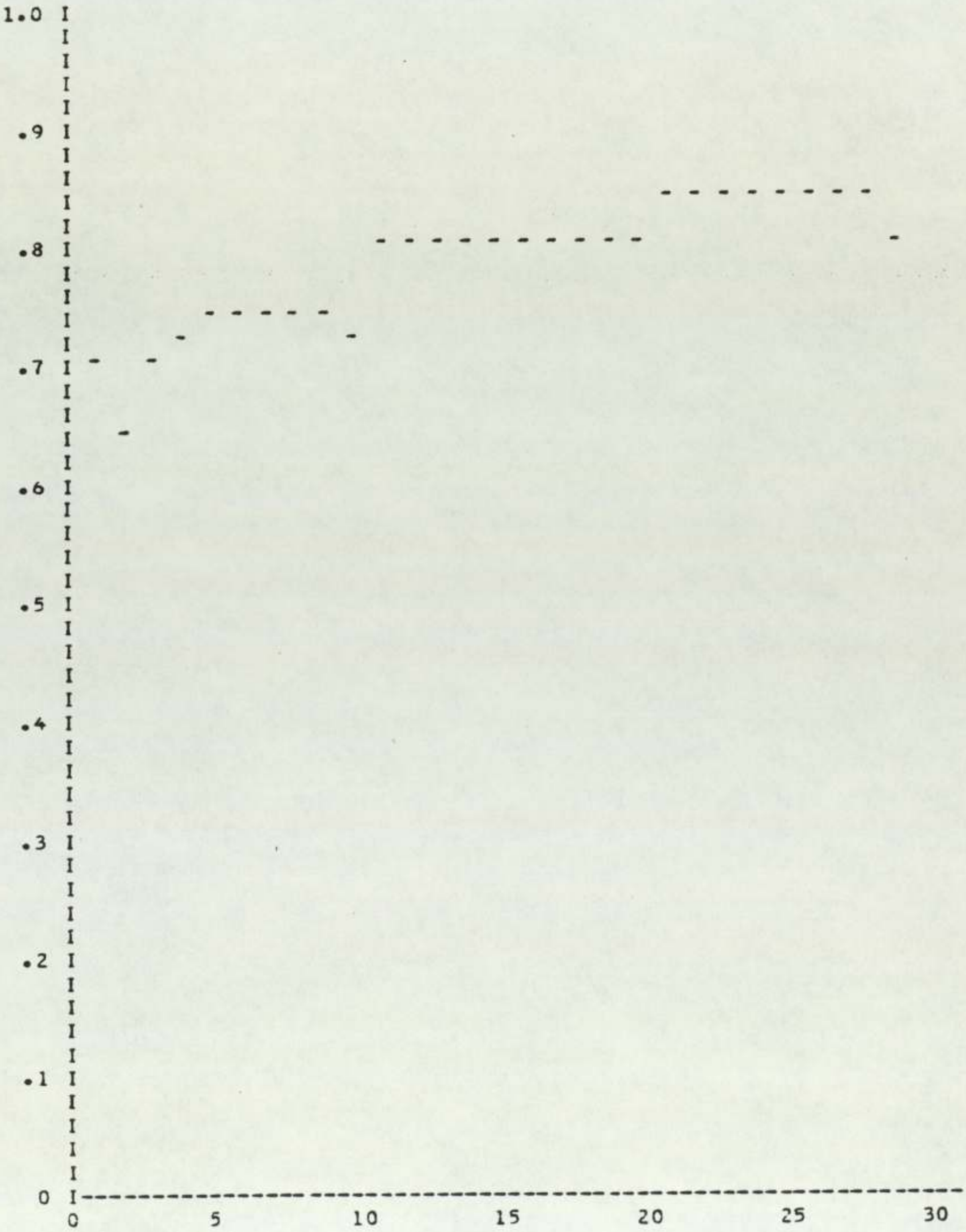


FIDELITY KNITTING PRODUCTION TO MACHINE USE DATA

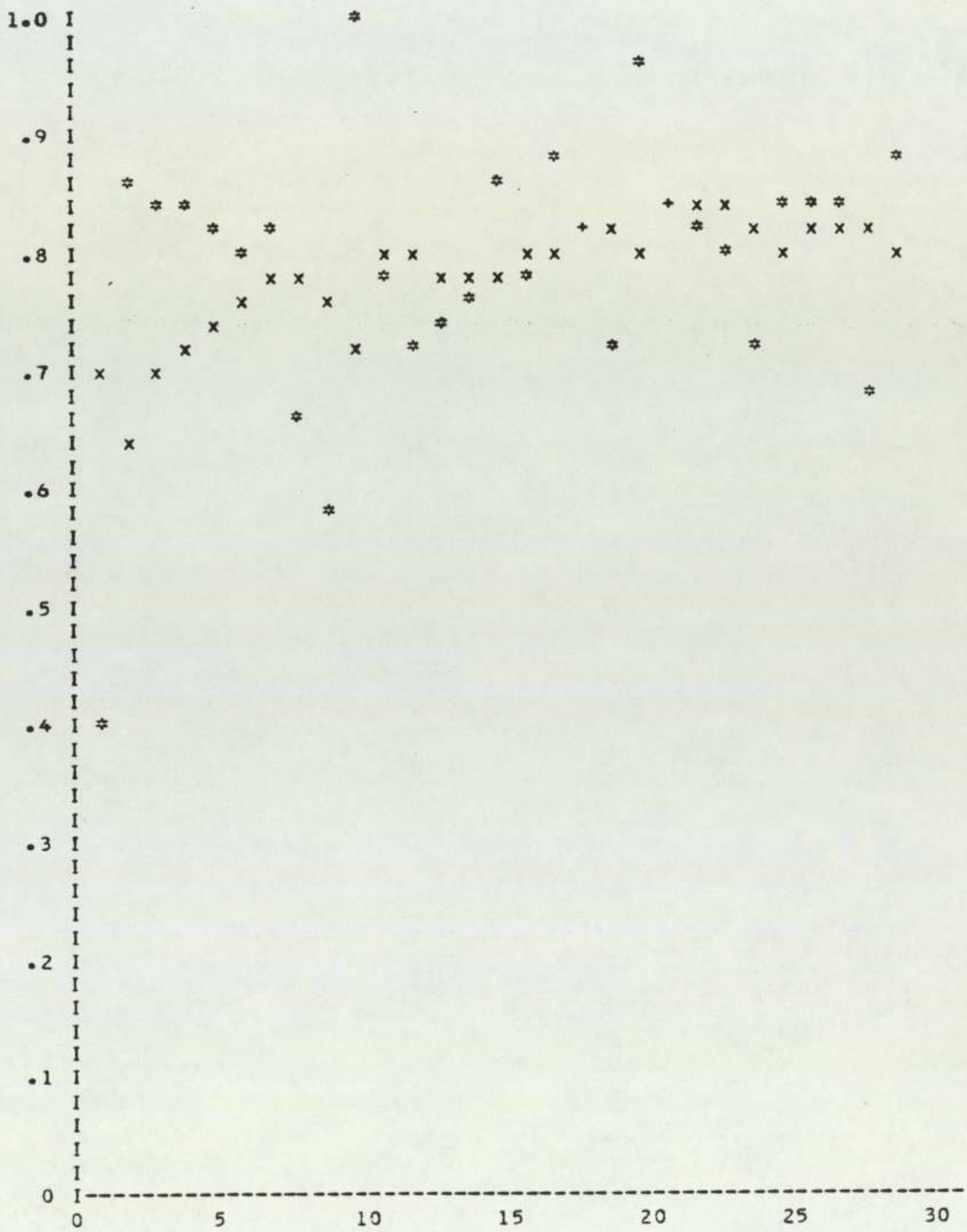
ALPHA = 0.20
FORECAST = 0.70
TYPE = N
LIMIT = 25 %
TRACK LIMIT = 63 %
WEIGHTING 1/1.17

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.75	0.00	1.08	
2	0.71	0.75	0.00	1.05	
3	0.72	0.77	0.00	1.03	
4	0.73	0.65	0.00	0.23	
5	0.71	0.65	0.00	-.13	
6	0.70	0.76	0.00	0.16	
7	0.71	0.64	0.01	-.18	
8	0.70	0.64	0.01	-.36	
9	0.69	0.65	0.00	-.44	
10	0.68	0.66	0.00	-.49	
11	0.68	0.51	0.01	-.73	E
12	0.64	0.54	0.01	-.80	
13	0.62	0.66	0.01	-.61	
14	0.63	0.60	0.01	-.65	
15	0.62	0.72	0.01	-.17	
16	0.65	0.75	0.01	0.16	
17	0.67	0.61	0.01	-.03	
18	0.65	0.61	0.01	-.14	
19	0.65	0.60	0.01	-.28	
20	0.64	0.53	0.01	-.50	
21	0.61	0.59	0.01	-.54	
22	0.61	0.73	0.01	-.03	
23	0.63	0.68	0.01	0.10	
24	0.64	0.67	0.01	0.19	
25	0.65	0.45	0.01	-.33	E
26	0.61	1.00	0.06	0.51	E
27	0.73	0.58	0.05	0.27	
28	0.70	0.55	0.05	0.04	E
29	0.67	0.67	0.03	0.04	

