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COMPUTER-ASSISTED PRODUCTION SCHEDULING, PLANNING AND
CONTROL IN FOUNDRIES

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Doctor of Philosophy

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its author and that no quotation from the thesis and no information
derived from it may be published without the author's prior, written
consent.
The present study describes a pragmatic approach to the implementation of production planning and scheduling techniques in foundries of all types and looks at the use of 'state-of-the-art' management control and information systems.

Following a review of systems for the classification of manufacturing companies, a definitive statement is made which highlights the important differences between foundries (ie. 'component makers') and other manufacturing companies (ie. 'component buyers'). An investigation of the manual procedures which are used to plan and control the manufacture of components reveals the inherent problems facing foundry production management staff, which suggests the unsuitability of many manufacturing techniques which have been applied to general engineering companies.

From the literature it was discovered that computer-assisted systems are required which are primarily 'information-based' rather than 'decision based', whilst the availability of low-cost computers and 'packaged-software' has enabled foundries to 'get their feet wet' without the financial penalties which characterized many of the early attempts at computer-assistance (ie. pre-1980). Moreover, no evidence of a single methodology for foundry scheduling emerged from the review.

A philosophy for the development of a CAPM system is presented, which details the essential information requirements and puts forward proposals for the subsequent interactions between types of information and the sub-systems of CAPM which they support.

The work developed was oriented specifically at the functions of production planning and scheduling and introduces the concept of 'manual interaction' for effective scheduling. The techniques developed were designed to use the information which is readily available in foundries and were found to be practically successful following the implementation of the techniques into a wide variety of foundries.

The limitations of the techniques developed are subsequently discussed within the wider issues which form a CAPM system, prior to a presentation of the conclusions which can be drawn from the study.

Key Words: Foundries, Computer Aided Production Management, Microcomputer Applications, Scheduling, Production Control
Dedication

For Evelyne and David
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CHAPTER 1
1. **Introduction**

1.1 **Attitudes and Trends**

There have been indications in recent years \([1,2,3,4]\) that the UK foundry industry is recovering from the depression years of the late 1970's/early 1980's. Indeed the outlook on a world-wide front \([5,6]\) supports the view that the remaining parts of the foundry industry are recovering, although the extent of recovery is not yet clear.

The causal relationships between the health of the industry and various (apparently influential) factors over the last twenty years or so, have been studied and documented. The interactions between: the industry and customer requirements; technological advances in other manufacturing sectors; untimely government/EEC legislation (from a business point of view, not environmental or ergonomic); social values and the world-wide recession form the basis of many articles \([4,7,8,9,10,11,12,13,14]\). Many authors admit to the complexity of such interactions and the subsequent difficulty of understanding the underlying relationships involved.

Not all parts of the foundry industry have suffered to the same extent as the ferrous castings sector \([15]\), but the overall output of castings has been falling for many years \([4,11,12,16]\). Appendix 2. contains statistics showing the decline of foundries in the UK and the changes which have occurred within the pattern of employment.

Reflecting a view of the industry, by the industry, Reynolds and Stevenson \([12]\) stated that it was at a 'crossroads' and:
"At this time (1984), the future of castings seems to lie in the balance, with great technological and economic possibilities counter-balanced by questions of productivity, labour and the environment."

Moreover, if the optimism and change in fortunes which McCombe [2] discovered in a survey of founding in the West Midlands (July, 1985), is paralleled across the U.K., then perhaps the 'balance' has begun to swing positively, in favour of the industry.

A recurring theme, especially since the late 1960's, has been the need for change, ie, a change in the way those responsible for the organisation of manufacturing, observe and act on advances in technology, and apply management techniques and organisational skills. This implied criticism suggests a lack of research into critical facets of the industry, relative to other manufacturing enterprises [17,18,19].

In 1971, Crock [20] pointed out the necessity of re-evaluating management attitudes and techniques in marketing, production control, the environment and people (customers and employees).

However, during his address to the Institute of British Foundrymen (Edward Williams Lecture, 1975), M. Grandpierre [21] suggested that one of the problems of engineering a change of 'attitudes' was:

"... the psychological resistance to change ... from the shop floor through to higher management ..."

With more relevance to the present study, Niles [22] reported a similar
problem, which he had encountered during the implementation of master scheduling systems into foundries, viz:

"Changing the people who scheduled the foundry and the managers and foremen who used the schedule."

A year later (1984), Kennedy [11] discussed the 'people and technology interaction' problem and stated that the weakness of much of the foundry industry was due to the failure of the industry to attract and retain the 'better' engineers and applied scientists (see also Appendix 2.).

If the industry is recovering and if relative prosperity is to be the aim, then with fewer foundries, the problem is not one of securing customer orders for work. Rather, it is producing components to meet the requirements of both customer and foundry.

This widely accepted view is thought to be achievable through the adoption of modern manufacturing/organisational techniques and the application of technology. However, it is suggested that these factors alone will only be partially successful - the 'key' factor being the ability and willingness of the people concerned to 'change'.

While it is undeniably difficult for those responsible for the day-to-day management of a foundry to get involved with 'manufacturing nouveau', help is available. The main stumbling block appears to be the 'time-out' required for adequate training. Yet, sufficient training time/money is essential for the successful application of technology and must be granted to those involved in implementing new
systems.

The use of independent consultants, especially with the aid of government grants currently available [23,24], is the most logical step forward in introducing new developments to those companies with minimal time and money budgetted for research and development, provided care is exercised in their choice [25,26,27].

Despite the problems, foundries have been involved; not only with advances in process technology (eg. Dismatic moulding lines, the 'V' process, robotics and computerised process monitoring), but also in improvements in estimating, job costing and 'methoding', together with improved organisational techniques for manufacture, made possible by the assistance of computers and associated technology [28,29].

All sources (literature, customers and foundries themselves) suggest that there is a strategic need for a UK foundry industry [2,4,12] (assuming that manufacturing in the UK as a whole, does not disappear!).

Therefore, the continued stimulation for research is essential. As other manufacturing industries (ie. those buying components from foundries) adopt advanced technology and implement modern methods of controlling their own organisations (eg. MRP, MRPII, JIT, OPT etc.) they will become increasingly 'strict' with their suppliers, especially in terms of:-

- Quality - heralded by BS 5750
- The placing of orders/schedules - as demonstrated by the motor
vehicle manufacturing industry and the ODETT project

- Guaranteed 'on-time' deliveries
- After-sales service

1.2 The Research Structure

The present study is concerned with the management of production, or the organisation of manufacturing, with the aid of computers. Essentially it is a study of the production control function in foundries, from receipt of customer orders to despatch from the factory. Currently, this topic is attracting much study in various manufacturing sectors \([30,31,32,33,34]\) and has acquired the formal name of Computer Aided Production Management \([34]\). In line with other modern terminology (eg. JIT, OPT, MRP etc.), the abbreviation 'CAPM' has become the recognised acronym for this particular field.

Specifically, the requirements for, and the applications of CAPM, within foundries (15 - 400 employees), of all types, are studied. As the title of the study suggests, particular emphasis has been placed on the production scheduling function.

Solutions to production control problems biased towards micro-computers predominate, since the foundry sector contributing to this research study has historically \([35]\), had difficulty finding both the time and money for computer systems development. Despite this, ideas for computer-assistance have not been curtailed by having to 'think small'.
It must be stated here that the researcher regards the computer as a tool, not as a panacea and the accent is on people and technology - not on computer 'wizardry'.

As one writer stated [36]:

"The human element in the computer-profit equation is this: Computers will never replace people - but computers will help people be more successful in making their business more profitable."

The study commences with a review of foundries and their operations, including the inherent problems facing production controllers. A study of the literature subsequently provides: evidence of the historical implementation of CAPM; a review of scheduling theory and practice, and an investigation into some of the 'packaged-software' solutions, currently available.

A suggested CAPM approach to foundry manufacturing organisation, together with a presentation of software proposals for feasible solutions to defined aspects of production control, form the basis of further chapters.

The study is completed by a discussion of the use of the software modules which have been developed during this research and subsequently installed at the participating foundries. Moreover, an examination of the areas for further research precedes the presentation of conclusions which can be drawn from the study.
2. A Profile of Foundries and their Production Control Systems

2.1 Introduction

The current chapter is devoted to examining the foundry industry by an evaluation of the following points:

- classification of the manufacturing organisations
- types of company and corporate objectives
- approaches to production control
- factors affecting the efficiency of production control

Therefore, it prepares the foundations for the research, upon which a framework for CAPM concepts can be constructed, via the literature review. A structure for CAPM can then be developed around the proposed framework, in the ensuing chapters.

2.2 Manufacturing Environments

Several ways of classifying general manufacturing companies have been proposed in the literature [37,38,39,40] and their applicability has been discussed [41]. The approach adopted by Barber and Hollier [41] is descriptively superior to many of the other systems referenced, and serves as a useful preface to the present section.

Their approach involved a cluster analysis of the results from a survey-questionnaire on production control complexity using numerical taxonomic methods. The analysis led to the definitions of six basic groups into which companies could be categorized. The 'group 4'
classification summary is quoted, in part, below:

"This group was characterized by low product complexity and a very low level of complexity of manufacturing operations. Companies in this group manufacture a wide range of products mainly to customer order. Throughput times were short. Very few components were bought in and labour costs were the major element of product costs."

The summary, is in the author's opinion, the closest (of the six groups) to describing foundries, indeed, valve manufacturing was referenced as one of the industries surveyed.

The first sentence of the quote, however, contrasts directly with general views put forward by authors involved with foundries; that cast products are complex in terms of both production methods used and finished product requirements [42]. Whilst the latter view was stated by (mainly) foundry people on foundries, the former quote was part of an industry-wide survey, taking into account other manufacturing organisations, producing for example, aircraft, radar-equipment and machine tools.

Barber's and Hollier's approach would therefore seem acceptable in this sense, but with the following provisos:

1. Some foundries can and do cast complex components, not only by size and weight, but for example, with up to ninety elements making up parts of the corework for a particular job [21,43,44]
2. Superficially, organising for manufacture in foundries appears to be relatively simple. Later sections in this chapter look at the functional problems and put forward the opposite argument.
Increased mechanisation is altering the balance of cost away from flexible labour to fixed overhead charges. The group classification above, serves to introduce batch production founding in the UK, but on a more general level it is useful to consider a second classification system (by production), developed by Burbidge [45]. The system involved the identification of three main factors affecting the complexity of production control (and hence the production method used). The third 'affecting factor' stated, was the:

"... variety of different products, components and materials which have to be produced."

Within the 'variety' factor, three types of production system were defined:

- explosive systems
- process systems
- implosive systems

Briefly, explosive systems cover organisations whose final products can be 'exploded' down through various levels to derive sibling sub-assemblies and component parts. For example, all assembly industries - automobile, television, aircraft, etc. Process systems (in their purest form) generally combine a few materials into one mass to produce one end product (variety-wise). Process industries include the chemical, food-processing and glassmaking. Implosive systems differ from process systems because a variety of end products, or components 'implodes' down to one 'mass' of a raw materials mix. In this category lie foundries, and both rubber and plastics moulding companies.
Combining the two classification systems enables foundries to be placed quite accurately within manufacturing in general.

In summary; as a basic industry \([2, 10, 13, 15]\), foundries generally combine a few raw materials into one mass prior to casting (via several types of process) a variety of components, or 'primary products' \([46]\). A wide range of metal and alloy specifications are cast in an even wider range of shapes and sizes. The components are mainly made to explicit customer orders \([28, 47, 48]\), with little or no assembly work involved in the final product.

Clearly, there will always be exceptions to the rule in any generalisation of this nature. Some foundries do produce both to stock and to customer order \([17, 49]\), for example, in the cast bar or tube sector. Moreover, the absence of assembly work in the end product suggests that what is conceived as a 'traditional' bill-of-materials (b-o-m) problem does not exist \([17, 28, 46, 50]\), although some 'assembly work' is necessary at times, for jobs requiring cores.

Despite these few exceptions, the general summary above, provides a base from which to study production control in the foundries with which the present study is concerned.

2.3 Companies and Corporate Objectives

"Nowhere is there greater complexity and diversity in manufacturing than in the foundry industry. Here types of metal and size of casting promote wide disparity of production method."

- 24 -
Such a statement [13] is indicative of the problems of developing a set of production organisation procedures which can be of benefit to many types of foundry.

A particular foundry may specialise in one specific metal or alloy (e.g. bronze, aluminium or stainless steel), but many foundries work in two or more metals/alloys, usually on one side or the other of the non-ferrous/ferrous divide. For example, aluminium and zinc, or spheroidal graphite iron and grey iron are regular combinations. Occasionally, a foundry crosses the non-ferrous/ferrous boundary and one or two notable examples cast components from all the materials listed above.

The type of metal/alloy, size, quantity and quality required determine the moulding/casting method which is most appropriate to the foundry. Figures 2.1 and 2.2 illustrate schematically, three types of mould/cast process. Figure 2.1 depicts the materials which are generally used in each of the processes, while figure 2.2 presents a general overview of the production flow through the types of foundry utilising these processes.

What is not apparent from the figures, is the extent to which the production is mechanised, semi-automated, or purely manual in nature, depending on the type of manufacture concerned (e.g. jobbing, batch, repetition, continuous). Moreover, some foundries provide two or more mould/cast processes to produce castings to the various specifications required.
Figure 2.1 Examples of Types of Foundries by Production Method

- Precision Foundry
  - 'Lost Wax' Process
  - Medium/Large Quantity

- Sand Foundry
  - Unboxed Moulds
  - Medium/High Repetition
  - Repetition, or 'One-Offs'

- Die/Permanent Mould Foundry
  - Gravity Die
  - High Production Rate, Large Order Quantities
  - Non-Ferrous, e.g., Zinc, Aluminium

- Pressure Die

- Ferrous, e.g., Steel, Iron
Figure 2.2  Types of Foundry Production Flow
One way to address the problem of organising manufacture in such a diverse industry is to consider the 'similarities' of foundries, with respect to the production control function, whilst clearly acknowledging the fact that intrinsic manufacturing differences between types of foundries do exist.

Figure 2.2 illustrates three distinct areas in all foundries, which production control departments have to co-ordinate. They are:

- the pre-casting stage
- the casting stage
- the after-casting stage

The type of foundry will dictate the level of complexity at any of the given stages of manufacture. For example, a foundry casting flake and spheroidal graphite irons may simply fettle, inspect and despatch its cast components. On the other hand, a non-ferrous, gravity or pressure die-caster may offer a whole range of after-casting operations, including heat-treatment, machining, powder coating, anodising, plating and polishing, prior to inspection and despatch. And similarly, a steel foundry may offer a comprehensive, but different range of post-casting operations.

Figure 2.2 also implies the sequence-dependent movement of castings from one processing stage to another and the 'cascading' [17] effect has led to foundry production flow being described as:

"... a single direction of work flow." [48], or

"... the production line in a foundry is uni-directional." [17]
The above generalisation, from an 'ideal-world' situation, does not cover problems occurring during component production, which lead to the scrapping and re-working of jobs. For example, the 'inspect - weld-repair - grind - inspect' cycle in a steel foundry sets up what can be described as a 'production eddy' from the main production flow.

Irrespective of the type of foundry, most companies have aims to which any production control system would aspire. Ultimately, the measure of a system's worth will be in terms of these aims, or corporate objectives, which are set by the foundries' directors or by, for example:

"... the triumvirate immediately above him (ie. Production Controller) - the Sales Manager, the Treasurer and the Plant Manager ..." [47]

Corporate objectives will vary from company to company, but most foundries would identify with some, or all of the following [21,28,51, 52,53] listed below:

- maximization of foundry profitability
- the production of quality finished castings
- satisfied customers through the on-time delivery of castings at the appropriate level of quality and in accurate quantities
- reducing customer complaints about servicing to near zero
- reducing clerical errors, especially counting errors, to zero
- reducing quality control errors on specifications and inspection requirements to zero
- order entry to be completed as soon as possible (at least
within twenty-four hours)

- customer order acknowledgements to be despatched within forty-eight hours, maximum, from receipt of order
- to free staff, especially managers, from tedious clerical work, and so enable more timely decisions

Many factors affect the success of a particular company's achievement of the objectives listed, with or without computer-assistance. An adequate return on investment will depend on a combination of the factors listed below:

- Selling price
- Volume of output
- Scrap rate
- Direct labour and material costs per unit of output
- Level of overhead expense

However, before investigating the factors affecting the efficiency of production control in foundries, it is useful to consider manual approaches to foundry production organisation with the aid of examples drawn from ferrous and non-ferrous companies.

2.4 Approaches to Production Control

The present section outlines a pattern of basic disciplines for traditional, manual approaches to production control. The procedures from the arrival of a customer's order into the production control
department, to despatch from the foundry will be investigated.

Yates and Fuller [35] identify two 'extremes' between which lie most foundries' (manual) production control systems.

- "... some operate with very informal production control arrangements based on meeting the demands of customers by frequent shop floor discussion, ...

- ... while others have highly sophisticated and formal systems in which the production control department becomes the nerve centre of the organisation."

Yet the literature supports the view that there is a commonality of approach to organisation and procedures and in the problems encountered [48,54,55]. Therefore, for the purposes of investigation, the activities within the production control sphere can be discussed under the following headings:

- Order processing
- Forward Planning
- Detailed Plant Scheduling
- Shop-floor documentation and monitoring of work in progress
- Management reports/analysis of foundry performance

2.4.1 Order Processing

Prior to the production of jobs a foundry has to decide which jobs to make. Most foundries work to explicit customer orders, which may be either schedules, calling for periodic quantities of a recurring job (batch production), or one-off orders for a specific quantity (jobbing work). A third type of order pattern involves the semi-continuous or
continuous production of running lines [17,28,52,56]. Many foundries work to more than one type of order pattern in their areas of specialisation.

Where several types of castings are covered by one order form, the sales department normally allocate an 'internal works order number' enabling separate identification of each order item. For example, one works order number may cover the whole customer order, but the addition of 'item numbers' to each job on the order provides a unique identification code.

All jobs require process planning and cost estimate documents. These can exist as combined, or separate documents and vary in the amount of information they provide. The process planning details may simply be methods instruction sheets, or 'castings history cards' [48], containing some, or all of the following:

- Customer name (and number)
- Part (or pattern or die) number
- Names of personnel with previous experience of the job
- Material specification
- Description
- Poured weight/casting weight
- Lead-time or Average make period
- Core (or insert) requirements
- Likely scrap weight (or scrap percentage)
- Moulding or casting output rate information
- Number of castings per mould (or shots per die)
. Required after-casting operations/monitoring stages
. Cost and selling price
. Pattern status
. Standard and actual timing data for operations
. etc

Each time a new customer order is received, foundries have a new design specification to work to; the estimation and quotation work for which, is normally required in a matter of days rather than weeks. The information held on previous, but similar jobs (as defined by various classification techniques), can be used as 'reference' data, together with calculated and empirical data to assess the manufacturing requirements.

Some foundries also produce detailed 'route-cards' which list the operations in sequence, together with instructions, for each work station involved in the production of the job. The cards usually detail 'standard quantity' information, that is, the resource quantity used, in the respective units, for each operation. Lead-times (usually in days or weeks) for each operation are normally held on the route-cards, when known.

Notification of incoming work to the production control department is in the form of several documents relating to the production of the job, accumulated and subsequently transferred from sales (usually). The pre-production department order processing activities can take from hours to days, from the arrival of the customer order; depending on the size of the foundry, the responsibility of its employees and the nature of
the work. Nevertheless, all work received by the production control department should be

"... completely defined and cleared for production ..." [47]

Official order acceptance procedures vary from foundry to foundry. For example, a foundry may hold a daily meeting between, for example, the works director, the quality control manager and the estimating manager to decide whether the customer order can be produced in a period acceptable to both the customer and the foundry. In all cases, to fulfil customer orders, the production of new, or repeat jobs has to be co-ordinated with:

i) existing jobs (some of which will already be in production), customer returns, re-works, re-issues for scrapped jobs and relevant finished stock supplies (for repeat jobs)

ii) the procurement of materials, patterns, cores (or 'inserts' for permanent-moulders)

iii) the requirements of the foundry (corporate

iv) the requirements of the customer (eg. delivery date and the relative importance of the customer to the foundry).

Such information is derived partly from formal procedures and partly from 'informal' knowledge. The evaluation of i), above, will determine whether incoming jobs can be started (ie. cast) and delivered on time.

Traditionally the amount and type of manufacturing capacity that jobs require is calculated at the moulding stage in sand foundries and at the casting stage in die foundries (ie. at the capital intensive
process stage). Thus, after the gross capacity requirements for incoming jobs have been determined (in the resource units used by the foundry), they can then be viewed with respect to the existing work-load, which is allocated to a foundry's regular production periods (usually a week in length). Based on the above technique, the customer delivery date requirements can be 'vetted' (see also Trinder and Watts [48]).

The formal procedure above, can be contrasted with the informal knowledge about a customer, or the availability of suitable labour normally retained mentally), which are additional, essential parameters in the evaluation 'equation'.

Via the above procedures, if a particular order is not accepted (ie. it is incompatible with either customer requirements or foundry management policy) then alternatives are suggested and re-evaluated until a compromise, or order rejection results. Once the orders are approved for production, the production controller assigns one, or more dates (see below for examples).

- casting date
- pattern inspection date
- delivery date

Providing that all jobs have been defined properly, realistic sample and production delivery dates can also be assigned for jobs which are being estimated.
At some point just before, or just after the above procedure, the raising of 'customer order acknowledgement' documents occurs. The responsibility for this procedure falls to the sales or production control department, depending on the traditional practices of the foundry.

The size of foundry, the sophistication of their production control practices and the requirements of customers' orders, will also determine the amount of works documentation which is subsequently produced. Where a large number of documents are produced for each customer order, some foundries have semi-automated the documentation production task, using masking/duplicating machines. For example, one exacting, steel repetition foundry produces a minimum of fourteen documents per customer order, so that all relevant departments are kept informed.

The production of works documentation leads to the planning, programming and scheduling functions, which are necessary stages in coordinating the parameters listed above. Most foundries (should) carry out these procedures, but do so in practice to different levels of complexity and effectiveness.

2.4.2 Forward Planning

The data obtained from the procedures above, which is supplied to the planners in a variety of forms (eg. Gantt charts, planning boards, lists), enables the 'forward planning' of jobs over a finite time period (or 'planning horizon') extending into the foundry's future.
Using purely manual methods, forward planning is normally restricted to identifying each of the jobs planned for moulding or casting in successive time periods (weekly, sometimes fortnightly), even though many foundries recognise the need to calculate the load on other major production sections (eg. coremaking). At this stage, the planner has to cope with both jobs that are awaiting resources (eg. raw materials) and jobs that can be started with the currently available resources, possibly within the same time period. The former category of jobs cannot be ordered into the shop until a confirmation procedure has been invoked, indicating that the jobs can go 'live'. For example, notification from the pattern department that the required patterns have been procured.

The allocation of jobs to individual time periods constitutes one part of the forward planning function, however. The use of the information provided on the documentation and empirical knowledge about the job, the foundry and the customer, assists the planner in 'balancing' jobs over the various workstations. Given the clerical capacity, future potential 'bottle-necks' can be avoided, together with the other extreme of under-utilization of workstations: although any course of action leading to the achievement of a balanced work-load (by, for example, combining orders to form economic batch sizes, or to optimize the use of the melting facilities or labour), will be conducted within the corporate policies of the foundry.

Communication with other departments (eg. sales) may also assist in balancing the future work loads on the foundry. The planner knows the impending work-load over a given planning horizon and therefore can
highlight potential 'lulls' which are forthcoming on particular workstations. Moreover, communication allows realistic decisions to be made concerning the uptake of 'rush' or 'asap' jobs.

Three other potential benefits should be obtained from forward planning. The raw material requirements, for jobs which have been planned, facilitates the calculation of forward metal loads, which in turn allows purchasing to co-ordinate the arrival of raw materials with planned production dates.

The highlighting of 'overdues' (ie. orders that have passed the due-date for either production or delivery) is another essential prerequisite to foundry operation. Such information allows the planner to 'work-in' the outstanding jobs as foundry capacity dictates.

A third benefit is the pin-pointing of recurring trouble spots. For example, if a particular section is continuously a source of bottleneck trouble, then changing the layout of existing plant may contribute to an improvement in production flow.

2.4.3 Detailed Plant Scheduling

Forward planning ('long-term planning') requirements are subsequently converted into 'short-term' plans, (shop schedules, or work-to-lists) which relate the forward load calculations with appropriate shop-floor documentation.

The forward load for a particular period is communicated to the
foundry, usually a few days in advance of the period-start-date. It may consist of a list of the appropriate jobs, sorted by section or metal type, or may simply be the manufacturing instruction cards for each job, or a combination of both. In drawing up the short-term plan, the planner will have analyzed the job requirements, including any scrap allowances on the various production resources and any stocks of cores/inserts which may be available.

Two detailed scheduling stages are normally identified in foundries. Scheduling of the moulding or casting sections and scheduling of the after-casting operations. Short-term scheduling of the moulding or casting stage consists of extracting from the forward load, a list of jobs for individual workers or sections to work to. The detailed schedule is passed to shop-floor supervision (eg. a foreman), who has the responsibility for organising the period's work on a day-to-day basis, although in some foundries exact instructions from the planning department are sent to foundry supervision on a daily basis. Several factors are taken into account prior to the selection of jobs. For example:

- shortcomings from previous days
- day-to-day demands from the production control department, requesting priority treatment for particular jobs identified as necessary by progressing activities
- production efficiency considerations, such as the hourly usage of metal (melting facility utilisation)
- pattern/die changes coinciding with meal breaks/shift changes
- balancing the load on the core-shops (sand foundries)
. matching up of small quantity jobs to ensure adequate mould utilisation

. to allocate jobs to individual casters (die foundries) so a full programme of work remains for all personnel throughout the period.

Much of the data associated with the points above is normally retained mentally by the foreman.

The second detailed scheduling stage is usually performed by the foreman and involves the scheduling of the after-casting operations. Given a number of jobs awaiting work at a particular work station, the foreman has to decide which of the jobs to tackle next. Such decisions are based on job priority (signified by due-date), supplemented by requests from progress personnel, sales and customers. In general, little documentation accompanies the after-casting scheduling tasks.

A current short-term schedule should be amended as often as is necessary, during the period, to take into account the work done and deviations from the schedule. Those foundries with sufficient clerical resources may advocate a daily issue of the schedule over say a four to five day period, rather than a weekly one to cover the whole period.

Forward and short term plans dictate the foundry’s proposed production commitments and therefore should be communicated to other departments (in an appropriate format), for example, to production and sales managers and to purchasing.
2.4.4 Shop-floor Documentation and Monitoring of work-in-progress

The media for issuing instructions to the shop varies from foundry to foundry. Instructions may be raised on cards, at the documentation production stage, with each relevant card bearing the title of the department or section it is to inform. Such cards would then be posted to the relevant departments informing personnel of the imminent arrival of jobs and the action to be taken.

Instructions may also be produced on route-cards which 'travel' around the foundry with the job - each section obtaining the required information from the appropriate part of the document. Various foundries employ both methods and sometimes a combination of both exists in a given foundry.

On the other hand, small foundries may operate mainly by word of mouth and use one document to inform several departments. For example, where cores are not specifically planned, the timely production of a moulding schedule provides forewarning to the core-shops of the job requirements. Similarly, the fettling shop is informed by the same document of what they can expect to receive.

Other departments need forewarning of jobs which are imminent. In a sand foundry, the pattern shop needs time to check on the availability of patterns and core boxes, so that the co-ordination of effort to bring the two resources together at the moulding stage is not hindered.

Shop instructions have another important role: that of informing the
foundry which job is being produced. As much information as is
required to avoid ambiguity between jobs should be included, taken from
a combination of the following (listed below):

- pattern number
- works internal reference
- customer name
- description

Each day, individual operators, section foremen or progress chasers
report the production or days achievements. Work-booking documents
exist in many forms (see fig. 2.3 for an example of a 'heat-sheet');
indeed one ultimate use for the shop-floor instruction sheets,
described earlier, could be as the basis for returning production
information from the shop-floor. Where separate documents are used,
the three basic sets, most commonly in use, are those listed below:

- time-sheets, heat-sheets or job tickets (production
department), listing the jobs that have been tackled
- inspection records, indicating good and scrap components (with
  reasons) against each job
- despatch returns, identifying the jobs which have been
despached.

In many sand foundries, the number of time sheets involved is one.
That is, a 'heat-sheet', recording the production from the mould/cast
monitoring stage. In contrast, die or precision foundries may monitor
at 'tooling available', 'cast', 'fettle', 'heat-treat' and 'sub-
contract' stages.

The ability to report and record incidences of batch-splitting, for the
Figure 2.3 Example Of A Heat-Sheet
re-working of jobs, or the economic utilization of resources is essential in any foundry work-booking system.

Inspection records show the jobs that have been passed as good production, those that require re-working and those that are to be scrapped, (together with appropriate reasons).

Despatch returns are frequently made up of 'multi-part' documents. After despatching a job, copies of the despatch document ('advice note') are sent to foundry departments and also the customer.

All work-booking sheets are normally routed through the production control department, prior to being sent to various commercial departments. Production clerks extract the relevant information from all three categories of sheet, enabling the work-in-progress file, or work's order cards to be updated as the various production stages required for the job are monitored. The work-in-progress file and its subsequent maintenance is one of the most essential control features of any production organisation system. It also provides quick response times to customer enquiries about their jobs, the status of which enables the production controller to estimate the production time remaining prior to job completion.

Another important feature of work-in-progress tracking is the provision of 'historical' data. Many foundries require the facility to be able to record the transactions that have occurred during a job's production sequence. The provision of historical records and their subsequent analysis allows feedback and control of the various aspects of job
production to be monitored. Moreover, recent quality requirements, applied to foundries, as to other component makers (eg. BS 5750), have greatly increased the need for the latter type of conformation.

2.4.5 Management Reports and Analysis of Foundry Performance

The information which is derived from the work-booking sheets can be compared to the original production plans in order to highlight areas where opportunities exist for improvement; for example, in the areas of existing production procedures and plant layout. Providing the clerical capacity is available, a performance analysis of a foundry's practice can be achieved, normally by the drawing up of management reports. The reports may cover areas such as those listed below:

- the percentage of on-time deliveries (and overdue margins)
- outstanding jobs, grouped by customer and required date
- evaluation of the work-in-progress
- scrap analysis by reason codes
- periodic stock (finished and unfinished) level checks

Management reports containing summary information in particular groupings, or sorted formats, are another essential output when processing the data acquired from the shop-floor.

Some approaches to manual production control methods in foundries have been stated. Use has been made of section headings to describe the 'sequence of events' in progressing a job through a foundry from the receipt of a customer order, to despatch from the foundry. It is worth remembering, however, that while many foundries will identify with the
procedures outlined, the exact order of execution of such procedures will vary, as will the detail to which the planning and scheduling functions are carried out. Moreover, it is common to find departments 'overlapping' in their responsibilities.

Many factors affect the successful practice of production control in foundries and this subject forms the basis of the next section.

2.5 Factors affecting Production Control

The overview to manual approaches to production control which has been presented, reveals an industry that has apparently fewer complications in its production organisation procedures than are found in other manufacturing organisations. For example, jobs are mainly made to specific customer orders obviating the need for forecasting future sales.

A corollary to making to order is that stocks of finished components tend not to be held; similarly, the scarcity of 'bought-out' components contributing to the finished product suggests that a formal inventory management system, with its associated data-processing requirements, is not generally applicable. Moreover, a single-level product structure denies a traditional b-o-m requirement and corresponding 'parts explosion'.

Taking these factors into account, together with the absence of a firm master production schedule suggests the redundancy of techniques such
as 'Material Requirements Planning' (MRP).

A closer study of foundry practice, however, contradicts the above implied 'simplicity'.

2.5.1 Order Processing Problems

By definition, foundries that 'make-to-order' rely on customers to place orders with them. However, irrespective of how efficient the sales department is, the arrival of orders cannot be reliably predicted and therefore little control can be exercised on the pattern of jobs arriving at the foundry (especially in jobbing foundries). Nevertheless, the influx of customer orders and their acceptance does form the basis for future load determination, production and delivery service promises and cost profiles, over a given foundry's planning horizon.

Job-costing is a vital pre-cursory activity to the acceptance, or otherwise, of customers' orders since realistic pricing is essential to the profitable existence of the foundry. And whilst the subject of job-costing is not one of primary concern to the present study, ultimately, the production control department has the responsibility of producing the required products within pre-defined cost limits. Therefore, some of the factors influencing its activities are listed below [57,58,59]:

1. Materials that go into a casting normally are not requisitioned or purchased for specific jobs.
2. In some sectors of the industry, far more material must be made
ready and poured, as a rule, than is afterwards present in the finished product.

- When a casting is poured, labour and overheads required for the melt, pour and shakeout cannot usually be charged to a specific customer.

- The cost of down-time on the moulding plant, or variation in the amount of metal required to fill individual moulding boxes.

- In some areas of the castings industry (e.g. steel), more than half of the total cost can be accrued after the casting has been poured.

Repeat jobs have still to be assessed, as a result of increases in energy and raw materials costs, labour and rates.

'Variety' may be the spice of life, but in the context of production control, the larger the variety of end products, the more complex the control system required. The 'product mix' (i.e. size, weight and shape of components and the material used) is not unique to foundries, but few industries experience the same diverse requirements for end products as (especially) the jobbing and repetition sectors of the foundry industry.

A further complicating factor is that of order quantity (or 'end-product volume'). In general, manufacturers who make high volumes-to-stock are able to create programmes for scheduling 'jobs' onto work-centres so as to make efficient use of their resources by allowing long production 'runs'.
The points above illustrate one category of factors influencing the efficiency of a production control system, ie, those that exist as a result of the nature of the industry. A second category consists of factors which reflect the limitations of manual procedures. In the former case, the lack of success in applying 'standard package' solutions, developed for general assembly-type manufacturing, is evidence of the inherent differences of foundry practice; whilst many foundry managers would agree that the major advantage of a manual system is that it is initially cheap to install.

A common limitation that has been levelled at manual paperwork systems is that their successful application depends on key personnel and to some extent on the ability of these personnel to memorize pertinent facts. The complete understanding of the system is limited to a few persons which makes the system vulnerable to staff changes [48,49,79]. The 'miracle worker' is a frequently met (and potentially dangerous) phenomenon in foundries.

2.5.2 Shop-Floor Planning and Control Problems

One of the key roles in any foundry is performed by the person (or persons) responsible for the forward planning and detailed scheduling of work, within the imposed timing restrictions. With the clerical methods available, the forward loading in terms of manpower and equipment availability is restricted to examining the demand level from the customers and translating this into a weekly manufacturing programme for the moulding or casting facilities. Furthermore, the difficulty of assessing the effect of forward loading on the foundry as
a whole, particularly between processes which are measured in different resource units, may lead to bottle-neck situations at various processing sections within the foundry.

Similarly, detailed scheduling and re-scheduling activities are frequently based on decisions concerning only part of the total manufacturing processes involved. This is due in part to the time required and the complexity of performing manual calculations to optimize the many criteria, especially where there is a lack of accurate 'timing' data.

Several other factors hinder the forward planning and detailed scheduling functions (extending sometimes into the actual production of jobs). For example: the integration of 'overdue' jobs into the production plans so as to cause the least disturbance to section loads which have already been balanced; the inclusion of 'rush orders'; the 'yield' factor which has to be taken into account when determining the required quantities from particular processes, and disruptions produced by changes in customer demands. These include amendments to the original order quantity, delivery-date revision, specification re-evaluation or even cancellation of the entire order. It is often not possible for a foundry to take a firm stance against this type of activity, particularly if the customer is the recipient of a large percentage of the annual output.

The production of jobs to a given programme (or schedule) is also subject to change especially if the procedures for ordering work into the foundry are informal. They include procedures which allow salesmen
to push:

"... particular 'pet' orders to the top of the list ..." [28],
customers to expedite their own jobs and the detrimental effect of
poorly designed incentive schemes, by which foundry employees are paid.
In addition, variable production capacity of foundry sections, due to
absenteeism and breakdowns, necessitates essential alterations to
current production programmes.

2.5.3 Information Transfer Problems

Foundries which produce complex castings (in terms of the core-work
involved) are clearly aware of the problems of co-ordinating the core-
requirements per job, with the existing work-load on the core-shop, to
ensure that sufficient stocks of cores are available at the job
moulding stage. In such cases, the identification of all the core
elements is desirable if not practically feasible, by existing manual
methods.

With coremaking, as with other subsequent processing sections, it is
not sufficient for a production control system to schedule work onto
the appropriate sections. The reporting back of information relating
to the job, in terms of quantity of good components produced, the scrap
quantities and the reasons for scrapping, are essential, if any form of
control is to be exercised. The limited (sometimes very) shelf-life of
cores merely exaggerates the difficulties.

Poor feedback from the shop-floor stems from inaccuracies of data
capture; usually the miscounting of quantities of components passing
through the monitoring stages and the failure to associate the components produced with the identification codes adopted by the foundry.

Normally, the shop-floor recognises the part or pattern number to which the job belongs. However, where there exist similar jobs, designated under a similar code number, it is not unusual to find that the wrong code number has been transmitted back to the production control department. Another problem is that time-sheets are sent back with only half of the code number on them. The production clerk then has the task of establishing the correct code identification before booking the work into the work-in-progress file.

A further task for the production clerk is the relating of work to a particular customer order, especially if there are several orders for the part in question, although the problem can be overcome, to some extent, by the design and accuracy of the works documentation. Tracing 'split-batches' complicates the work-booking task further, especially when irate customers are demanding to know the whereabouts of their order.

The use of data which has been fed-back from the shop-floor, in conjunction with existing job and methoding details forms the basis of management reports, normally prepared on a weekly basis. However, the clerical effort required precludes the provision of anything other than limited management information, presented in the form of long lists or tabulations. Thus, the manager has the task of sorting out the important from the trivial, prior to taking decisions.
The above points complete the background introduction to foundries. Their place within general manufacturing has been discussed and the diversity of the industry, together with corporate objectives, have been examined.

Some approaches to production control (manual procedures) have been considered and many of the factors affecting the organisation for production have been investigated. However, no attempt has been made to indicate how individual foundries have manually resolved the conflicts of interest between themselves and their customers, or their intrinsic problems in controlling production.
CHAPTER 3
3. CAPM Philosophy and its Application to Foundries

3.1 Introduction

Background literature has already been referenced during the course of introducing the present study. The main purpose of the research, as defined by the title of the study, commences with the following investigation/review.

CAPM is a composite subject, existing as several interacting sub-systems. To illustrate this point, figure 3.1 shows the functions of CAPM within general manufacturing, proposed by Corke [30]. The sub-systems of CAPM required within the foundry environment (described in section 2.2) are somewhat different to those employed in general manufacturing and figure 3.2 represents an equivalent, interdependent set of CAPM functions, which are considered to be fundamental to the organisation of foundry manufacturing.

The differences between the two CAPM systems begins with how both types of industry answer the manufacturing question of 'what to make and when'. For example, greater emphasis is placed on the function of sales forecasting by companies whose modus operandi is more suited to the interaction of the sub-systems represented by figure 3.1 (i.e., engineering companies which, in general, assemble component parts to stock). These companies use various forecasting techniques in conjunction with existing sales orders to produce a master schedule - from which the outstanding material (and component) needs can be computed.
Figure 3.1  Functions Within CAPM
Figure 3.2 Functions Within CAPM Required by Foundries
The master schedule can be evaluated, in material terms, by an application of the widely publicized technique of material requirements planning (MRP), which produces a time-phased plan of 'how much is required of what, and by when'. Purchase orders for items which are to be 'bought out' and shop orders for items which can be made 'in-house', can then be raised.

Ultimately, the combination of manufactured items and purchased materials and components are processed and assembled into the final product. However, a highly efficient stock control system is required to co-ordinate the movement of materials and components into and out of the works. Figure 3.1 illustrates the 'closed-loop' activity surrounding the stock file in order to achieve a high level of inventory management efficiency.

In contrast, whilst few foundries manufacture components for stock, the majority of foundries do experience continually changing demands for components (section 2.5). As a result, the production of a master schedule is impracticable and therefore they must work from the most 'up-to-date' version of the works order book, to enable an accurate analysis of the outstanding raw materials requirements.

Raw materials are foundries only 'bought out' items, in terms of the final component (other purchased items may include, for example, chills and exothermic sleeves). Consequently, foundry purchasing is normally limited to a small range of alloys, which precludes the need for an extensive stock control sub-system - a fact which is conveyed by figure 3.2.
The only realistic way to assimilate the literature relating to CAPM in foundries is to group the various aspects of the subject under a series of 'broad headings', rather than try to cover the whole research area at once. Such an approach is adopted here. A relative comparison of writers' opinions is then possible, within the context of the work presented in the current study.

3.2 Subjects for Review

The major categories which evolved from reviewing the literature are as shown in figure 3.3.

![Diagram of CAPM categories]

**Figure 3.3 The Literature Classified**

The first of the categories investigates the implementation of computer technology, historically, in the foundry industry and reviews the choices which face the potential 'system-buyer'.