FIDELITY COVERING PRODUCTION TO MACHINE USE INCICES
MEAN PRODUCTIVITIES



FIDELITY COVERING PRODUCTION TO MACHINE USE INDICES
PRODUCTIVITIES AND FORECASTS



FIDELITY COVERING PRODUCTION TO MACHINE USE DATA

ALPHA = 0.20
FORECAST = 0.70
TYPE = N
LIMIT = 25 %
WEIGHTING = 1/1.08

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.41	0.01	-1.59	E
2	0.64	0.86	0.02	-.33	E
3	0.69	0.83	0.02	0.05	
4	0.72	0.84	0.02	0.27	
5	0.75	0.81	0.02	0.37	
6	0.76	0.80	0.02	0.43	
7	0.77	0.81	0.01	0.50	
8	0.78	0.67	0.02	0.11	
9	0.76	0.57	0.02	-.26	E
10	0.72	1.00	0.06	0.38	E
11	0.31	0.79	0.04	0.34	
12	0.80	0.71	0.03	0.15	
13	0.78	0.74	0.03	0.05	
14	0.78	0.77	0.02	0.03	
15	0.77	0.87	0.02	0.25	
16	0.79	0.78	0.01	0.19	
17	0.79	0.88	0.02	0.41	
18	0.81	0.82	0.01	0.43	
19	0.81	0.72	0.01	0.07	
20	0.80	0.96	0.02	0.48	
21	0.84	0.84	0.02	0.49	
22	0.84	0.83	0.01	0.43	
23	0.84	0.80	0.01	0.23	
24	0.83	0.72	0.01	-.13	
25	0.81	0.84	0.01	-.03	
26	0.32	0.84	0.01	0.08	
27	0.32	0.83	0.01	0.13	
28	0.82	0.68	0.01	-.33	
29	0.80	0.87	0.01	-.01	

FIDELITY LINING PRODUCTION AND FORECAST DATA

ALPHA = 0.30
FORECAST = 0.70
TYPE = N
LIMIT = 25 %

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.72	0.00	0.83	
2	0.71	0.69	0.00	0.18	
3	0.70	0.86	0.01	0.88	
4	0.75	0.83	0.01	0.92	
5	0.78	0.75	0.01	0.63	
6	0.77	0.77	0.00	0.63	
7	0.77	0.81	0.00	0.75	
8	0.78	0.69	0.01	-.11	
9	0.76	0.68	0.01	-.43	
10	0.73	0.59	0.01	-.71	
11	0.69	0.64	0.01	-.77	
12	0.68	0.67	0.01	-.77	
13	0.67	0.59	0.01	-.86	
14	0.65	0.81	0.02	0.13	
15	0.70	0.85	0.02	0.50	
16	0.75	0.91	0.04	0.72	
17	0.80	0.61	0.05	0.07	E
18	0.75	0.62	0.04	-.21	
19	0.71	0.72	0.02	-.18	
20	0.71	0.85	0.03	0.27	
21	0.76	0.54	0.04	-.28	E
22	0.70	0.84	0.04	0.12	
23	0.74	0.70	0.03	0.00	
24	0.73	0.68	0.02	-.16	
25	0.72	0.67	0.01	-.30	
26	0.70	0.77	0.01	0.05	
27	0.72	0.64	0.01	-.27	
28	0.70	0.49	0.02	-.65	E
29	0.64	0.49	0.03	-.77	E

FIDELITY LINING PRODUCTION AND FORECAST DATA

ALPHA = 0.20
FORECAST = 0.70
TYPE = A
LIMIT = 25 %

REFERENCE NO.	FORECAST	INDEX	STAND. DEV.	TRACK. SIG.	
1	0.70	0.72	0.00	0.64	
2	0.71	0.69	0.00	0.09	
3	0.71	0.86	0.00	0.78	
4	0.83	0.83	0.00	0.77	
5	0.83	0.75	0.00	0.09	
6	0.82	0.77	0.00	-.18	
7	0.81	0.81	0.00	-.20	
8	0.81	0.69	0.01	-.56	
9	0.75	0.68	0.01	-.66	
10	0.70	0.59	0.01	-.76	
11	0.62	0.64	0.01	-.64	
12	0.63	0.67	0.01	-.42	
13	0.65	0.59	0.01	-.54	
14	0.62	0.81	0.01	0.19	
15	0.66	0.85	0.02	0.50	
16	0.76	0.91	0.03	0.65	
17	0.86	0.61	0.04	0.07	E
18	0.85	0.62	0.05	-.23	E
19	0.80	0.72	0.04	-.32	
20	0.78	0.85	0.04	-.16	
21	0.79	0.54	0.05	-.41	E
22	0.69	0.84	0.05	-.13	
23	0.71	0.70	0.03	-.15	
24	0.71	0.68	0.02	-.20	
25	0.71	0.67	0.02	-.26	
26	0.70	0.77	0.02	-.05	
27	0.70	0.64	0.01	-.18	
28	0.69	0.49	0.02	-.47	E
29	0.60	0.49	0.02	-.57	