The second category details the applications which have been developed for foundry use. These include references from 'case-studies',

- 59 -
describing how individual foundry's have 'done it' and an examination of some of the commercially available packages - which provide evidence of why some of the accepted CAPM techniques for general manufacturing are of little use to foundries.

The subject of scheduling forms the basis of the third category, in which a theoretical introduction is followed by a review of the practice of foundry scheduling, as described by the literature.

Whilst scheduling is perceived to have a vitally important role within foundry CAPM systems, the literature reveals that few foundry practitioners in the UK have experienced the benefits to be gained from operating a scheduling 'tool'; the reasons for the lack of success in implementing scheduling packages are investigated in section 3.3. In addition, it is suggested that a generally applicable scheduling function must be designed with inherent 'flexibility', to enable several different combinations of criteria to be examined and to be sufficiently responsive to the type of manufacturing environment which exists within the foundry industry.

The latter category overviews the extent to which CAPM has been adopted by industry in general, through the use of several surveys/reports.

3.3 The Literature Reviewed

3.3.1 The Implementation of Computer-Assistance

Computer-assisted production control in foundries or, to be more exact,
the historical development of computer-assistance, is the subject under review. The picture that emerges is that CAPM was not generally available for small to medium-sized foundries until the advent of the microcomputer as a business tool.

The assumption that a degree of computer-assistance was (and is) required by most foundries is overwhelmingly supported by the literature [19,42,49,50,51,54,57,60,61,62,63].

3.3.1.1 Early Developments in CAPM

To illustrate the development of CAPM in foundries, it is useful to consider some of the conclusions of one of the earliest surveys of computer technology in the foundry industry, conducted in the United States by Knight [18], in 1967, viz:

i. very few foundries have a reliable base of data which can be used to develop operating and administrative systems.

ii. the majority of the work done was in the administrative area, with computer applications being information and/or accounting oriented.

iii. the cost of developing and implementing a 'system' was prohibitive for most foundries with less than 500 employees

iv. either each foundry 'does it alone' (as some of the larger foundries had attempted) or some type of industry-wide effort was necessary, to be of benefit to all participating foundries.

A comparison can be achieved in terms of availability (ie. cost), by comparing the third point listed above, with the following statement
"Fully interactive computer systems can be cost justified by foundries with as few as 20 employees, ..."

Moreover, further observation uncovers a second level of development. The type of data processing carried out in the majority of foundries in the late 1960's is indicated by Knight's second point. The types of computer system referred to in the latter quote would typically include:

- an order entry system
- production scheduling
- customer order status evaluation
- core scheduling
- invoicing
- sales forecasting (order backlog)
- cost estimating
- foundry accounts

Hence the areas of implementation have become more identifiable with the needs of foundries, a feature which figures largely in many researchers' work.

In the intervening years, three major developments have occurred bringing about the current level of progress in today's foundry systems.

Firstly, there has been a gradual increase in the awareness of foundry
management of the need for improved organisation of manufacturing (especially over the last few years with the tightening of standards, for example, the onset of BS 5750).

Secondly, the rapid advances in micro-computer technology have meant that data storage has become relatively cheap (and is becoming cheaper); processing power can be housed in a fraction of the space required twenty years ago, and a greater variety of hardware and software is now available - with the emphasis on choosing the software first.

Thirdly, the interest shown by external 'bodies', apart from the foundry industry's own technical institutions (including software houses and consultants), has enabled many smaller foundries to get involved. There is no doubt that the availability of financial support for CAPM implementation by means of government grants (eg. ETAS, AMT, etc.) has accelerated the adoption of CAPM.

The literature reveals a number of case-studies [36,43,44,46,49,51,60, 63,65,66,67,68,69,70,71,72,73,74] which provide firm evidence in support of the attempts by individual foundries to adopt some form of computer-assistance (these reflect the 'successes': the extent to which foundries have been unsuccessful is not so well documented!). All of the case-studies approached the implementation of a 'system' on a 'do-it-alone' basis (see Knight's conclusion iv, above) and the early systems (pre- 1970 to mid 1970's) were largely implemented on mainframe computers ('in-house', bureau service or time-sharing), progressing onto mini-computers as the technology advanced.
Therefore, during this period, unless a foundry possessed its own data-
processing department, had access to the computer when required and had
its own programmers, the actual benefits gained from utilizing a system
were limited. For example, using a bureau service/time-sharing
dictated when reports could be 'run off' the system and in many
instances, a foundry would receive revised schedules only once in a
period of several days [51,67].

In 1969, topical reports in the foundry journals of the UK examined the
features which had combined to produce the [19]

"... present low status of the computer art in U.K. foundries;"
identifying, among others, the cost of computers, intrinsic differences
of the industry in the UK, disparaging computer applications press and
the lack of stimulation from foundry media [19,56].

A year later, similar reports from Swiss and German sources [56,75],
described the 'mechanism' and some applications of 'Electronic Data
Processing' (EDP) in Europe, but warned of the dangers of poorly
applied systems.

Thus, an understandably cautious approach was advocated by many papers
[42,48,51,56] reflecting the high cost of the initial hardware
investment and the added cost of developing software. Only those
foundries with sufficient capital resources, together with the 'drive'
of highly motivated individual(s) [51,76] were able to take advantage
of some form of EDP.
3.3.1.2 Initial Generalised Systems

This unsatisfactory situation (especially, for the typically 'small' foundries in the UK) was partially addressed in 1972, by the collaboration between the British Cast Iron Research Association (BCIRA) and Hoskyns Systems Limited (HSL), which performed a study of the feasibility of developing common, computer-assisted production control systems for the British Foundry Industry [35] (the second 'approach' observed by Knight).

The primary objective of this study was that foundries should be able to use a system at a fraction of the cost of developing their own system. Moreover, of equal importance, the grounds were established for a commonality of approach towards computer-assisted production control [55].

Almost in parallel with the work of the BCIRA/HSL, the British Non-ferrous Metals Research Association (BNFMRA) carried out their own survey [77], which supported the findings of the BCIRA/HSL study (i.e. the 'commonality of approach' and the need for 'simple' systems). The results of the study were projected further [48], proposing that the approach to organisation and procedures appeared to extend to the practices employed in the ferrous sector.

Despite this work, the potential 'gains' of using the new technology were only being realized by a few concerns and in 1974, the first of a series of reports was published by 'Working Group E2' - formed under the auspices of the Technical Services Committee of the IRF - to
evaluate and advise on the use of computers in the foundry industry [42].

The 'softly, softly' approach to implementing a system was advised, with 'low-risk applications' only (eg. scrap analysis) being considered as first applications, hinting at the need for the hitherto undefined, 'modular' approach to system design.

Thus far, although the literature [1,17,42,49,54,56,63,65,68,78,79] stated the advantages of computerised systems over the disadvantages of manual methods, as yet, only the BCIRA/HSL collaboration had resulted in a basic, standard system for production control [48,50]. Unfortunately, small and medium-sized foundries were not able to afford the hardware requirements for this system and a scheme was devised whereby these foundries could 'rent' an amount of computer time at a data processing centre.

To overcome the limitations of the BCIRA/HSL system, the British Non-Ferrous Technology Centre (BNFTC) developed their own system for foundry production control during 1974 to 1977. The system operated in 'real-time' and required a minicomputer to run the package. Although the initial investment in the BNFTC system was about a tenth of that reported [80] for an implementation of the BCIRA/HSL's system, it was sufficient to deter the smaller foundries and many of the medium-size concerns.

The criterion of 'foundry-size' which seemed to determine the potential 'user' from a 'non-user' (of CAPM systems), was stated more firmly by a
survey of more than 200 British foundries [81], in 1974. The survey revealed that the size of foundry was the over-riding factor, a factor which also influenced the extent to which a system was used.

However, for those foundries who could implement computer-assistance, several options were available in terms of the type of system which could be purchased, for example:

- 'tailor-made' (bespoke software) systems
- 'packaged' ('turnkey') programmes
- modified, general package solutions

To complicate matters further, the rapid advances in the technology meant that a choice of automation (in terms of the information processing capabilities) was available; a system could operate in one or more of the following modes:

- batch processing
- 'on-line'
- 'real-time'
- 'on-line/real-time'

The new technology was also accompanied by a new set of 'jargon' and the problems facing foundries attempting to select a system were rooted in understanding how the technology worked and what the computer could do, quite apart from the justified 'fear of change' [62], which the technology might bring.

The literature of the late 1970's/early 1980's [17,53,62,63] began to
address the 'need to know' aspect and emphasized the areas of foundry production control practice which should be investigated with a view to automation, listing among others:

- order acceptance and forward plant loading
- detailed plant scheduling encompassing the issue of 'work-to' lists for work-centres
- monitoring the progress of work and taking immediate decisions concerning modifications to schedules to react to variances from the planned course of action
- preparation of management reports

3.3.1.3 Micro-Computer-Based Systems

The underlying problem of providing a means for implementing computer-assistance (apart from a very basic level) in the small to medium-size range of foundries was not really overcome until the early 1980's (1981/1982). The turn of the decade saw the emergence of the micro-computer as a viable business tool, sufficiently powerful to process relatively large volumes of information, rapidly.

Thus, the potential to utilize the assistance provided by computers was now available to most sizes of foundry, but the problems of choosing an appropriate system still remained. The 'micro' had emerged, but it required its own applications software if it was to be of use.

The procedures for controlling production in the multi-level, b-o-m manufacturing industries were amongst the first to be analysed and 'improved' through the evolution of more formal techniques, such as
MRP and 'Manufacturing Resources Planning' (MRPII).

These techniques had proved practically impossible to maintain by manual methods, yet were readily adaptable to the type of logical processing power provided by the computer. However, their application to the foundry industry was questionable, due to the nature of the industry (reference section 2.) which in turn affected the suitability of the available software. Moreover, as one foundry practitioner stated [82]:

"Immediately you start talking about computers you are likely to be surrounded by very good specialists who will tie you up in knots."

Such an opinion was not felt in isolation [54,83,84] and thus it was evident that the further education of foundry staff in the 'new' technology and the further education of computer 'experts' in foundry practices (and other production control techniques), was required.

3.3.1.4 The Present Position

From 1981 onwards, entrepreneurial enterprises penetrated the foundry software market offering hardware/software and training in the use of both. Whilst the majority of companies (eg. software houses) subsequently favoured the more 'fashionable' sector of manufacturing, that is, the multi-level, b-o-m industries (high volume production/assembly to stock), a few kept their focus of development upon the foundry sector. Of these, a clear market leader has developed, with a claim of 120 systems in use at the time of writing.
In effect, packaged software, which would otherwise be provided on a 'one-off' basis costing thousands of pounds, became available for under ten thousand pounds (say £7,500), so that a system - hardware and software - could (and can) be purchased for an investment of around £10,000.

Packaged software represents only one of the available methods which could be used to implement CAPM into the foundry, which is taken from a list comprising:

- in-house systems
- bespoke systems
- mini-computer packages (both foundry specific and general CAPM)
- micro-computer packages (""
- mainframe links
- turnkey approaches
- database/code generators
- spread-sheet systems
- expert/rule-based systems

Of these, a 'packaged' version of an expert system (as developed for the medical profession) may prove to be of extreme interest in the next three to five years. The use of artificial intelligence and 'fuzzy logic' [85] to overcome the relative inflexibility of traditional logic, has enabled users to get more than a simple 'yes-no' answer.

Nevertheless, for the small to medium-sized foundry (especially the first-time user) the packages available for micro-computers are
currently the most cost effective - the more proficient of which, impose a few desirable codes of practice for organising production, rather than totally re-organising the existing procedures.

The following section reviews some of the techniques ('computerised procedures') which have been applied/suggested to foundries, via the use of computers and concludes with a brief look at the options which are available to the potential 'system buyer', within the context of the commercial packages currently available.

3.3.2 Applications and Options

What remains to be done?

The question aptly provides the aim for the following review, which surveys the applications and proposals that have been developed for computers in the foundry environment. The objective refers to the additional research which is required for the continuing development of 'general solutions' for small to medium-sized foundries. However, it is necessary first to investigate what has already been achieved.

3.3.2.1 Experience Pre-1972

Some of the first published articles (pre - 1970) to report on 'how they did it' were large, American 'tied-foundries', possessing their own data-processing departments and main-frame computer installations. Computer-assistance had been initially employed in the areas of process control (eg. furnace monitoring, spectrography, oxygen consumption),
power consumption monitoring, payroll, accounts, sales and estimating/costing.

Examples of such installations [44,65] reported on the use of computers for order processing, w-i-p monitoring, scrap analysis and scheduling. However the cost of developing such comprehensive systems was not stated, nor the time requirement or the problems encountered during implementation (which is also true for most of the articles reviewed).

Articles from 1970/71 [66,67] provided evidence of the two basic approaches which foundries had adopted in 'going-it-alone'. The choice of whether a system was to be 'decision-based' or, 'information-based' was determined by the amount of information which a foundry possessed on its operations (eg. accurate process times, yield allowances, machine performances, etc.) and which had been captured, manually, over a period of several years [60,67,70].

The use of the term 'decision' is perhaps unfortunate, since in practice, no system was capable of actual decision making. Instead, the stored information was processed via a pre-determined logic route to provide a 'solution', as opposed to simply presenting the information to the user, as with information-based systems.

Whichever type of approach was adopted, the foundries controlled their operations by the resulting 'reports', which were specifically written to suit the individual concern's requirements and biased towards a particular criterion. The Flynn and Emrich Corporation [66] preferred the orientation towards "dollar value", rather than that of "weight",
favoured by other installations.

By 1972, the success (or otherwise) of implementing a system was recognised as requiring the involvement of all relevant personnel [66, 68] and total commitment from the top management hierarchy. Such commitment was indeed required to overcome periods of disenchchantment, occurring as a result of lengthy implementation times.

For example, in the same year, a published review in the UK [68] reported that after nine-months development, a system was partially installed in a small (130 employees) foundry which was capable of producing four reports. An additional eighteen months work resulted in a more comprehensive system which was totally information-based. In spite of this, the report concluded that small foundries could justify the time and money spent on developing a computer-assisted system and added that

"... if foundries were to stay in business they are left with no option but to use the computer as a management tool."

A comparative report from the US, provided evidence [69] of how a small foundry (105 employees) had utilized the benefits of computer assistance. A more sophisticated system was in evidence, enabling the reformatting, analysis and reporting of information for the functions of order processing, work booking and report production.

Both the case-studies stated that the greatest benefit derived was in the area of customer relations, through the increased ability to quote (and meet) reliable delivery dates. Unfortunately, further quantitative comparison is not possible through the lack of published
cost and time information.

3.3.2.2 Subsequent Developments

The support for information-based systems for the ferrous sector in the UK [50,55] grew with the BCIRA/HSL collaboration which advocated for simplistic systems, in opposition to decision-making systems. The details of the system developed by the collaboration are not included here as the source material is unpublished work, as classified by the BCIRA.

The non-ferrous sector were also represented, as described by a report [77] in 1973, detailing a common production control framework and how computer-aided systems might improve on the "current" situation. Moreover, it was suggested [48] that the main areas of improvement lay in the production and dissemination of information for making decisions, during

"... such procedures as accepting orders, expediting orders, (and) meeting changing market demands ..."

The package developed by the EMFTC was similar in design to the BCIRA/HSL concept, being information-based through the provision of reports, but it had the advantage of operating in real-time on a mini-computer. The comprehensiveness of the package dictated the need for a complex set of procedures, which once mastered, provided the user with a satisfactory tool for computer-assisted production control in foundries.
The common theme was that whilst the information requirements of foundries were very similar, the criteria for taking decisions varied widely. This extremely valid point highlighted the need for 'flexibility' in the way selected items of information should be accessed and manipulated if a system was to be of general use.

In contrast, a paper published in the Foundry Trade Journal in 1974, of Swiss origin [60], provided evidence of the apparent difference of opinion (and development) between European foundries and their counterparts in the UK - see also [58,75]. The case-study emphasized the need to record processing times, transport times and storage times in order to schedule production operations. However, it was also stated that the cost of a system was a function of the volume of information which was available for processing.

In the same year, the first report of Working Group E2 [42] (see 3.3.1) suggested ways in which the computer could be used to assist management to control the foundry. With the high costs of development abundantly clear, 'low-risk' applications (eg. scrap reporting) were proposed as a useful introduction to computerisation, following the sequence outlined in a 'five-step plan'. No reference was made to the feasibility of creating generally applicable programmes, for use in a number of different types of foundry.

Essentially, individual foundries were still the prime initiators in the quest for CAPM, which required the participants to survey the hardware and software markets with extreme care. Such an approach was adopted by the Dudley Foundry Company [51] in 1977, whom were confident
of their existing manual procedures, but required computer-assistance to remove the tedium of administration and to improve the integrity of the information being processed.

The system was installed on a minicomputer and the programs were custom written for the foundry's use to cover the areas of order processing, forward loading, scrap analysis, plus limited reporting facilities. The problems of dual and triple responsibilities developed between the foundry, the hardware supplier and the software house and the advantages of single-sourcing were subsequently expressed. Following an initial investment of £25,000 (hardware) and seven months of programme development, the system went 'live' and ran with limited success for two years.

A second system was installed on different hardware (costing £70,000) with further bespoke software, and was claimed to fulfil most of the foundry's requirements. However, subsequent company closure led to the failure of the development of the system on a wider scale.

3.3.2.3 Trends Toward General Solution Systems

Thus far, the literature had revealed a wide, but limited variety of applications of computer-assistance to the foundry industry in the UK (also see 3.3.2.1). The attempts at a cohesive effort towards a general 'solution' suffered from the general (lack of) availability of hardware, the education 'gap' between foundries and computer suppliers and the problems of producing a package to satisfy the individual requirements of foundries from a common production control structure.
A similar situation was being experienced in the US. A summary of the utilization of computers [54] confirmed that the variety of systems implemented there reflected the diversity of the industry. Moreover, whilst it was acknowledged that:

"... similarities ... exist between a large-scale captive production foundry and a small, closely held, family-owned-and-operated facility, the problems of each must be addressed at different levels."

Accordingly, computer-assistance in the US was reported as being implemented at different levels, although the lengthy 'lead-times' for software generated by individual foundries (from 1 to 3.5 years) were stated as a warning to the unwary, since they opposed the prompt start of operations.

An equivalent review in 1979 by The British Foundryman detailed the findings of the re-constituted Working Group E2. The first part of the report [62] identified the following trends:

- the continuing reduction in size of companies which could effectively use computers had meant that foundries with a turnover of £0.5M derived benefit from computers costing £14,000, which provided comprehensive facilities for order processing, payroll and accounting
- there was an increased implementation of computer systems operating in 'real-time'
- the development of process control applications had been been hindered by the high costs
- The development of firms selling expertise in the use of
computers was increasing

The second part of the report [63] reviewed an application of the BCIRA/HSL product which had been implemented on a computer installation at a tied foundry, over a period of two years. The reported costs (both original and running) ensured that only the larger foundries were likely to derive benefit from computer-assistance, other than in the areas of financial administration.

In an attempt to 'bridge the gap' between foundrymen and computers, a series of articles [64,74,83,86,87], appeared in the journal of Modern Casting, describing: what the computer could do for a foundry, the decisions and planning required prior to 'computerization' and reports on how particular companies had 'done it'.

The call for more pressure to be placed on software houses was supported by a report [57] published in 'Foundry Management & Technology' (1982), proclaiming that manufacturing software must be capable of application to a variety of needs. The author stated that the development of hardware into a more reliable, less costly instrument had not been matched by equivalent developments in the field of software design, highlighting that the manufacturing-type software, currently available, had been designed for companies that typically purchased component parts.

The concern for applications covering the functions of production control was given impetus, ironically, as a result of the recession. The worst effects of the recession had left a much leaner industry and
the emphasis, for those foundries surviving, was on productivity and profitability. The efficiency of the production control system employed had the most direct effect on these measures and was identified as the area which was likely to gain most from the introduction of computers [1,17,53].

3.3.2.4 Current Concepts Of Computer-Based Systems

In a report on 'Whose foundry needs production control?' [17], the members of Working Group M62 of the Institute of British Foundrymen addressed the problem of the lack of analytical study afforded to the subjects of production planning and monitoring. The tentative conclusions suggested that production could be controlled via a computer used by foundrymen themselves, without the need for 'computer staff'.

The report also included a review of three case-studies, in different types of foundries, which indicated the developments occurring in hardware technology, but more importantly provided evidence that at least one 'packaged-system' had been developed for production control in foundries, on a micro-computer.

A more recent study [79], in 1984, of the use of computers for production control, advocated the use of real-time computer systems to provide more up-to-date information, for the functions of:

- Estimating and quotation preparation
- Maintenance of records of casting master data
- Order entry and acknowledgement printing
- Re-pricing to reflect changes in metal prices, labour and overhead cost movement
- Planning of work-loads for moulding and casting work centres
- Printing of operational documents such as moulding tickets and route-cards
- Recording of w-i-p movements as castings are processed
- Recording of despatches and advice note/invoice preparation
- Historical cost reporting
- Preparation of reports on production performance

The concluding remarks urged foundries to place sufficient emphasis on the specification and pre-planning stages to ensure that the most effective system was designed and successfully implemented. The use of generally applicable systems was considered unsuitable, since the engineering approach to package development 'did not reflect important aspects of foundry control', however, at least one apparently successful foundry software package had been omitted from the study.

Taking the literature as a whole, it was evident that the next phase in the development of micro-computer applications should be directed towards the functions of production planning, scheduling and monitoring, in order to assist in the making of better decisions, which in turn should contribute to increased profitability [242,243].

The controversial subject of scheduling is dealt with as a separate section, whilst the current section is completed with a brief look at the main production management packages which are available for micro-computers.
3.3.2.5 Packages

In addition to the 'packages' developed by the ECIRA/HSL and the BNFTC, at least one other foundry package had been developed for use on mini-computers by 1982. A small, non-ferrous foundry (35 employees) used a system for production control, payroll and accounts which was originally developed specifically for the company (Gascoignes Foundry) [88]. The system was subsequently modified and marketed under the title of 'FO.COM 42' at a cost of around £20,000, by a commercial software house (ADS). The package is no longer available.

By 1984, a second, more comprehensive system, had been advertised under the name of 'FORUM' by Management Information Services Ltd (an associate company of Foundry Management and Design Ltd.). The package had been developed over a four-year period and was expected to cost between £35,000 and £50,000, providing the facilities of order processing, production resource availability, master production scheduling, advanced scheduling and reporting, metal analysis, progress reporting and integrated stock control, together with payroll and financial systems.

The package provided satisfactory facilities for production control but not at a cost which induced many different types of foundries to 'take the plunge'. The industry required 'low-cost' competent packages if the introduction of CAPM was to be on a large scale.

Since 1980, the annual 'Which Computer?' production control surveys [25,89,90,91,92,93] have provided a concise (if not complete)
indication of the packaged software available for CAPM. The most recent survey [93] indicates that the packages which are capable of running production control on micro-computers are becoming more numerous although the field is reduced when applying the criterion of 'foundry'.

Nevertheless, the current vendors of production control software for micro-computers fall into one of two categories. Those whose packages address the light engineering industries, typified by multi-level b-o-m and large volume assembly (category 1.) and those whom address the component making industries, particularly foundries (category 2.).

Table 3.1, below, lists the main contenders in each category - the cost figure is included for reference only, since the modular design of each package enables them to be sold as a series of units, which are individually priced (see also Appendix 3.)

Table 3.1 Examples of Production Control Packages For Micro-Computers

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Product Name</th>
<th>Cost (£)</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category 1.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kewill Systems Plc</td>
<td>Micross</td>
<td>6500 +</td>
<td>250 +</td>
</tr>
<tr>
<td>Safe Computing</td>
<td>Micro-SaPeS</td>
<td>7000 +</td>
<td>80-100</td>
</tr>
<tr>
<td>Sheffield Micro</td>
<td>Planit/Uniplan</td>
<td>7000 +</td>
<td>80-100</td>
</tr>
<tr>
<td><strong>Category 2.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dewtec Computer Systems Ltd</td>
<td>Dewtec Multi-User</td>
<td>7500 +</td>
<td>120 +</td>
</tr>
<tr>
<td>Management Information Services PC-Forum</td>
<td></td>
<td>7500</td>
<td>5-10</td>
</tr>
<tr>
<td>Foundry Business Systems Ltd</td>
<td></td>
<td>7000 +</td>
<td>10-15</td>
</tr>
</tbody>
</table>
In addition, the ECIRA have recently released a micro-based system for Production Planning, at a cost to non-members of £300.00, which is a singular price for the claimed facilities. The author has not seen a review of this package to-date, but it is supplied as a program only, with no installation support.

At least four other micro-computer based packages for foundry production control have been reported in the US [64]. Again, no references to their use in the UK has been reported, to the author’s knowledge. However, the clear market leader is a package advertised by B & L Systems Inc., of Michigan, whom have 'down-sized' a system which formerly ran on their IBM-36 computer.

The main difference in the system design of the packages from the two categories, is the emphasis which is placed on the primary sub-systems comprising each type of package. Category 1. is concerned with the problem of large volumes of mainly dependent component parts, which is reflected in the commonly found modules (eg. b-o-m, stock control, trial kitting, MRP, purchase control).

The important aspects of the packages comprising category 2. (eg. capacity planning, detailed scheduling, monitoring w-i-p, performance analysis) are of secondary importance in the industries addressed by the packages grouped under category 1. For example, foundry production purchasing is basically limited to just a small range of raw materials and therefore, computer-based stock control of these few items does not carry the same importance as a module for performance analysis.
Moreover,

"... production consists mainly of single-item products so material requirements planning and multi-level assembly structures are irrelevant." [79]

In both cases, the primary sub-system requirements, which are of most importance to the application, forms the basis which most probably determines the sequence of implementation of the rest of the system [94]. For example, MRP depends on bills-of-material, stock recording, order processing and forecasting modules for its inputs. The amount of data processing required at this stage, however, is prohibitive to the majority of foundry applications and therefore, a much simpler materials requirement module is balanced by more comprehensive modules addressing different aspects of CAPM (eg. capacity requirements planning and performance analysis functions), in the packages grouped under category 2.

Whilst these general engineering packages are comprehensive/impressive in their own right, their basic unsuitability for foundry applications clearly dictates that first choice should be given to the packages which have been developed specifically for the industry.

Of the three packages listed, only the Dewtec system is currently advertised widely, whilst both Dewtec and MIS were in evidence at the recent "Foundry '86 International" show at the National Exhibition Centre, (September, Birmingham). The main features of the two packages are presented below.
PC-FORUM is to FORUM what Micro-SafeS was to SafeS, that is, an alternative system, capable of running on a micro-computer to address the requirements of "smaller companies", in this case, foundries. The package comprises five interactive modules, viz:

1. Foundry Management Package
2. Production Control
3. Financial Control
4. Payroll and Personnel
5. Stock Control

For the purposes of production control, a combination of modules 1 and 2 is claimed to provide the following facilities:-

- a database system + casting file and reports
- weight estimating
- cost estimating/re-costing
- quotation preparation/sales order processing
- despatching and advice notes
- invoicing
- scrap reporting and analysis
- works order creation
- forward loading/production scheduling
- production programmes/shop floor documentation
- production monitoring.

The Dewtec Multi-User system is comprised of a similar range of facilities, including:-

- a database for storing 'methodings' and order details
standard reports and report generator
weight estimating
cost estimating/re-costing
price/quotations and wordprocessing
works order processing and order acknowledgement
forward loading/production scheduling
preparation of production programmes
works documentation/quality assurance
statistical process control
production monitoring
advice note and invoice preparation
historical production/despatch records
payroll

No evidence is available to the author on any installations of the former package (although two installations of the original minicomputer version have been referenced [95]), whilst the latter system has been discussed on at least two occasions [17,26]. Both systems are reports-based and run on a variety of micro-computers (eg. IBM, Apricot, etc.)

3.3.3 Scheduling - Theory and Practice

The scheduling problem is extremely complex as demonstrated by some of the authoritative texts on the subject [96,97]. Therefore, it is necessary to move away from 'foundry specific' areas in order to give a broad picture of the possible solutions, before attempting to relate the theory of scheduling to the practical applications which have been reported in foundry (and other) journals.
It is proposed to demonstrate that no generally applicable package exists for the purposes of scheduling foundry operations and that the design of such a package involves a combination of techniques, which is strongly influenced by human rules.

So that it is clear what the author understands by scheduling, the general definition, provided by Baker [96], is re-iterated here.

"Scheduling is the allocation of resources over time to perform a collection of tasks"

Within the general definition, scheduling can also be applied to the tasks of planning what product is to be made, what resources will be used to make the product and on what scale, whilst the actual function of scheduling presumes that all the information relating to the task of planning, is known.

The literature reveals a wealth of research which has addressed the problem of scheduling the production of jobs, encompassing the whole manufacturing spectrum from pure-flow production environments through to pure job-shop manufacture, of which the following references are but a few [96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113]. The discrepancies between the idealised models studied by researchers and the complexities of the 'real-world' have led to a 'theory-practice' gap [114], the closing of which has traditionally been left to the practitioners in 'real world' environments.

Scheduling theory begins with a translation of decision-making goals into an explicit objective function and decision-making restrictions
into explicit constraints [96]. Frequently, a solution to a scheduling problem amounts to answering the questions of:

1. which resources will be allocated to each task
2. When will each task be performed

Therefore 'allocation' decisions and 'sequencing' decisions have to be made for a satisfactory schedule. In addition, if the set of tasks available for scheduling does not change over time, the system is termed static, in contrast to cases in which new tasks arise over time, where the system is termed dynamic. Static models have received the most research attention, but have proved to be of little practical value. Foundries provide good examples of the intractable dynamic models, where the arrival of jobs, though continuous, is intermittent - which has stimulated research into 'queuing theory'. The main scheduling techniques which have emerged are:

1. Network Methods
2. Mathematical Programming
3. Enumerative and Partially Enumerative Methods
4. Heuristic Rules and Simulation
5. Algorithmic Rules
6. Manual Methods

A combination of more than one technique is common and has been discussed in depth [96].

3.3.3.1 Network Methods

 Traditionally, network methods such as Critical Path Analysis (CPA) and
Programme Evaluation and Review Technique (PERT) have been regarded as tools for the planning and scheduling of large, non-repetitive jobs. Scheduling involves the expenditure of resources over a pre-defined set of 'activities' or operations, which are subject to certain logical constraints. The resources are expressed in units of time and the 'lines' of the network, which join up the activities, are proportional to the time consumed.

3.3.3.2 Mathematical Programming

The determination of an optimal schedule can be formulated as an integer programming problem, for example, by making use of linear programming to build a model which is capable of representing a multitude of constraints. Boolean-type operators are handled by the introduction of integer variables, usually 0 and 1. The inclusion of these variables, however, prevents the use of efficient Simplex linear programming codes which in turn reduces the 'realism' of the model. In a similar manner to CPA, linear inequality constraints may be used to prevent operations being performed until the previous operation in the specified sequence is complete.

3.3.3.3 Enumerative and Partially Enumerative Techniques

The effect of the 'combinatorial' problem on the number of possible ways of scheduling work over resources, is demonstrated below. Since it is not practically feasible to enumerate all the possible combinations, techniques have been devised for partial enumeration, aiming at optimal or, near optimal solutions [114].
The 'branch and bound' technique is an example of a partially enumerative technique, in which a tree-structure is generated. The nodes in the tree constitute the jobs and the branch connecting a group of nodes (which starts from the root of the tree) constitutes a unique schedule sequence. The 'bound' refers to the lower bound, for example, 'makespan time'. Thus, in the build-up of a schedule, at a given node in the schedule tree will be the opportunity to branch in one of a number of ways. The choice may be determined by always branching from the node with the lowest bound value (the 'travelling salesman' problem provides a good example for the application of this technique [112]).

3.3.3.4 Heuristic Rules and Simulation

The difficulties of scheduling dynamic situations, especially dynamic job-shops, by analytical means, has led to the use of simulation models. The output from a simulation is a set of statistics which describes the behaviour of the model over the simulated interval of operation. Detailed scheduling decisions are usually produced by applying 'rules of thumb', or dispatching/heuristic/priority rules, during the course of the simulation.

For example, the SPT rule (shortest processing time - priority is given to the waiting operation with the shortest imminent operation time) provides an example of a local priority rule, whilst FCFS - first come, first served and EDD - earliest due date - provide examples of global rules. Moreover the rules are termed either 'static' or 'dynamic', depending on whether the set of tasks available for scheduling changes with time.
3.3.5 Algorithmic Rules

Algorithms (literally step by step procedures) involve the arrangement of jobs in a matrix in such a way as to minimize a 'time-based' scheduling rule - the so-called 'dominant' property. The Algorithmic rule can take many guises and is usually a formal representation of one of the analytical techniques described. For example, the Ignall-Schrage algorithm [96] which describes the basic branch and bound procedure.

3.3.4 Manual Methods

3.3.4.1 The Use Of Gantt Charts

An example of a manual technique for scheduling is the widely known Gantt Chart. Similar charts are a common enough sight in foundries, where use is made of peg-boards, or plastic sheets (or even the four walls of a room) to graphically represent the timing of current job production. The Gantt chart also provides an example of a combination of two techniques, since in manipulating the chart, the scheduler is making decisions largely based on heuristic rules.

No simple graphic means exists to measure or describe the success of the practical application of scheduling in either the engineering sector or, the foundry sector. The researchers themselves have admitted that the pursuit of optimality remains intractable in all but the 'smallest of problems' [107] (eg. one machine with a variety of criteria). Moreover, it has been shown that as far as manufacturing
costs are concerned, there is at most only a difference of 0.5% between the best and the worst priority rules [115,116].

Attention is thus drawn back to foundries and the relevant literature, which provides written evidence of the techniques which have been employed.

The literature reveals that the approaches adopted by foundries have been the result of specific applications to inherent requirements, which have been implemented, mainly, on large computers. The problems of creating a general packaged 'solution' for use with micro-computers are based in the machine's capability to process volumes of information and the fact that foundries occupy several niches in the continuum of manufacturing.

Foundry scheduling has not always been conceived as problematical [117]. The approach adopted by Gillespie assumed that all timing information associated with operations would be known and a straightforward back-schedule from the customer's due date would determine when a job had to be started. This type of scheduling alone, however, tends to neglect the overall effect of the job on the rest of the foundry in terms of the capacity requirements and the 'flow' of jobs through the foundry. Moreover, the amount of manual computation involved is often prohibitive.

One of the first reported computer-assisted applications of scheduling involved the listing of 'sorted' information, to assist the Caterpillar Tractor Company (US 1969) [44]. The problem of scheduling up to 32
different castings on a moulding line at any one time - and there were
eight moulding lines - was pared down to relative simplicity through
the printing of a daily schedule by pattern set and castings within the
set. Thus, through the use of a set of sorted criteria (ie. types of
castings within pattern sets) a 'feasible solution' was obtained, which
was reported to provide a satisfactory, workable schedule.

The type of problem referenced above, in which the ordering of jobs
completely determines a schedule, is a specialised scheduling problem,
and more usually referred to as a sequencing problem. The difficulty
of producing 'the best' (or, optimal) solution to sequencing problems
is due to the 'combinatorial problem', which all schedulers face in
such circumstances and to which the literature has provided an apt
name, viz: the 'n jobs/m machines' problem (in the example above, the
'n jobs/m lines' problem).

In theory, the number of possible alternative schedules facing the
scheduler is give by \( (n!)^m \), and whilst in practice there are technical
and policy restraints which limit the number of alternatives (eg.
meeting due-dates) unfortunately, even the reduced set of feasible
schedules is often too large for complete enumeration.

Table 3.2, below, demonstrates the full magnitude of the problem using
a 'cut-down' version of the example quoted above (so that meaningful
numbers can be computed!) and which assumes that all jobs could be
processed down all the lines.
Table 3.2 Scheduling - the Combinatorial Problem

<table>
<thead>
<tr>
<th>'n' jobs</th>
<th>'m' machines</th>
<th>Alternative Schedules (\binom{n}{m})</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>1,625,700,000</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
<td>tens of billions</td>
</tr>
</tbody>
</table>

3.3.5 Applications of Computer-Based Simulation to the Scheduling Problem

The interest in foundry scheduling in the UK was underlined by a paper [52] presented at The Institute of British Foundrymen's annual conference in 1970, which examined the feasibility of a foundry's existing technical people, installing their own computerized scheduling and control systems. The author's opted to develop a sequential simulation model, based on the heuristic rules used by moulding department personnel for scheduling moulding production at a malleable iron foundry.

It was reported that a schedule for one particular grade of iron, established by the programmes governing the model, corresponded closely to that produced in practice. Unfortunately, no follow up reports have been found to detail the results of this promising early research.

Not only the UK foundry industry was involved with the possible application of computer technology to production scheduling. Swiss publications [58, 60] provided evidence that the subject was of
international interest and in the same year, a report [75] in the German journal 'Giesserei', described the scheduling of capacity in the foundry industry with the assistance of electronic data processing.

The method of scheduling was similar in concept to that described above. A 'simulation model' of the plant's characteristics was developed and subsequently governed by a set of priority rules to meet a defined objective function. For example, following a 'back-schedule' from the customer's due-date, if a job was obviously late, the programme attempted to 'split' the order over a series of machines, such that part of the order could be completed whilst (say) the moulding operation for the rest of the job was continued.

In conclusion, the report stated that applications of the programme were about to be implemented in foundries in Germany, although its initial application had been in a Finnish foundry (since German foundry concerns had considered the programme more useful to the engineering sector). Virtual elimination of late deliveries was claimed (after a 'running-in' period of twelve months). No cost information was divulged, whilst the prerequisite for adopting the system was the existence of valid production timing and capacity information.

Yet another example of employing a simulative technique was provided by the Sibley Machine and Foundry Corporation [67], whom had their foundry 'translated' into a mathematical model which utilised foundry data captured over a period of three years. Production schedules were received every five days, covering furnace loading and after-cast operation capacity loading, for a finite time period. To put their
achievement into perspective, an observer noted that:

"... few foundries keep sufficient records to assure efficient manual control, much less computerized scheduling."

Clearly, Sibley was one of the 'few', but the observation was supported by other authors [18,42] as being the general case.

In 1974, the Foundry Trade Journal published an article [60] describing the use of the PSK production scheduling system at the Oberwinterthur foundry in Switzerland. The system took 64 man-months to develop and was expected to take two years to implement. Characteristically, the system was based on a foundry model, governed by heuristic rules.

Back in the UK, the consensus of rather mixed opinions on the desirability of computer scheduling, forwarded by Working Group E2 [42], supported the use of simulation/heuristic techniques by generally agreeing that a system should be based on the

"... loading rules used by an experienced human scheduler..."

3.3.6 Applications of Other Theoretical Scheduling Techniques

Further stimulation on the subject of scheduling was provided by a report [21] which considered the problem of scheduling mould production. The report examined the feeding of a moulding line with cores and identified two extreme situations which were plagued by the combinatorial problem.
The technique of linear programming was employed to optimise the mould combinations, but a revised schedule was produced only once a month and foundry supervision had a 'free choice' on the sequencing of jobs, providing that the monthly demand was met.

Further case-studies from the US [70] and Italy [71] described the use of simulative techniques which were subject to various criteria, whilst one of the first (1978) workshop scheduling packages (SWORD) to appear in the UK, formed the basis of an interesting application involving the organisation of the production of malleable-iron chain links for stock/specific chain orders [49].

The package had been developed for the Department of Industry (DOI) and was designed primarily for the smaller engineering company in a batch/jobbing environment. The system was run via a bureau service (at Leeds) and after an eleven week implementation period began to provide scheduling information on a twice weekly basis. No clear indications of how the package functioned was given, but the claimed benefit was in the area of improving the flow of work through the foundry and chain-assembly shop.

The subject of job-shop scheduling (JSS) had received much attention in the literature [97,98,104,118,119], and in 1978, a direct application of JSS to foundries, using computer-assistance, formed part of a wider and more detailed study of foundry management control [112].

The study addressed the problems of scheduling in two distinct types of foundries - one representing jobbing/batch production in a small
foundry and the other, batch/long run production in a gravity die-casting concern.

The author devised a simulation model to describe the jobbing/batch production foundry and a mathematical algorithm (utilizing 0-1 integer programming) to describe the batch/long run production foundry. The results of the study were encouraging in the sense that the outputs from both models were shown to have financial benefits when compared to the figures which were actually obtained, using the normal procedures adopted by the participating foundries.

The simulation model was reported [112] not to be totally proven, however, due to a lack of accurate process data for the machine shop, whilst the number of alternative job choices for the production mix (linear programming) problem, precluded the determination of an optimum solution within a satisfactory span of computer processing time. A 'best' solution was therefore accepted, rather than the optimal, although the construction of a classification system, as a precursory activity, was proposed to assist in moving the problem toward a more optimal solution.

A follow up paper [13], summarized the results of the study and reported that the financial advantages were enhanced as a result of the successful transition from running the programmes on a mainframe computer to a 'low-cost' micro-computer.
3.3.7 The Integration of Manual and Computerised Systems

Thus far, the literature revealed that the complexity of scheduling foundry operations necessitated a simplification of the 'real-world' situation and in the first instance, it was considered that the priority rules should be applied to the scheduling of mould production, which for most concerns is the focal point of foundry operations [53,64]. The need for 'human interaction' with the 'suggested' schedules produced by the computer, was also stressed [64], so as to retain the flexibility which was (and is) available through the use of manual systems.

The scheduling of after-casting operations is not as clearly defined. A method which has been suggested [53] is that a list of jobs, ranked according to priorities (eg. due-date and customer) could be issued and subsequently expedited by shop supervision. Other work [120] stressed the potential for deliberately de-coupling pre-casting/casting and post-casting operations, and theorised on the use of 'buffer stock' as a 'de-coupling mechanism', in order to assist the development of 'good schedules' for both mould/cast operations and for post-casting operations.

Clearly, the emphasis on getting the computer to do 'everything' was not a policy advocated by most exponents of foundry scheduling and the use of a model (of whatever sophistication) which was governed by a set of rules was (and is) favoured by many authors and practitioners. The research into the theoretical side of scheduling still continues, but current literature suggests that the authors involved at a practical
level, are now equally concerned with the planning of capacity and the establishment of 'lead-times' [28,30,115,121,122,123,124].

The term 'lead-time' as used in the present context, describes the manufacturing lead-time experienced in intermittent production systems, although 'manufacturing throughput-time' would perhaps, provide the more clear definition.

The problem of production scheduling in foundries is often exacerbated by uncertainties and variations in the manufacturing lead-times. Tatsiopoulos and Kingsman [115] stated that in intermittent production systems, manufacturing lead-times are often very long, yet the actual job processing times are usually quite small. They identified the 'move' or transit time between operations as the dominating factor governing manufacturing lead-times, as witnessed by the speed with which 'rush' orders can be expedited through a system.

They further identified the method of capacity planning and the backlog of work in the shop as important parameters which affected manufacturing lead-times and hence the production of schedules.

Capacity planning has already received a great deal of attention [30, 124,125,126,127] and currently adopts one of the three proven approaches identified by Goddard [127], viz:

- resource requirements planning (RRP)
- rough cut capacity planning (RCCP)
- capacity requirements planning (CRP)
Each technique involves a time-phased prediction of the resources required but differs from the others in terms of who uses them and the amount of detail which is produced.

The two methods of loading each technique have been the subject of much debate, that is, whether to load the resource to infinite or, its finite capacity - such that at no point in the resultant schedule is the maximum stated capacity of any resource ever exceeded [96].

In summary, the problems of scheduling foundries have stemmed from a combination of balancing fluctuating loads with fluctuating capacities, a lack of accurate information and conflicting criteria from which to formulate an objective function.

3.3.8 Formulation of a Workable Scheduling Routine

Published foundry reports have provided evidence of the individual attempts by foundries to utilize the computer for production scheduling. Many of the systems involved the preparation of production schedules which were subsequently distributed on a weekly or, even monthly basis. Yet, their achievement depended on the completion of schedules from the previous period and the day-to-day events occurring on the shop-floor. Therefore, the schedules proved [129] to be unnatainable and had little in common with what was actually manufactured during the period.

The literature has not provided any real evidence of a generally
applicable methodology for foundry scheduling on micro-computers and it is proposed that capacity planning and careful lead-time management, together with the application of heuristic rules to a simulated foundry 'model' (however superficial) will provide the means for addressing the two areas comprising the scheduling problem. That is, the making of allocation and sequencing decisions. In addition, the feedback of accurate production information, on a real-time/daily basis is considered an essential function to the development and execution of satisfactory production schedules.

3.3.9 CAPM - An Overall Picture

The implementation of CAPM into manufacturing in general has been the subject of numerous studies since the early 1970's [130]. At least twelve studies undertaken over the last ten years have been grouped [131] into:

- Large-Scale Surveys - [132]
- In-Depth Studies - [76,129]
- Diagnostic Studies - [131]

The methods of implementation have been discussed widely [22,33,133,134,135], yet the evidence provided by the literature is often pessimistic, pointing to a large gap between the success and failure rates of companies implementing CAPM systems [33,136,137]. Indeed, research at UMIST in 1984 [33] revealed that 80% of companies surveyed were dissatisfied with their choice of system.
The most recent (1986) report on the 'state of the art' in CAPM applications has been compiled by researchers from the Science and Engineering Research Council (SERC) [76]. An in-depth study involving 33 manufacturing sites yielded an overall impression that the implementation of CAPM in the UK was "woefully unscientific", with users not making full use of the facilities provided by CAPM packages.

Within the context of system design, the findings of the report suggest that users will clearly benefit from functionally simple packages which are capable of easy integration. In addition, a programme of further research is currently being evaluated to address the problems which are preventing users from perceiving their problems clearly.

Until the time comes when potential users understand completely their requirements and the software manufacturers have produced packages which can be quickly tailored to meet these requirements, the 'bon mot' provided by the concluding remarks of a report by Working Group E2 [42] still holds true, viz:

"... for the less experienced - and that means the majority - the motto must be to 'make haste slowly'."
CHAPTER 4
4. An Approach to CAPM in Foundries

4.1 Introduction

The present section addresses the question of:

"What information is required for the organisation of manufacturing in foundries and how may it be expressed and manipulated within the constraints which govern foundry practice, in order to meet corporate objectives?"

The study of these requirements has led to the development of a philosophy for the application of CAPM in foundries, which is presented here within the context of current micro-computer technology.

4.2 An Overview

The overall picture which emerges from the literature review (supported by the author's discussions with foundry personnel) suggests that the successful implementation of CAPM in foundries depends on three factors:

1. The ability (of a system) to 'mechanise' the inherent production control functions required by foundries.
2. The facility to provide several 'levels of sophistication' in terms of the functions offered for production control, whilst maintaining a simplistic appearance.
3. The ability and willingness of employees to adapt to new procedures and revised documentation.
The underlying conditions which influenced the proposals developed in the current study reflect the constraints which govern a foundry's choice of system and take into account the evidence provided by the literature review.

In practice, the implementation of a CAPM system is limited by cost considerations which usually stipulate that a system must be capable of use by existing foundry personnel, albeit with some training, and that the total cost of a system (hardware, software, installation, customization, training and maintenance) should not exceed a given (often very limited) budget.

Moreover, the literature survey implied the need for 'versatility' of system design, with the emphasis on 'suggestive/informative' systems, over 'decision-based' systems. Two factors could be identified in support of information-based systems:

Firstly, theoretical and practical research has indicated the complex problems of attempting to pass control of foundry operations over to executive control by the computer.

Secondly, for the system to make 'good' decisions, all pertinent data would have to be available to the system. This factor alone, would impose an intolerable degree of rigidity in any system designed for CAPM in foundries and the work involved in collection/maintenance of information would render the timely making of decisions, impossible.

At the present time, the only feasible course of action for
many foundries who propose to implement a system, is to purchase a foundry-specific software-package 'solution', which in general, exploits the features which have proved to be common to many types of foundry organisation. The investment required for such a system is relatively small (since development costs have normally been spread over a number of users) provided that micro-computer applications are sought after.

The following sections describe the types of information which are integral to CAFM, prior to a presentation of proposals for the 'paperless' organisation of manufacturing. The proposals are directed towards the functions of production planning, scheduling and monitoring, as opposed to dwelling on the design of a suitable information retrieval/storage system (database), which has been the subject of detailed development work by many systems and software-houses; eg:

- 'Informix' - Sphinx Limited
- 'Retrieve' - Sage Business Software
- 'dBase II' and dBase 'III' - Ashton Tate
- 'Paradox' - Ansa
- 'Q & A' - Paradigm
- 'Delta 4' - Compsoft
- 'DATABASE' - Sapphire Systems Ltd
- 'Omnis 3' - Elyth Software Ltd

These are just a few of the database management packages currently available. In addition, most software applications-packages
incorporate their own database management system which has been specifically designed for the intended application.

4.3 Types of information

The information which is being processed continuously by foundries can be organised into basic groups. Further study reveals how one type of information interacts with another and a system for managing and manipulating the information for the purposes of production control, begins to emerge.

Table 4.1, below, identifies the major categories of information which can be associated with the function of production control in foundries.

Table 4.1 Types of foundry information

<table>
<thead>
<tr>
<th>Information Type</th>
<th>Relative-Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Casting/Methoding</td>
<td>Mainly Static (Revisions)</td>
</tr>
<tr>
<td>Customer Schedules/Orders</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Work Booking/Scrap/Despatch</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Foundry Resources</td>
<td>Static and Dynamic</td>
</tr>
<tr>
<td>Routing/Process Layout</td>
<td>Mainly Static</td>
</tr>
<tr>
<td>Production Archives</td>
<td>Static Transactions</td>
</tr>
<tr>
<td>Customer Details</td>
<td>Mainly Static</td>
</tr>
</tbody>
</table>

The table is incomplete in the sense that the information required for a total CAPM approach for foundries (eg. job-costing information) has been excluded, but it is considered sufficiently complete for the
purposes of organising and controlling the manufacture of jobs.

A further 'property' may be attributed to the data-types in Table 4.1 which reflects the amount of maintenance a particular category of data requires, once it has been created. It is an important property and one that a foundry should consider carefully. For example, are there time and clerical resources available to keep a system up-to-date, once it has been set-up? Will there be sufficient keyboard time? The single-user/multi-user micro-computer environments allow a great deal of flexibility over these matters and a CAPM system should be capable of being 'upgraded' from single-user to multi-user, if required at a later date.

4.3.1 Basic Casting/Methoding Information

Examples of elements of information comprising this category are expressed in summary form, below (see Table 4.2):

Table 4.2 Basic Casting Information

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Element Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern/Part/Die Number</td>
<td>Description</td>
</tr>
<tr>
<td>Customer Account Number</td>
<td>Customer Name</td>
</tr>
<tr>
<td>Base Metal Grade</td>
<td>Metal Grade Specification</td>
</tr>
<tr>
<td>Gross (or Poured) Weight</td>
<td>Cast &amp;/or Felled Weight</td>
</tr>
<tr>
<td>Castings per Box/Impressions per Die</td>
<td>Moulding-Box/Die Spec.</td>
</tr>
<tr>
<td>Pattern/Die Details</td>
<td>Drawing Number</td>
</tr>
<tr>
<td>Typical Batch Production Size</td>
<td>Manuf'g Thro'put Time</td>
</tr>
<tr>
<td>Core Requirements</td>
<td>Production Scrap %</td>
</tr>
<tr>
<td>Sales Price</td>
<td>Cost</td>
</tr>
<tr>
<td>Product Group Category Codes</td>
<td>Free Form Notes</td>
</tr>
<tr>
<td>Free Stock</td>
<td>Job/Pattern Status</td>
</tr>
</tbody>
</table>
In addition to the information in Table 4.2, the details on each work-in-progress 'monitoring' point, where components are counted after processing, should be closely related to the basic casting data, and would normally be described in terms of the following:

- Process Stage Number & Description
- Section/Workstation
- Actual Time
- Standard/Estimated Time

The monitoring points are 'selected operations' taken from a more complete list of operations normally defined as a route-card or process layout.

4.3.2 Customer Orders/Schedules

Unlike the basic casting information, the information relating to customer orders/schedules can be termed 'dynamic' because of the frequency of modifications which have to be made to the schedules/orders, involving changes to quantities, call-offs, specifications and delivery patterns.

The elements of information comprise those which are required to raise an order (in addition to those provided by the basic casting details) and those which refer to the subsequent production of the job. Table 4.3, below, identifies examples from both groups of information.

The left-hand side of Table 4.3 describes the additional information which is required to raise a new customer order/schedule, whilst the
right-hand side represents the breakdown of work-in-progress, together with planning and summary information relating to the production activities surrounding job manufacture.

Table 4.3 Schedule/Order Information Elements

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Element Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundry/Works Internal Reference</td>
<td>Production Planning Dates</td>
</tr>
<tr>
<td>Part/Pattern/Die Number</td>
<td>Work-in-Progress Quantities</td>
</tr>
<tr>
<td>Order/Schedule Received/Entry Date</td>
<td>Total Cast</td>
</tr>
<tr>
<td>Order/Schedule Required Date(s)</td>
<td>Total Despatched</td>
</tr>
<tr>
<td>Customer Order Reference</td>
<td>Total Scrapped</td>
</tr>
<tr>
<td>Order/Schedule Quantity</td>
<td>Total Returns</td>
</tr>
<tr>
<td>Type of Order</td>
<td>Total Rectified</td>
</tr>
</tbody>
</table>

4.3.3 Work Booking (Work-in-Progress) Information

The return slips (eg. heat-sheets, time-sheets) which are passed back from the shop-floor, vary in format and content from one foundry to another, and provide a number of departments with work-bookings information. For the purposes of updating the records held by the production control department, the information typically required, is summarised by Table 4.4, overleaf.

The information listed in the table contributes to the requirements for maintaining a further set of records, the 'production archives', which are discussed, below.
Table 4.4  Shop-floor Monitoring/Work Booking Information Elements

<table>
<thead>
<tr>
<th>Element Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundry/Works Internal Reference or, Part/Pattern/Die Number</td>
</tr>
<tr>
<td>Heat Number and/or Cast Code</td>
</tr>
<tr>
<td>Employee Clock Number and Shift</td>
</tr>
<tr>
<td>Actual Production Time</td>
</tr>
<tr>
<td>Booking/Monitoring Date</td>
</tr>
<tr>
<td>Production/Inspection/Despatch/Scrapped Quantity</td>
</tr>
<tr>
<td>Section, Work Station/Centre</td>
</tr>
<tr>
<td>Despatch Advice Note Number</td>
</tr>
<tr>
<td>Reasons For Scrap</td>
</tr>
</tbody>
</table>

4.3.4 Foundry Resource Information

Resource information comprises 'static' elements and 'dynamic' elements which relate to the capacity loading for that resource over a given time period (or 'planning horizon'). Table 4.5 lists examples of the static elements.

Table 4.5  Foundry Resource Information - Static Elements

<table>
<thead>
<tr>
<th>Element Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section, Work Station/Centre</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Cost Centre Number</td>
</tr>
<tr>
<td>Standard and Current Labour Rates/Std.Time Unit</td>
</tr>
<tr>
<td>Scrap Rate</td>
</tr>
<tr>
<td>Alternative Resource(s)</td>
</tr>
<tr>
<td>Move Time &amp; Units</td>
</tr>
<tr>
<td>Set-up Time &amp; Units and Process Time &amp; Units</td>
</tr>
<tr>
<td>Resource Units and Capacity Values</td>
</tr>
<tr>
<td>Etc.</td>
</tr>
</tbody>
</table>
The section/work centre does not refer solely to mechanised resources, eg. 'human capacity' constraints can be considered as a resource.

Elements which can be termed 'dynamic' relate to the actual 'loading' of that resource and consist of quantity and timing information (eg. production dates). These elements should be 'updated' as jobs progress through the resource.

4.3.5 Routing Information

As foundries in Britain strive to meet the requirements of BS 5750, the quality control procedures involved will demand more exacting details on the processes required for component production (equivalent pressures are seen to exist also in other countries with the proliferation of legislation covering product liability). Such information is normally held as part of a route-card or process layout document. The minimum amount of information which needs to be held for each distinct operation or instruction, is as follows:-

- Operation Number
- Set-up Time
- Operation Description, or
- Section, Workstation/Centre
- Run Time
- Quality Control Instruction

In addition, a 'move' time may also be held, together with notes detailing special requirements; eg. 'non-conforming' items.

4.3.6 Production Archives ('Historical' Information)

In providing full 'traceability', ie. a permanent record of the
'events' describing the production of a component, the types of information required are 'derived', rather than manually created.

Table 4.6, below, lists examples of the types of information which can be associated with this category (the abbreviation 'P.T.D.' stands for period-to-date).

Table 4.6  Archived Transaction Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part/Pattern/Die Number</td>
<td>Cumulative Made</td>
</tr>
<tr>
<td>Foundry Internal Reference</td>
<td>P.T.D. Made</td>
</tr>
<tr>
<td>Production/Inspection/Despatch Quantity</td>
<td>Cumulative Despatched</td>
</tr>
<tr>
<td>Advice Note/Heat Number</td>
<td>P.T.D. Despatched</td>
</tr>
<tr>
<td>Customer</td>
<td>Cumulative Scrapped</td>
</tr>
<tr>
<td>Customer Order Reference</td>
<td>P.T.D. Scrapped</td>
</tr>
<tr>
<td>Transaction Date</td>
<td>Cumulative Returned</td>
</tr>
<tr>
<td>Shipment Value</td>
<td>P.T.D. Returned</td>
</tr>
<tr>
<td>Production Section/Stage</td>
<td>Cumulative Rectified</td>
</tr>
<tr>
<td>Employee Clock Code</td>
<td>P.T.D. Rectification</td>
</tr>
<tr>
<td>Weight of Material</td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td></td>
</tr>
<tr>
<td>Required Delivery Date by Customer</td>
<td></td>
</tr>
<tr>
<td>Scrap Reasons</td>
<td></td>
</tr>
</tbody>
</table>

4.3.7  Customer Details

Most of the static information associated with customer's details is of little value to the functions of production planning, scheduling and control, but the peripheral activities of raising documentation (eg. customer order acknowledgements, advice note production and invoicing) provide for a more complete order processing system.
4.4 Foundations for a CAPM System

Each of the information categories defined in Table 4.1 can be regarded as a 'database' (or as belonging to a database), which collectively form the foundations of a CAPM system. A database is defined here as a group of information which can be manipulated by a set of utilities. It is assumed that a system would possess the maintenance facilities to create, amend, delete, enquire and duplicate 'records' of information.

The level of control which can be achieved is a function of: the number of databases which are being maintained; how 'complete' the databases are, in terms of the information held within them; the integrity of the information and the system's ability to process and present the information in a form which is readily understood by foundry personnel whilst reflecting sound production control practices.

Database definition, however, is just one aspect of a series of 'set-up' procedures which a system should support through the provision of 'parameter-driven' software. Such a facility enables the terminology currently used by a foundry to be incorporated into a system and the definition of the number of elements of information which are to be maintained by each database. Most of the set-up details should be 'transparent' to the user, being implemented at the users request during system initialisation.

An initialisation procedure which is of more direct relevance to the functions of production planning, scheduling and control, is the definition of a 'production calendar' within the system. The utility
should provide the user with the ability to designate calendar days as 'non-working days' (for example, works 'shutdown', weekends, public bank holidays). Moreover, it should be possible to define 'non-working days' to cover more than a one-year period (taking into account leap-years!) - thus enabling a contribution towards long-term forward planning practices. The full use of the calendar is investigated during the sections dealing with production planning and scheduling.

4.5 Proposals For Foundry CAPM

The preceding sections have presented the types of information which are required for foundry production planning, scheduling and control and have briefly described a mechanism for maintaining the information. The problem of manipulating the information toward an effective CAPM solution is addressed by the following proposals.

The structure of a CAPM system should reflect the sequence of tasks which are required for production planning, scheduling and control. Thus, following the creation of the databases described, a system should guide the user through the primary activities of:

- order processing/order book maintenance
- production planning
- capacity loading and scheduling
- the raising of production programmes/works documentation
- work bookings

The additional tasks of:
creating management reports

production performance analysis (e.g. scrap analysis, delivery performance, variance analysis of estimated versus actual cost)

breakdown of job production by employee

etc.

... should be provided and maintained automatically by a system, from the information afforded by the primary activities.

Each of the activities is discussed below. Where relevant, sections are included (e.g. 4.5.1) which describe how one set of information interacts with another, stipulating the conditions which should prevail prior to certain types of action.

4.5.1 Methoding Maintenance

Following the installation of a CAPM system, one of the first tasks required of the production control department involves the entry of basic casting details (for each pattern/die record) into the system so that the 'computerized records' would have as much information (usually more, in one collective area) as the existing manual system.

The pattern/die code should be unique for each job and prior to accepting further details, a system should check to ensure that the pattern/die code had not previously been entered. Care should be taken over the 'construction' of the pattern/die number. For many concerns, the numbers used by the existing manual system can be transferred to the computerized records; however, an opportunity is
presented for the classification of patterns/dies, should a company wish to pursue this course of action. Once they have been identified to the system, the pattern/die records should act as the 'trigger' for most of the other CAPM related functions.

The removal of records from the system should be possible either manually, or by automatic means. The latter case would require certain criteria to be met prior to the deletion of records; eg. a comparison between the current calendar date and a 'last used' date. Furthermore, in both cases, up to three validation checks should be made by the system, before initiating the deletion procedure, viz:-

1. a check to see if any orders, in the current order book, were for the specified pattern/die
2. a check to see if any routing information had been created for the pattern/die
3. a check to see if any 'production archive' details were related to the pattern/die

If one, or more, of the checks failed, the system should advise the user to remove the necessary records from the appropriate sources first, before trying to delete the pattern/die record.

It should be possible to link into five other databases from a given pattern/die record using the 'key' elements, already entered, as links to the respective modules, for example (Table 4.7):
Table 4.7  Key Elements for Information Interaction

<table>
<thead>
<tr>
<th>'Key' Element</th>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>customer name</td>
<td>--&gt; customer base</td>
</tr>
<tr>
<td>customer number</td>
<td>--&gt; accounts/ledgers*</td>
</tr>
<tr>
<td>material code</td>
<td>--&gt; raw material stock records*</td>
</tr>
<tr>
<td>pattern/die number</td>
<td>--&gt; routing file</td>
</tr>
<tr>
<td>process/monitoring section</td>
<td>--&gt; resource file</td>
</tr>
</tbody>
</table>

* Assuming that these functions were part of a system.

4.5.2 Route-Card Maintenance

It should not be possible to create a route-card if the relevant pattern/die card has not been created first.

In addition to defining the operations which constitute the route-card, the system should enable the separate definition of the sequence in which operations are to be carried out, enabling a foundry to exploit any flexibility it may have in its manufacturing resources. By default, the standard routing should be assumed by the system unless the alternative sequence had been defined.

Assuming that it was possible to define the particular operations which were also monitoring points, any changes in the normal routing of a job would then also reflect in the sequence of monitoring points for that job. Moreover, the 'cyclical' processing of jobs could be catered for.
4.5.3 Resource Maintenance

For every resource in the foundry there is a corresponding 'resource capacity', measured in a set of units which ultimately can be related to time.

The resource loading information should also be expressed as a function of a time-base, i.e. as indicated by the resource units (for example 'weekly'). The information would normally be updated automatically from work bookings and the activities surrounding customer orders/schedules maintenance (eg. call-off amendment).

Such a facility would provide a 'real-time' enquiry facility on at least the 'key' resource centres of a foundry together with a potentially powerful tool for planning the flow of work throughout these (usually identified as 'bottleneck' resources) and other resources.

4.5.4 Orders/Schedules Maintenance

The same restriction should apply to the orders/schedules database as imposed on the route-card database. That is, it should not be possible to enter orders/schedules without prior reference to an existing pattern/die record. In practical terms, the restriction renders the raising of an order for which there is no methoding, impossible.

However, three advantages would be derived from the proposed 'restriction'. Firstly, a minimum amount of information would have to be entered into the system, facilitating the 'batch input' of new
orders/schedules, consisting of the:

- pattern/die number
- customer order reference
- the 'type' of order and the internal reference
- order/schedule/call-off quantity
- required/due date
- order/schedule/call-off entry date

Secondly, by referencing the pattern/die details (which would be created and stored once only) any duplication of effort is avoided and therefore the risk of clerical errors being introduced is greatly reduced. Moreover, the minimum amount of media storage is utilized for 'filing away' the customer requirements.

Thirdly, at the time of raising an order, the system should present other 'parameters' for consideration by the user. That is, whether:

- a scrap percentage, based on the expected yield, should be incorporated into the order quantity/call-off
- the number of impressions/die, or number of moulds/box (or plate) should be taken into account
- finished components which had not been allocated to a particular order, should be used

The facility to print off 'customer order acknowledgements' (and revised schedules) should be an integral part of an order processing module, but on a batch basis, so that the user can incorporate any special comments (eg. pattern of delivery) prior to printing.
For the majority of foundries there exists a close relationship between the components progressing through the foundry and the customer orders to which they are being manufactured. The relationship may not be so apparent on the shop-floor, but one aspect of the production controller's job is to know how a job is progressing, especially when a customer enquiry is telephoned through.

The w-i-p and summary information (eg. total moulded) can be stored as either a separate database or as part of the individual customer's order/schedule record. It does not really matter to the foundry which method is adopted by a system, providing the utilities are available to organise the information accordingly; for example, the provision of utilities for the purposes of re-allocating/re-scheduling work-in-progress.

4.5.5 Production Planning and Scheduling

One of the chief aims of a foundry planning and scheduling system should be to engineer a change from 'heap scheduling' [22] or, 'management by crisis', towards a system which organises the manufacture of jobs in such a way as to:

- increase the performance of on-time deliveries
- decrease work-in-progress inventory levels
- increase productivity by improving the balance between resources and orders/schedules

Such a system can be achieved without computers, but computer-
assistance greatly enhances the 'tools' which are available to the planner/scheduler to organise work loads [139].

The literature review provided evidence of the essential tools for foundry planning and scheduling, viz: lead-time (manufacturing throughput-time) management, capacity planning and the application of 'rules' to a model of foundry production management procedures. A planning and scheduling 'model' can be described as consisting of:

- establishing minimum lead-times for each product
- profiling the order book: identifying 'overdues', current work and future or, 'forward' requirements
- planning production capacity by time period
- creating production programmes
- Analysing performance: eg. delivery performance

In the absence of a firm master production schedule, foundries require a schedule of jobs from which to draw a fixed (short-term) programme of work, even though the schedule will be subject to amendments on a continuous basis. Provided that the information stored by a CAPM system is kept up-to-date, the computer can be directed to provide such a schedule, as frequently as required by the production planners and/or schedulers, based on the results provided by 'modelling' the current foundry situation.

4.5.5.1 Minimum Lead-Time

Ideally, the run-times, set-up times and move-times would have been defined for all the processes involved in the manufacture of a
particular job. Then, using the customer’s required delivery date and/or the 'current date', a backward or, forward scheduling procedure would determine the 'earliest start-date', 'latest start-date', 'earliest finish-date', 'latest finish-date', etc.

Unfortunately, few foundries store the amount of timing information required for such detailed analysis. Furthermore, for those foundries with fast throughput times (eg. days rather than weeks) a system has to respond quickly to limited information in order that the most timely and useful information is made available for organising the manufacture of jobs.

However, foundries tend to 'know' or, are able to estimate, typical batch processing times for jobs, which comprise of, for example (assuming no 'move' time, i.e. waiting in a backlog of orders):

- pattern shop \( p \) days
- coremaking \( c \) days
- mould making/casting \( m \) days
- fetting \( f \) days

\[ \text{total} = p + c + m + f \text{ days} \]

Therefore, the minimum lead-time, or the shortest possible 'promise-date' would be the 'total' number of days from the time a firm order was received.

A 'typical lead-time' can be associated with every job - as one of the elements of the basic casting details - and used each time an order for
that job is placed on the foundry. A CAPM system should be designed to cater for this function, whilst providing a more sophisticated approach, i.e. a 'factored' lead-time which can accommodate differing order quantities for the same job.

In addition to establishing lead-times, there are other constraints which have to be considered simultaneously, before taking the decision to order a job on the foundry; e.g. those areas of the foundry which are known to govern the flow of work through the foundry, i.e. the so-called 'bottleneck' sections. Moreover, the impact of new jobs onto foundry resources should not be considered in isolation, yet only the overall production picture which is presented by an evaluation of the order book (firm orders) provides much of the information required for production planning.

4.5.5.2 Order-Book Profile

For many foundries, computer-assistance provides the only method for evaluating the order-book in its entirety and a CAPM system should be designed to provide several methods of obtaining an overall production picture, taking into account:

- who is using the system (and therefore, what the user wishes to receive from the system)
- the level of sophistication which a foundry is prepared to accept and/or is practically capable of.

For production management, a summary 'backlog profile' or, delivery schedule, would describe the quantity of undelivered orders by time
period, beginning in the current time period and extending into the future over a practical time-span ('delivery horizon'). Clearly, the delivery schedule would be subject to continual change as new orders were received and old orders were delivered. The CAPM system should be called on to re-evaluate the order book by sorting the 'balance-to-deliver' quantities into the time periods covered by the delivery horizon (eg. weekly 'time buckets'). The number of orders which were 'past due' (ie. 'late') should also be signified, acting as a 'red flag' to the production manager that a situation required attention.

The delivery profile report can be taken a stage further to provide a second summary order-book profile report, which begins to show the effect of product lead-times on the required-dates promised. For each order, the system would subtract an appropriate lead-time from the customer required delivery-date, to arrive at a 'suggested production date' for the order.

Jobs would be designated as 'overdue' if the calculation produced a suggested production date which lay in the 'past in terms of the current time period). A further refinement to the calculation would take into account any days which had been defined as 'non-working days' to the production calendar (eg. by adding one day to the suggested-date and re-testing the suitability of that date. If the revised date proved unsuitable, the 'loop' would be repeated until the first 'working-date' was found).

Thus, the production manager would be provided with a schedule, sorted (eg.) by customer and pattern/die number, showing the 'balance-to-make'
quantities and suggested start-dates for the production of jobs.

So far, the 'profiles' described have not taken into account any capacity requirements, yet the 'suggested production' schedule would attempt to predict the load on the foundry (to infinite capacity) for each time-period, thus providing the production manager with a summary rough-cut capacity plan which can reflect the product mix. However, to plan within capacity and to create meaningful short-term schedules, the planner requires more information about each order which should be presented in such a way as to enable ease of interpretation and manipulation.

4.5.5.3 Planning Production with Capacity Constraints

Foundry planners would require a breakdown of the suggested production schedule, in a format which reflected the criteria normally used for scheduling jobs. Therefore, the system should enable the planner to select the contents of a 'planning report', incorporating the elements of information stored in basic casting and order-book 'files'.

Further versatility should be provided by a system to enable a planner to define a specific 'planning horizon'. Moreover, it should also be possible to specify the order in which the information should be presented (the 'sort' sequence), for example:

- by 'suggested-date' and process section
- by process section and 'suggested-date'
- by material grade and 'suggested-date'
- etc.
In the first instance, a planning 'report' should be displayed on the computer screen - see figure 4.1, below.

**Figure 4.1 An Example of a Production Plan**

<table>
<thead>
<tr>
<th>Seq.</th>
<th>Internal Ref.</th>
<th>Pattern /Die No.</th>
<th>Process Section</th>
<th>Material Grade</th>
<th>Mould /Die</th>
<th>No. of Req'd Shots</th>
<th>Date</th>
<th>Date</th>
<th>E/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>xxxxxxx</td>
<td>xxxxxxx</td>
<td>xxxxx</td>
<td>xxxx</td>
<td>xx</td>
<td>x</td>
<td></td>
<td></td>
<td>E</td>
</tr>
<tr>
<td>2</td>
<td>xxxxxxx</td>
<td>xxxxxxx</td>
<td>xxxxx</td>
<td>xxxx</td>
<td>xx</td>
<td>x</td>
<td></td>
<td></td>
<td>E</td>
</tr>
<tr>
<td>3</td>
<td>xxxxxx</td>
<td>xxxxxxx</td>
<td>xxxxx</td>
<td>xxxx</td>
<td>xx</td>
<td>xx</td>
<td></td>
<td></td>
<td>C</td>
</tr>
</tbody>
</table>

Sub-Total -> xxx

<table>
<thead>
<tr>
<th>Seq</th>
<th>Pattern /Die No.</th>
<th>Process Section</th>
<th>Material Grade</th>
<th>Mould /Die</th>
<th>No. of Req'd Shots</th>
<th>Date</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>xxx</td>
<td>xxxxxxx</td>
<td>xxxx</td>
<td>xx</td>
<td>xx</td>
<td>xxxx</td>
<td>xxxx</td>
</tr>
</tbody>
</table>

A planner would therefore be presented with a list of jobs, sorted (say) by resource section and 'suggested-date', sub-totalling on change of week - the suggested start-of-production-date should be calculated as described above, incorporating the production calendar.

The 'E/C' option would enable a planner to 'confirm' the suggested date, or, to 'enter' one of a planners own choosing, eg. based on the simultaneous consideration of the potential loading on the process section, the numbers and type of mould/die required and by utilizing his/her own knowledge in conjunction with the customer's required delivery date. If a planner chose to enter a date, the system would check the entry against the production calendar, before acceptance.
The sequence number ('Seq No.') should be provided, enabling a planner to 'batch' a number of jobs together, by the appropriate movement of one 'line' of the production plan at a time.

Having 'saved' a satisfactory plan, further options should be provided enabling a planner to view the results of the plan under different sort categories, eg. material grade and suggested-date. In effect, a 'what-if' facility should be provided by the system.

Ultimately, a production plan would be printed off for confirmation by the production manager. The print-out format should reflect the changes made and also incorporate additional information (process times, core requirements/times, total weight of material) - made possible by the increased line length.

Furthermore, by accepting the production plan, not only the appropriate order records should be updated with the confirmed 'planned dates', but also the associated load-on-resource information, which would be stored in production-date order, adjacent to the resource capacity information (section 4.3.4).

To complement the planning procedure described, the system should also provide the facility for examining the load on particular 'key' resources (ie 'bottleneck' resources) at any stage during the evaluation of a production plan. The identification of bottleneck resource centres is essential since all subsequent planning and scheduling operations would be governed by the organisation of work through these key production centres. Thus, assuming a planner had
batched sets of jobs over several time-periods, the impact on the resource centres concerned should be graphically displayed at the planner's command. The resources would still be loaded to infinite capacity, but where the load for a particular time period (e.g., a week) exceeded the stated maximum resource capacity for that time period, the system should 'flag' the situation, drawing the planner's attention to the potential problem (e.g., by means of a capacity 'line' traversing the chart).

Since each 'load-column' would contain summary information of all the pertinent jobs, expressed in the designated resource units, the system should also enable the planner to 'enquire' on the jobs comprising a particular week's load, thus identifying the jobs 'causing' a potential overload situation. Moreover, the facility to re-plan the start-of-production-date, for any job, would be essential, providing a mechanism for balancing the flow of work through the resource. In re-planning the start of production, any date entered should be subject to a production calendar 'cross-reference', to avoid the entry of invalid dates.

By providing the facility to identify jobs with an appropriate resource and by 'sorting' and 'storing' the resource loadings for given time periods, the system should then enable the planner to cope with the phenomenon of 'split batches'.

For example, if a given weekly load on a resource was found to be 'over-capacity', a review of the orders comprising the weekly load-total would identify the job-load composition. If the planner had to split a
particular batch quantity (and say make \(x\) amount this week and \(y\) amount next week) in order to balance the flow of work through the resources, the system should:

- enable the \(x\) and \(y\) quantities to be established against a start-of-production date, respectively
- 'file' the split-batch-quantity, in 'date-order', together with the internal order reference against the appropriate resource

Any 'confirmed' changes made to the production plan via the load-chart module would be reflected in the original production plan when the planner instructed the system to 'return' to the former mode of operation. However, the system should enable the planner to use the load-chart function without necessarily invoking the interactive planning procedure (ie. in 'stand-alone' mode).

Using the techniques described above, the planner should be able to produce a 'short-term' plan for job production, in terms of satisfying the customer orders, whilst balancing the flow of work through the resources. Following the acceptance of the production plan, the system should enable the printing of production programmes ('work-to-lists') detailing the weekly manufacturing requirements for the foundry, by production section.

4.5.5.4 Production Programmes

The production programmes would subsequently be handed to the foundry supervisor whom would sequence the jobs on a day-to-day basis and would have the responsibility of ensuring that the weekly targets were
achieved.

4.5.6 Works Documentation

A system should provide the means for producing works documentation although it should not 'force' the maintenance of this module on the users, since many foundries can adapt other documentation (which should be provided by a system) to describe the route of a job. The ability of a system to complement existing manual procedures also reflects the necessary flexibility of design.

Whether the medium for producing the documents takes the form of a 'document generator', or consists of a series of 'standard' documents (or both), it should be possible to select one, or a batch of documents to be printed either by pattern/die number or works internal order number. The following list represents a typical set of works documentation:

- route card
- operation card/batch card
- material requisition card
- pattern release card
- quality assurance documentation

The information printed on the documentation would normally be derived from the pattern/die register, the order/schedule records and the route card records. In addition, the provision of areas of 'free-form text', for users to convey special notes/instructions should be made available, for subsequent transfer to the relevant documents during
printing.

The issue of pattern release documents informs the pattern department of imminent work. The pattern department can signify the availability of patterns by returning the document, appropriately 'marked', to the production control department. Where patterns are supplied by the customer, stores should use the document to signify when the customer has delivered them to the foundry. In both cases, a job or, pattern 'status' can be identified which can be 'flagged' against a system's record of the pattern/die.

Operation cards represent the breakdown of production programmes and can serve at least two purposes: the first is to inform the operator of what has to be done and how to do it, the second is for the operator to inform the production control department of what has been done. Thus, on completion of a job, the operation card should be signed by the operator/supervisor and include all relevant work-booking information for subsequent processing by the production control department.

4.5.7 Work Booking

The modules presented thus far have been concerned with the pre-production activities of organising and planning for the manufacture of jobs and the subsequent dispatching of works orders to the foundry.

To provide 'control', it is essential that feedback from the shop-floor to a CAPM system is maintained on at least a daily basis, although preferably on a more regular basis. At the most basic operating level, the work-booking information can be manually entered
against the individual order/schedule records held by a system. At the other extreme, 'terminals' (i.e. micro-computers) which are located at monitoring points within foundries can be used to update a system in real-time, which provides the most accurate (and most expensive) basis for subsequent planning and scheduling activities.

Another option is to make use of 'hand-held' terminals with which to record information from the shop-floor for subsequent transfer to a CAPM system on a regular basis (of which the author has first-hand experience). The hand-held units are powered from rechargeable batteries and can be easily carried around the foundry.

Periodically, the unit would be returned to the production control office for interrogation of its 'transaction files'. By transferring the information from the hand-held machine into the system (normally via an asynchronous communications cable connected to the RS232-C parallel port of the micro-computer) the w-i-p information can be updated, but only on a batch basis. Any exceptions (e.g. badly entered pattern/die numbers) can be printed out in the form of a report, which would necessitate manual adjustments to the order and w-i-p records.

The manual version of a batch updating procedure involves entering the information returned from the shop-floor into a 'work booking module' which is integrated into a CAPM system and provides the user with the same alternatives for dealing with anomalies (e.g. 'over production') as the real-time option.

Whichever method is employed, the work-booking module should enable the
booking of work against either the pattern/die number or the works internal order number and be capable of accomplishing several other tasks, simultaneously, in addition to automating the manual procedure of updating the works order cards. Moreover, the provision for booking scrap, despatches, rectifications and customer returns should be incorporated into the method employed.

For complete flexibility, a CAPM system should support all of the options listed, enabling a foundry to progress through stages of sophistication when it was considered appropriate.

4.5.7.1 Updating Production Archive/Resource Records

To provide full traceability of the events surrounding the production of jobs, the system should automatically update the production archives from the bookings of production, scrap, despatches, rectifications and customer returns. Each 'booking' should be stored in summary form, together with relevant details from the pattern/die and order/schedule records, for later interrogation.

The module should also update the relevant resource records enabling the loading of new jobs onto production centres, whilst passing w-i-p onto the next designated resource.

4.5.8 Despatch Notes and Invoicing

The system should provide a facility for the printing of advice notes and invoices, in a similar manner to the production of customer order acknowledgements, described earlier. Following the despatch procedure
a transaction file should be updated with the relevant details necessary for producing the documents.

At an appropriate time, the transaction file would be interrogated and unprinted documents could then be 'flagged', which should invoke a procedure to enable selected documents to be 'prepared', prior to printing. The ability of a system to provide documents which emulate the existing paperwork is desirable since it assists in the acceptance of a system by enabling users to 'identify' with the output from a system.

4.5.9 Reports

The provision of information on the current situation and also for the purposes of comparing predicted and actual events, is essential to the control of the foundry. The application of the micro-computer to this chore is one of the areas where time-savings are most apparent.

Without doubt, the most convenient vehicle for performing the necessary tasks is the provision (by the system) of report generators.

The following list presents some of the features which should be provided by a system's report generator(s):

- report title
- column headings
- data element definition
- identification of 'key' data elements
- identification of 'sort' data elements
- identification of 'sub-total' data elements
- identification of 'total' data elements
- the option to create and save 'keylists' (high volume data processing)
- the option to suppress meaningless data (eg. zero quantity data)
- the option to print summary information only
- the provision to select 'blank' columns of data to be printed
- the provision of a calculator function, enabling users:
  - to input their own algebra
  - to 'round' figures down, or up
  - to subtract a span of time from a selected date
- reports library
- the option to run a 'saved' report, or to re-use the report 'mask' for a different selection of data elements

4.5.10 Production Archives

For production traceability and to provide the production department with a performance analysis utility, the keeping of production archives (or 'historical') information, is an essential part of the system.

The information stored within the database consists mainly of cumulative quantity information and work-booking transactions. Apart from the initial setting of the cumulative elements, the database should be extended from the activities surrounding other modules within a CAPM system.
Periodically (e.g., every six months, or annually), the information within the historical database would require 'clearing' from the system (depending on the capacity of the storage media and the degradation of the speed of response exhibited by the system). The system should provide the option of clearing all the information from the database, or just a part of the information. Whichever option is taken, the information designated to be cleared from the system should be printed, prior to deletion, so that a permanent, 'hard-copy' of the information can be manually archived. The 'cumulative' quantity figures would be left untouched by this action, but the 'period-to-date' figures would be re-initialised to zero.

Reporting facilities are an essential requirement for this module, including the ability to link to the pattern/die register. As with the reports section, discussed above, a report generator should be provided by the system for the creation of management information and performance analyses; for example, a report showing the number of jobs despatched on time (produced by comparing the actual date of despatch and the customer 'required-by' date).

The preceding sections have suggested an approach towards production planning, scheduling and control in foundries, using the assistance provided by micro-computer technology.

Emphasis has been placed on the need for 'flexibility' to be incorporated into the design of a system, thus enabling many foundries
to enjoy the benefits of packaged software. At the same time, the adoption of a CAPM system will impose a certain degree of standardization into procedures and the advantages of 'change' must be communicated and demonstrated to the employees whom will ultimately be operating the system, at all levels.

Attention is now turned to the presentation of feasible solutions which address specific functions within foundry CAPM, viz: the functions of production planning and scheduling.
5. **Approaches to Production Scheduling**

5.1 **Introduction**

The work presented in the current chapter describes practical approaches to 'levels' of foundry scheduling which have been developed and installed into several foundries.

Discussions with foundry production personnel (see Appendix 1.), together with the overall picture obtained from the literature review suggested that the design of a scheduling system should be centred around the provision of 'structured' information (ie. information which has been selected and sorted, etc.) thus forming a basis for executive decision making.

Moreover, the fact that foundries work to an order-book which can only be described as erratic dictated that a scheduling and planning system had to be flexible, and capable of responding rapidly to the inevitable order-book fluctuations.

5.2 **The Scheduling Problem**

Foundries often lack reliable time "standards" for individual manufacturing operations. Where standard times are available, they are usually confined to the capital intensive "key" operations. As a rule, the key operations may also be identified as 'bottleneck' resources, ie. resources which limit throughput (assuming that a perfectly 'balanced foundry' does not exist!). Since the bottleneck resources
determine the flow of work through 'non-bottlenecks' (a principle of the OPT philosophy), the foundry scheduling problem can be simplified, initially, to scheduling the flow of work through defined bottleneck areas. Such areas are usually identified as coremaking and moulding (for sand foundries) and casting (for die foundries).

Whilst the bottleneck resources associated with these key areas may be loaded to finite capacity, true 'backward scheduling' is generally impractical because the 'after-casting' operations times are either inaccurate or 'missing'. The problem is exacerbated in 'jobbing' foundries where a high proportion of the live order-book consists of jobs for which only 'estimates' are available at best.

However, given the identity of bottleneck resources for each job, the next stage in co-ordinating the manufacture of jobs involves scheduling work through these resources. This task usually falls to the person(s) responsible for planning and controlling production (eg. the production controller, production planner, production scheduler, etc.) whom will be referred to as the 'production planner' for the remainder of the chapter.

5.3 The Production Planner's Problem

The problem of scheduling castings manufacture in any foundry may be stated as follows:-

...... Given an 'order-book' detailing outstanding customer requirements, when should the balance-to-deliver-quantities
be processed through the bottleneck resource(s) in order to meet the required dates.....

More specifically, the production planner's task is to produce production programmes or, 'work-to' lists for the coremaking, moulding and casting areas (sand foundry), or the casting machines (die foundries). For die foundries it may also be required to produce a listing of any requirements for cast-in inserts or miscellaneous additional assembled components.

To accomplish this task, up-to-date information must be on hand, detailing:

- customer delivery requirements
- replacements
- customer returns
- work-in-progress
- lead-time to manufacture castings
- expected scrap rates
- available resource capacities

Attempts to manipulate all these factors simultaneously have proved to be practically impossible by manual methods, but a computer can be programmed to actively assist in the preparation and presentation of information, in a form which is readily understood and which can be used effectively by the production planner.

In essence, the computer-assisted scheduling techniques described
below, reflect different levels of computer involvement with foundry planning/scheduling information requirements.

5.4 Scheduling Concepts

The conflicting objectives of balancing the flow of work through key resource centres, whilst at the same time satisfying customer requirements for 'on-time' deliveries, ensures that 'ideal' solutions to scheduling problems are rarely possible.

Moreover, the evidence provided by the literature survey suggested that entirely computerised solutions to the scheduling problem were not favoured by the industry, whilst few systems developed for use in a micro-computer environment were of practical value or, generally applicable to a wide range of foundries.

These points are addressed in the approach to scheduling adopted here, which makes use of the micro-computer's effective searching, sorting and calculating functions for information manipulation, leaving the production scheduler to apply detailed knowledge to the 'suggested' schedule which is generated.

In each of the scheduling techniques described below, the initial computer-based task is to simply identify the production load: i.e. by considering the entire order-book, the balances to cast, or 'nett requirements' can be determined. The calculation to establish 'nett requirements' is accomplished in two steps, viz:
Gross requirements = Customer Orders (discrete orders/schedules)  
+ Replacements (internal scrap & customer returns)  
+ Samples and Pattern/Die checks (eg. for approval)  
+ Make-To-Stock (eg. policy for long-running parts)

The 'nett requirements' or, balances-to-cast are computed from:-

Balance-to-Cast = Gross Requirements (as determined above)  
+ Scrap Allowance (to allow for foundry scrap/'yield')  
- Quantity Already Cast (Work-in-progress 'stock')

The computed balance-to-cast is finally 'rounded up' to account for the number of moulds per box or, impressions per die (eg: if the balance-to-cast turned out to be 267 for a part with 4 moulds per box, then the number would be rounded up to to 268; ie. 67 boxes; since 'partial-boxes' cannot be made).

A second computer-based task involves the computation of 'suggested start-of-production-dates' or 'suggested manufacturing-dates', for jobs which have not been 'planned' (jobs/orders are referred to as 'firm' until they have been given a 'planned' date. Thus, only planned orders should have their delivery dates confirmed by the foundry). That is:

the suggested manufacturing-date = customer required date - lead time  
(where 'lead time' = manufacturing throughput time)

The computers 'suggested manufacturing-date' may also be subject to automatic revision: eg. a check for this date against specified 'non-working' days may prove positive, which would result in the revision of
the suggested date. Normally the procedure is to 'add-a-day' and re-check the revised date, continuing in the 'loop' until an acceptable date is found.

The final balance-to-cast figure and suggested manufacturing-date are used by the scheduling techniques presented below. The difference between each of the techniques, lies in the degree to which work-centres are actually loaded by the computer and the relative contributions required from the production scheduler and the computer, towards the provision of workable schedules.

5.5 Scheduling Techniques

The techniques developed provide the facilities to:-

- identify (in advance) all 'non-productive-days'
- define resources in terms of nominal capacities
  - expressed in appropriate units
- perform rough-cut scheduling
- perform infinite capacity scheduling
- perform interactive scheduling
- produce production programmes

To assist the description of the scheduling techniques, 'screen dumps' have been incorporated into the text, which have been taken from a micro-computer installation (see Figure 5.1, overleaf, for an example of the hardware). The installation maintains the databases, and the information associated with the databases, as specified in Chapter 4.
Illustration removed for copyright restrictions

Figure. 5.1 Example Of A Micro-Computer
5.5.1 Production Calendar Definition

The production calendar is the equivalent of the Gregorian calendar which is used in every day life. By assigning particular days as 'non-working' days (over a range of years), the user can define works shutdowns, public bank holidays, etc. for later use in conjunction with the planning and scheduling functions.

Figure 5.2, below, represents the computer display of the calendar maintenance function. The user is prompted for a 'year' and a 'month' and the computer calculates the correct number of days to be organised against the appropriate weekdays - two months at a time.

![Calendar Display](image)

Figure 5.2 Example of Production Calendar Maintenance
The functions in the bottom right-hand 'window', enable the user to define non-working days: for example, by moving the 'arrowhead' to the appropriate day and "toggling" the '0' key or, by using the parentheses to define a 'range' of dates. The user is given the option to 'save' any changes made, which instructs the system to update the calendar 'file', stored on the computer (program listing A4.1 - Appendix 4.).

5.5.2 Production and Delivery Schedules

The scheduling techniques can be accessed from one menu (see Figure 5.3), which represents a sequence of procedures for realising the planning and scheduling 'model' described in Chapter 4.

![Figure 5.3 Options Within the Production Planning and Scheduling Model](image-url)
The first and second 'levels' of scheduling involve the provision of summary information relating to the backlog of orders (delivery schedule) and the creation of a rough-cut capacity plan. These are represented by option '(01)' off the menu shown in Figure 5.3, which produces the information selected in the form of a report. To access the report, production staff enter the following parameters:

1. a range of customers
2. a date - from which the planning horizon can be calculated
3. the required report (both the delivery schedule and nett requirements schedule run from the same program)

The program scans through the order book, sorting the 'firm' and 'planned' customer orders/schedules by part number within customer name and accumulating the relevant 'quantity' figures for each part number: subsequently, each cumulative figure is allocated to an appropriate weekly 'time-bucket'.

Selection of the delivery schedule report instructs the program to place the 'balance-to-deliver' quantities 'into' the time-buckets which incorporate the customers' required delivery dates, whilst the nett requirements report places the 'balance-to-make' quantities against the time-buckets which correspond to a 'suggested production-week', as calculated by the computer or, to a 'planned production week', which has been previously defined to the system by the production planner.

Figures 5.4 and 5.5, below, show examples of each report (program listing A4.2 - Appendix 4.).

- 150 -
<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>D/due 12/86 13/86 14/86 15/86 16/86 17/86 18/86 19/86 20/86 21/86 22/86 23/86 24/86</th>
<th>Fwd. Made</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT/1272</td>
<td>CRANKED LINK</td>
<td>0 0 0 0 0 0 0 0 258 0 280 188 0 188 0 0 188 351</td>
<td></td>
</tr>
<tr>
<td>TT/2288</td>
<td>PORT INLET</td>
<td>0 188 808 0 0 0 1420 200 1898 850 0 288 0 0 188 0</td>
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</tr>
<tr>
<td>Sub-Totals</td>
<td></td>
<td>0 188 1128 0 0 1670 200 1298 1920 0 308 0 0 288</td>
<td></td>
</tr>
<tr>
<td>Customer:</td>
<td>TITEX TOOLS LTD</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>BALANCE WEIGHT</td>
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<td></td>
</tr>
<tr>
<td>BM-8781</td>
<td>PUMP HOUSING PIN</td>
<td>0 0 0 0 0 0 0 0 12 15 0 15 0 0 0 0 0 36</td>
<td></td>
</tr>
<tr>
<td>BM-920/0</td>
<td>FRONT YOKE</td>
<td>0 0 0 0 0 0 1408 1298 1198 958 0 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>BM-2912</td>
<td>BACK PLATE (5)</td>
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<td></td>
</tr>
<tr>
<td>Sub-Totals</td>
<td></td>
<td>0 0 0 0 0 0 1487 1551 1495 1143 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Customer:</td>
<td>BRICK'S SHARP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer:</td>
<td>MELLINGS LTD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RLV851T</td>
<td>PUMP HOUSING 4IN</td>
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</tr>
<tr>
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<td>BACK PLATE</td>
<td>0 0 0 0 0 0 35 46 35 23 0 0 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Sub-Totals</td>
<td></td>
<td>0 0 0 0 0 0 205 448 418 323 0 0 0 0 0 0 0</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.4 Order Backlog Report
### Nett Requirements Summary

<table>
<thead>
<tr>
<th>Customer</th>
<th>TITEK TOOLS LTD</th>
<th>BROWN &amp; DURAP</th>
<th>MELLINGS LTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D/due 82/86 89/86 14/86 23/86 38/86 87/87 21/87 22/87 84/88 11/88 18/88 Fwd.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TT/1272</td>
<td>10.56 256 286 194 184 84 84 84 84 84 84 84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TT/2228</td>
<td>1894 1494 211 1853 894 211 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sub-Totals</strong></td>
<td>1894 1754 211 1257 1978 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D/due 82/86 89/86 14/86 23/86 38/86 87/87 21/87 22/87 84/88 11/88 18/88 Fwd.</td>
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</tr>
<tr>
<td>GHU-2578</td>
<td>10 1 48 0 0 0 0 0 0 0 0 0</td>
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<td></td>
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<tr>
<td>GHU-2821</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>GHU-2821/8</td>
<td>0 140 130 210 120 120 974 0 0 0 0 0</td>
<td></td>
<td></td>
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<tr>
<td>GHU-2915</td>
<td>92 256 256 256 92 0 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sub-Totals</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Part Number</td>
<td></td>
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<tr>
<td>Description</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>D/due 82/86 89/86 14/86 23/86 38/86 87/87 21/87 22/87 84/88 11/88 18/88 Fwd.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RL/2160</td>
<td>264 412 388 316 0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RL/2160</td>
<td>8 36 42 36 36 27 0 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sub-Totals</strong></td>
<td>264 454 424 343 0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.5.3 Production Planning

Option '(02)' off the menu (Figure 5.3) is used to address the capacity planning aspects of the planning and scheduling model. The approach adopted here is based on a manually interactive principle ('man-in-the-loop'), which delegates the sorting and 'number crunching' activities to the computer, leaving the production planner to exercise judgement and practical experience to override the computer's suggested production plan.

In order to produce a production plan, the planner enters the 'planning criteria' requested by the prompts displayed in Figure 5.6, below.

![Figure 5.6 Examples of Production Planning Criteria](image-url)
The information which is located within the order book (i.e. firm and planned orders with 'balance-to-cast' quantities greater than zero) is grouped according to the criteria specified and the program 'suggests' a manufacturing-date if the job has not already been 'planned' (as signified by the presence of a 'planned-date' within the order record). A date-range can be selected to suit the forward planning requirements of a particular foundry (program listing A4.3 - Appendix 4.).

The resulting printed report shows the 'suggested' production plan for successive weeks, although at this stage, no attempt has been made to consolidate the required production capacity with what is actually available. Instead, the report quantifies the consequences of it's suggested schedule in terms of several units of measure: eg. work hours, number of moulds or shots, value, tonnage and so on, as illustrated by Figure 5.7, overleaf.

The 'S' against the 'Suggested Start Date', in Figure 5.7, signifies that the computer has 'suggested' the manufacturing-date, whilst the 'P' defines existing 'planned-dates'. By scrutinising the production plan, the planner can accept the 'suggested-date' or, manually 'set' a revised manufacturing date (i.e. by writing on the report). Thus, a facility is provided for 'job-batching', since the 'same' date can be set against appropriate jobs, by the production planner. Any dates that are altered can subsequently be entered against the appropriate order/schedule using the order-book correction utility, provided with the database.
Figure 5.7 A Suggested Production Plan
The 'man-in-the-loop' scheduling approach therefore relies on both man and machine to turn a suggested production plan, which loads resources to the infinite capacity rule, into a feasible production programme in which resources are loaded to finite capacity.

5.5.4 Interactive Scheduling

The third (and most sophisticated) level of the planning and scheduling model incorporates:

- the creation and maintenance of a resource database
- the projection of load profiles for specified sections
- the provision of an interactive capacity scheduling tool

The resource database (program listing A4.4 - Appendix 4.) enables sections, work stations, manpower, etc. to be defined in terms of a series of resource units so that more than one criterion can be used to evaluate the effect of particular planning decisions.

The resource profiling module is based on a presentation of the workload which is to be routed through the resource for discrete time periods within a given planning horizon. It is similar in concept to the production plan in the sense that jobs are sorted according to a set of criteria and where necessary, a suggested manufacturing-date is determined by the computer (which is checked against the production calendar). Whilst the resource selected is still loaded to infinite capacity, the nominal capacity associated with the resource (ie. as defined within the resource database) is used by the computer to flag an overload situation (see Figure 5.8, overleaf).
The planner is prompted for a set of criteria, which include:

- the section 'code' (eg. SHELL - shell moulding section)
- the order category (eg. "P" - 'planned' orders only)
- the 'quantity category' (eg. the quantity available to process as opposed to the order quantity)
- the resource units (eg. moulds/week)
- a date from which to start the planning horizon

The computer selects the jobs from the order-book which match the criteria entered and following the 'sorting' of jobs into specific time periods, a load-chart is displayed on the monitor, see Figure 5.8.

![Load Chart](attachment:image.png)

**Figure 5.8 Resource Profiling**
Figure 5.8 shows a resource profile for the 'SHELL' section covering the first ten weeks of a thirty-week planning horizon. The 'first week' is designated for 'overdue' jobs, i.e. jobs which the computer has calculated should have been started in terms of the date entered (from which the planning horizon was calculated).

A nominal ('one hundred percent') capacity line is drawn across the chart, so the planner can observe where overload situations are likely to occur in a given week.

The bottom left-hand window contains the 'range-marker' which shows the current ten-week period displayed of the thirty-week planning horizon. Using the function keys listed in the right-hand window, the planner can select any ten-week range within the planning horizon and re-display the appropriate load-profile.

Since the production planner will normally be most interested in those weeks where overloads have been highlighted, the system provides the facility to select and interrogate the jobs which comprise a particular week's work: eg. depressing function key '9' "toggles" the planner in and out of the 'individual-week look-up' mode of operation. Selecting this mode has the effect of 'freezing' the position of the range-marker, whilst enabling the planner to select a particular week.

Continuing the example provided by Figure 5.8 (which highlighted an 'overload' in the week ending '30/06'), Figure 5.9 shows the functions of selecting the 'problem week' and displaying the orders making up the load total (which are sorted first by metal grade).
Figure 5.9  Weekly Load Composition
Where the computer has suggested a manufacturing date, the date displayed under the heading 'planned' (in Figure 5.9) is suffixed with the letter 's'.

A further set of function keys enables the planner to alter the 'planned' dates which appear on the screen. Thus, the suggested manufacturing date can be confirmed, or a revised manufacturing date can be entered (which is checked against the production calendar). The action of entering a revised date, which moves a job from the original week to a different week, affects the weekly load composition, such that when the load chart is re-displayed the planner can see the effect of the changes made (see Figure 5.10).

---

**Figure 5.10** Example Of Load Chart Balancing

[Diagram]

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Using the 'what-if' functions provided, the planner can therefore allocate 'planned manufacturing-dates' to particular jobs, and attempt to balance the flow of work through the resource specified. Once an acceptable load profile has been achieved, the computer automatically revises the manufacturing dates of all jobs concerned.

The planner may wish to review the load profile under an alternative resource unit (e.g. to see if sales targets will be met) and figure 5.11 overleaf, illustrates the procedure for re-displaying the load-chart, together with the resulting profile. The interactive scheduling procedure can be repeated if necessary if the 'new' load profile demands attention. (Program listing A4.5 - Appendix 4.)

5.5.5 Production Programmes

Following the approval of a production plan, master production programmes or, 'work-to-lists' can be generated for each work-centre (or resource). Work-to-lists are only produced for jobs which have been planned for production and are mainly concerned with the 'key' resource activities of coremaking, moulding and moulding/casting.

The planner selects the required key resource activity and enters a 'finish-date', which provides an upper limit on the planned jobs to be selected from the order-book. In this way, a means of controlling the release of work into the foundry, over (say) a week or fortnightly period is provided, although revised programmes can be produced as often as required. The details printed on the resulting production programmes include technical/descriptive information stored on the
Figure 5.11 Load Profiling With Alternative Resource Units
computer database (see Figure 5.12, overleaf).

Figure 5.12 shows a production programme which covers the 'BENCH' and 'PIN-LIFT' sections of a foundry. The dotted dividing-line between each section enables the programme to be separated into individual lists which can be handed to the supervisors concerned, who can organise the sequencing of jobs from the production programmes.

Jobs requiring cores (or inserts) can be printed-off in a similar manner, thus forewarning the coreshop supervisors of the need to 'supply' particular cores by a certain date.

(The production programme computer program is incorporated within program listing A4.3 - Appendix 4.)

The preceding pages have presented approaches towards the planning and scheduling functions within foundry CAPM.

Three specific techniques were described, which provide three levels of production scheduling 'sophistication' in terms of the:

- functionality of each technique
- information that is required by each technique
- potential for manual interaction

The discussion which follows assesses the integration of the techniques into foundries and covers the wider issues concerning foundry CAPM.
### PRODUCTION PROGRAMME

**Selected Option**: Hold & Cast  
**Date Produced**: 23/9/86

<table>
<thead>
<tr>
<th>Internal Ref No.</th>
<th>Part Number</th>
<th>Casting Section or W.C.</th>
<th>Total Process No of or Gross No. of</th>
<th>Total Metal Type.</th>
<th>Cores or Inserts or Delivery Casting</th>
<th>Required Planned Costing Date</th>
</tr>
</thead>
<tbody>
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<td>40/P</td>
<td>266194</td>
<td>BENCH</td>
<td>0.00</td>
<td>286 1410,109</td>
<td>142 340.00 SAE 14 YES</td>
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**Figure 5.12** A Production Programme
CHAPTER 6
6. Discussion

6.1 Introduction

The pragmatic approach to CAPM adopted throughout the course of the research, has led to the development of techniques which assist the organisation and control of manufacturing in foundries.

Three distinct techniques were described in Chapter 5, which collectively form a scheduling and planning 'package'. The package has been implemented in several foundries whom agreed to participate in the research programme (Appendix 1).

The present chapter first reviews the background considerations which stimulated the particular planning and scheduling methodologies. It continues with an appraisal of the subsequent use of the 'package' and establishes the benefits of employing the system, as well as identifying the limitations.

Finally, an overview is presented of some of the wider issues pertaining to CAPM systems, which contributed to the development of the ideas implicit within the current study.

6.2 Planning and Scheduling Methodologies

The rationale underlying the adopted approach to a generalised computer-assisted production planning and scheduling system for foundries, was developed from three sources of information:-
i) an in-depth review of the literature

ii) discussions with foundry personnel

iii) published reviews of several existing CAPM users within the industry

Specific considerations included the lack of accurate information; for example 'standard times', especially 'move' times, which are significant in controlling the throughput of jobs in production systems of an intermittent nature.

Probably the most notable difference in the adopted approach is the provision of a facility to evaluate delivery commitments in terms of one or more 'units of resource', other than 'times'.

Such a facility is essential when, for example, measuring the 'production capacity' of heat-treatment furnaces, or shot-blast cabinets, etc., where it is meaningless to use resource units of man-hours or machine hours. That is, different sized castings may require the same 'run-time' in a shot-blast cabinet, but the physical space requirements in each case would be very different - thus the forward load for 'shot-blasting' could not be assessed in terms of the extension of quantities and run-times.

Another example is the loading of, say, a mechanical moulding section in terms of the number and type of boxes per day. Whilst it may be possible to express this capacity in terms of moulding hours, the use of 'moulds per day' is certainly more familiar to foundry personnel. There are, however, cases with loose pattern work (in which more than
one job is moulded in a box) in which individual times are not available and the only measure of capacity would be 'box-type'.

6.21 The Basis For A Workable Solution

It emerged that any 'useable' methodology could not be based on the capture and maintenance of large volumes of manufacturing data, if it was going to be applicable to a wide variety of foundries (reasons: lack or absence of such data; unavailability of staff to monitor and input the data/revisions, etc.). Consequently, the applications software was designed to rely only on the information which is readily available in foundries, thus enabling data to be maintained on a regular basis as part of normal production department practice, without adding to the clerical workload.

A 'three-level' structure of increasing sophistication eventually evolved, through which 'user-specified' information (ie. data selected via keyboard entries) could be sorted and presented for decision making by the production controller.

The philosophy of having three 'levels' of computer-assisted scheduling was based on the principle of providing foundry staff with a gradual introduction into CAPM. The increase in sophistication associated with each technique, enables the user to 'grow into the system', by providing a route to more refined (and potentially more accurate and responsive) scheduling.

At the most simplistic level, the information provided by the package
enables the production planner to assess the amount of 'capacity' which is likely to be required to meet the outstanding nett requirements. At the other end of the scale, the most sophisticated technique provides the planner with a facility to 'interactively plan' jobs into production, whilst being made aware of the loading implications of any planning decisions made.

All three techniques are based on the loading of jobs (ie. the 'nett requirements') onto 'bottleneck resources', to the infinite capacity rule. This is achieved by the 'subtraction' of lead-times (or, manufacturing throughput times) from customers' required-dates. Therefore, jobs are loaded according to the EPPD priority rule ('Earliest Planned Production Date') - see Figure 6.1, below.

Figure 6.1 The Scheduling Approach Adopted By The Present Study

<table>
<thead>
<tr>
<th>Start of Manufacturing</th>
<th>&quot;Lead Time&quot;</th>
<th>Required Delivery Date</th>
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<td>(ie. 'bottleneck' resource)</td>
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<td></td>
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<tr>
<td>Process Time</td>
<td>&lt;-------------&gt;</td>
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6.22 The Use Of Lead-Time

In the present context, 'lead-time' has the same implication as in standard MRP systems - namely, the elapsed time from placing the order (on the foundry) to completion. By subtracting lead-time from the required delivery date we are implicitly adopting the J-I-T ideal. Moreover, lead-time is assumed to be the same (for a given job)
regardless of batch size.

Clearly, lead-time should be viewed as a "company policy" for each casting. For example, straightforward jobs will have a lead time of 2 weeks; jobs requiring sub-contract heat-treatment have 8 weeks, etc.

Whilst the lead-time concept has, so far, been used to plan moulding (the bottleneck operation) it would be relatively simple to associate move times with other key operations, so that scheduled 'start-dates' could be related to the moulding date. The step towards practical finite capacity scheduling would then be quite small.

6.23 Finite Capacity Considerations

In order to balance the flow of production within true finite capacity planning constraints, a system would require the run, set-up and move times (see Figure 6.2, below) for each operation to be monitored on the shop-floor and 'fed-back' to the production control department, so that a system could 'learn' from actual performance. In addition, priority rules and scheduling constraints would need to be devised and combined in such a way as to produce an optimal or, near optimal solution. As evidenced by the literature, such an approach has proved to be unworkable in the foundry environment, except in the most simplified of cases.

Whilst the finite-capacity methodology may be possible in the repetition environment, it is highly questionable whether the jobbing environment would lend itself to such an approach because of the
'guestimate' methoding which accompanies new (and therefore each) job. A further complication is that of combining, say, the scheduling of work on moulding sections with the need for 'batch' furnace charges for particular alloys.

Figure 6.2 A 'Traditional' Approach To Scheduling

Move Time
<------------------>  Set-Up  <-------->  Process
                        Time               Time

Elapsed Throughput-Time  <------------------>
For Each Operation

The conclusions to be drawn from the various considerations suggested that a man/machine partnership would provide a 'best solution' to the problem of foundry planning and scheduling. The philosophy of 'human intervention' was ultimately adopted in all the techniques developed.

6.3 System Applications and Limitations

The variety of foundries (from both material and mould/cast process considerations) who adopted the planning and scheduling techniques presented here, are as listed in Appendix 1.

6.3.1 The First Level

The 'first level' technique comprises the 'order-backlog' and 'nett
requirements' reports, which are used by most of the production management staff. Since the Order-Backlog Report lists the outstanding 'balances-to-deliver', over a planning horizon of 12 weeks, plus the quantities which are 'overdue', production staff are provided with a summary of what will be required during the forthcoming weeks and what jobs need chasing to honour delivery commitments.

The Nett Requirements Report enables planning staff to get an overall picture of the forward load on the foundry, based on the order-backlog report, plus the identification of jobs which are behind schedule, in terms of their start-of-production dates. From the summary information provided by these two reports, production planning staff can request more detailed information on the required jobs by moving to the 'second level' technique - the 'planning report'.

6.32 The Second Level

The Planning Report, which facilitates 'man-in-the-loop' scheduling, is used extensively by production planning staff to organise the loading of batches of work onto production centres. The required criteria for 'sorting' the report is selected by the user: for example, the planner at Parker Foundry selects jobs to be listed by 'mould section' and 'suggested-week'. The resulting report is then used to batch jobs together based on the mould section and the planner's current knowledge of the foundry. Another common sort-sequence is 'mould section' and 'alloy type' - again in date order. Such a listing will readily highlight overloads in melting capacity for certain alloys.
The 'planner' at Wolverhampton Ironfounders (who is also the Managing Director!) is more concerned with cored-jobs. In his case, the timing of core-production/-assembly with mould production is critical, especially so with the fast throughput times which typify this particular foundry's production methods.

The extent to which jobs are 'planned', using the procedure detailed in Section 5.5.3, is dependent on several factors, which include:-

1. How advanced a particular foundry wishes to make its planning procedures

2. Access to the computer: in a single user environment (which covers 60% of the foundries listed) the activities surrounding other CAFM functions are competing for keyboard time. Thus, the entry of new orders/methods has to be balanced against work bookings, the printing of management reports, supplying the planners with the appropriate information, printing off works documentation, revising the order details in line with customer amendments and the entry of revised or confirmed production manufacturing dates.

Recent, feedback from production staff suggests that the procedure for "man-in-the-loop" scheduling could be automated further. It is suggested that this could be achieved by printing the report to the screen in the first instance, thus enabling the planners to amend the timing and batching information relating to jobs on a more direct basis. A print-off could then be obtained and, on further study, other changes made via the screen prior to printing off the 'final plan'.
6.33 The Third Level

Before committing the 'final plan' to the foundry, the 'third level' technique enables the planners to 'fine-tune' the proposed schedule, by a consideration of the effects of the decisions made, on various resources. Thus, the two main ways in which the resource profiling module is used is as follows:-

1. Simply as a means of 'enquiring' on the loading of a particular resource for a given planning horizon.

2. As 1., together with the interactive scheduling facility

The interactive scheduling module can be set-up to provide a resource profile on a single resource, a group of 'similar' resources or, all resources for a particular process - eg. the total loading on all moulding sections within a company. This was achieved by defining individual resource records (in terms of the resource capacity) within the resource 'file' in a particular way, as demonstrated by the following examples for the shell moulding section of a company:-

1. S100 300 moulds/week - defines a standard machine
2. S100A 300 " " - defines a standard machine with 'alterations'
3. S100AS 250 " " - defines a standard machine with 'special alterations'
4. S100A? 550 " " - a cumulative resource capacity for all S100A machines
5. S100? 850 " " - a cumulative resource capacity for the S100 section
Thus the planner could request a load profile for a particular machine or the resource section in total.

In practice, a limiting factor reported by many foundries was the time required to survey the key sections, since the load-profiles had to be produced one at a time (5 to 15 minutes per section depending on the size of the order-book) and the speed of the micro-computer on which the software was 'running'.

A further constraint within the module was pointed out by several users and concerned the interactive scheduling part of the module. The system did not provide a facility to enable the planner to 'split-batches' over several time-buckets in order to balance production flow. Discrete order/scheduled quantities could be handled (ie. 'moved' from one time-bucket to another) but not the interactive breakdown of these orders into 'partial batches'. In these cases, the planner had to note the time periods and the jobs concerned for later manual revision (facilitated by the order-book 'amend' utility).

However, within the bounds of these constraints, the planners can, 'at the touch of a button', review a load profile of a specified work-centre, under a variety of different resources. Overload situations are highlighted and the 'interactive scheduling' function enables production controllers to 'fine-tune' the production plan, which has been created, initially, via the second-level technique.

Despite the limitations, the overall results of the combined planning and scheduling 'model' were encouraging and underlined the practical
success of the implementation of techniques which were based on the infinite capacity rule (which also proved to be OPT oriented).

6.4 **CAPM - A General Need?**

Since the late 1970's, manufacturing industries in general have been under severe pressure to reduce costs, which has resulted in reductions in labour employed and a corresponding total fall in output.

The foundry industry has experienced severe reductions in its numbers, which have been caused by a variety of factors (as listed in Chapter 1) leaving the remaining parts of the industry in competition to stay in business. In common with other industries, competitive pressure has fuelled the search for a strategy for higher industry efficiencies, with the aim of 'closing-the-loop' around all facets of the procedures governing order entry to final delivery.

The strategy has become known as Computer Integrated Manufacture (CIM).

CAPM is one aspect of CIM (others include CAD, CAM, CAPP, MRP, etc.) which can be regarded as a centralized and integrated approach to the organisation of manufacturing operations.

Applications of general purpose CAPM systems in foundries have met with little success as a result of the inherent differences between foundries and other engineering and assembly companies (for which CAPM systems have mainly been developed).
This is to a large extent due to foundries being primary industries, that is, 'component makers' and as such, they tend to experience a very erratic order book, which reflects the customer's nett requirements for parts, which are usually revised each time a customer demands alterations to a schedule. It is therefore impossible for most foundries to have their own master-schedule which can be 'frozen' for a period of time.

As a result, the application of widely publicized techniques such as MRP, inventory control, bills-of-materials, etc. are of secondary importance (or even irrelevant) to the 'cycle of functions' which collectively provide a production control procedure for foundries; which consists of:

![Diagram of the cycle of functions for the organisation and control of foundry manufacturing](image)

**Figure 6.3** The Cycle Of Functions For The Organisation And Control Of Foundry Manufacturing

The characteristic nature of foundry operations has more in common with the principles of the production control philosophy known as Optimised
Production Technology (OPT*) - although the application of such a philosophy to the foundry industry, in its present form, is highly improbable as a result of the copious amounts of accurate information which are required to augment the system software. Moreover, central to OPT is "establishing the bottlenecks" - in foundries this is inevitably moulding or coremaking.

6.41 The Case for Implementing Foundry CAPM Systems

One of the principle reasons for implementing a CAPM system is the deterioration of manual systems, from the point of view of accuracy and speed of access, whilst one of the main benefits which should be identifiable from implementing a system, is the improvement in the quality of information.

Moreover, the adoption of the J-I-T philosophy by companies which purchase castings (eg. the automobile industry) is placing pressure on foundries to adopt new technology (eg. the transmission of information by paperless means). If the information is to be received in a form which can be read by a computer, it seems logical that a CAPM system should be devised which would be automatically updated from the 'electronic mail' being 'posted' down the telephone lines.

The overall aim governing the implementation of a foundry CAPM system, however, should be directed at the conflicting objectives which govern

* However, this does not mean that OPT and MRP are incompatible, quite the reverse in fact, since OPT makes use of order, routing and bill-of-materials information which have to be provided from within the OPT system itself or, from an external (MRP) system.
foundry practice, viz:

- to provide good customer service: ie. to quote
  and stick to acceptable delivery dates

... whilst at the same time:

- keeping finished stock and work-in-progress to a minimum
- keeping the flow of work through the available resources (ie.
  manpower and plant) as balanced as possible

Proper use of a CAPM system should provide the necessary basis for
optimising these 'conflicts' - but it must have whole-hearted support
from the 'top down' to be successful.

The overall Production Control function within a foundry CAPM system
should be seen as:

- An Organising Function
- A Controlling Function
- A Management Function

... and not simply:

- A Technical Function
- Only A Progress Function
- A Data Processing Function

The factors governing the success (or failure) of a CAPM installation
are listed in order of importance, below:
6.42 The Human Factor

A system will stand or fall depending on the people who are operating it, regardless of how valid the system might be. For successful operation, a CAPM system requires that foundry managers and staff who are using the system on a day-to-day basis, possess a comprehensive understanding of the principles involved. They must fully understand their respective roles and be aware of the impact they can potentially have on the system (e.g. the consequences of inaccurate information on work-in-progress movements).

The importance of training foundry managers and staff in the new procedures cannot be overstressed and it is considered that the area of 'systems training' will develop significantly during the next 2-3 years to accommodate the increase in the implementation of techniques for CIM. For example, at the time of writing, the EITB have launched a series of Awareness Seminars for Foundry Directors and Special Topic Courses for Operations Staff.

6.43 Information Requirements

The types of information required for a CAPM system have been detailed in Chapter 4. Summarising, these data may be broadly categorised as follows:-
1. Parts Register
2. Commercial, Technical and Financial Information
3. Orders/Schedules
4. Work Centres (resource information)
5. Operation Times
6. Work-In-Progress Monitoring Points ("milestones")
7. Routing and Quality Control Instructions
8. Work Bookings, plus scrap, despatches, rectifications and customer returns
9. Material Details
10. Customer Details

It is vitally important that a foundry take steps to ensure the accuracy and validity of the information within the categories listed above.

6.44 Software Considerations

The software used to develop a foundry CAPM system is of relatively little importance to foundry managers and staff who are chiefly concerned with the way in which a system functions. However, within the context of the present study, the two levels of software which had a bearing on system development were:

1. The Operating System Environment
2. The Programming Language

The common choice of operating system for many business micro-computers is currently MS-DOS or PC-DOS and was the operating system used during
the development of the systems described in Chapter 5 (single-user systems). In multi-user implementations, the system workstations operated under a network architecture known as Novell NetWare.

The important criterion governing the choice of programming language was 'transportability': i.e. the ability of a language to be compatible across a range of different micro-computers (within the same operating system environment).

The version of the BASIC language developed by Microsoft – MS-BASIC – exhibited this quality and was subsequently used to develop the planning and scheduling applications, although the final programs were 'compiled', using the proprietary compiler supplied by Microsoft. The act of compiling the source-code programs had the following beneficial effects over the original coding:-

1. Increased speed of execution time (by a factor of between 5–10, depending on the application)
2. Reduced program size (in bytes) which took up less media storage capacity
3. 'tamper' proof programs, once installed at a remote site

6.45 Hardware Considerations

Hardware is no longer considered as the most important part of a system due especially to the developments in micro-processor technology (circa 1981/1982) and the subsequent emergence of 'machine-independent software'.
The governing factor which restricts the choice of hardware will be the 'budgeted figure' which a company has allowed for a system. Within this figure, foundries should ensure that the 'ideals' of: 'reliability', 'proven hardware support availability' and 'speed of operation', are all met to acceptable levels. However, the emergence of the micro-computer as a 'serious business tool' ensures that foundries are offered a 'low-cost/low-risk' entry point into CAPM.
CHAPTER 7
7. **Future Work**

The paths of development which emerge from the results of implementing systems lie in several directions, although each has a common focus, viz: the continued profitability of foundries, via the simultaneous reduction in operating costs, reduction in work-in-progress levels and increase in productivity.

The present study has concentrated on the technical problems of developing a workable foundry-based scheduling system which could operate on low-cost micro-computers.

The 'future work', within the context of the systems developed, lies in the improvement of the limitations discussed in Chapter 6 and the further development of a fourth level of 'scheduling sophistication' which combines all the above techniques, so that the planner can view the relevant information in whatever form is required, immediately.

The pursuit of more advanced (and hopefully more accurate) scheduling methods is to be continued with the emphasis on identifying piece-part lead-times and process move-times. Moreover, in parallel with this work, research into improved shop-reporting techniques and methods of identifying jobs as they are being processed is of paramount importance.

The wider issues surrounding the implementation of a CAPM system incorporate people problems, the need for staff training and organisational problems which affect (eg.) the flow of information from
one department to another.

It is considered that low-cost comprehensive training programmes, which are aimed at the clarification of the principles of production control (relevant to the industry) should become an integral part of a total CAPM package and should provide invaluable assistance in overcoming the problems of system 'acceptance': i.e. by demonstrating that it is in everyone's interest to work around the information provided and requested by the system.
CHAPTER 8
8. **Conclusions**

1. There is a strategic need for a UK Foundry Industry.

2. The current economic climate has left foundries with no choice but to increase the economic measures of productivity and profitability (in order to stay in business within a highly competitive industry).

3. The most direct effect on these 'measures' is the efficiency of the production control system in operation.

4. The application of computer-assistance to the functions within production control is considered (by the industry and the literature) to be the 'tool' most likely to improve the efficiency of a system.

5. Prior to 1981/1982, practical (ie. useful) computer-assisted production control methods were only available to those foundries who could afford the high initial investment for hardware and subsequent software development.

6. The rapid technological advances in the computer industry in the early 1980's, brought about the emergence of micro-computer's which could be considered as serious business 'tools' (a trend which is continuing at the time of writing) and thus provided smaller foundries with a method of implementing computer-assistance.
7. The subsequent development of packaged-software by entrepreneurial enterprises (eg. software houses) has enabled many foundries to adopt computer-assistance in the area of production control.

8. At the time of writing, there are three main foundry-specific packages available in the UK, which address most of the aspects of foundry organisation for manufacturing, and one clear market leader.

9. The emphasis placed on Computer Integrated Manufacture (CIM) by other manufacturing industries (ie. companies which buy components from foundries) has put pressure on foundries to adopt more advanced methods of production management.

10. Both external and internal stimuli have fostered foundry interest in one of the functions contributing to CIM, known as CAPM (Computer Aided Production Management).

11. The inherent nature of foundry operations challenges the systematic order of implementation of the sub-systems which form the traditional CAPM approach (ie: inventory control, bills-of-materials, MRP, etc.) and is seen to have more in common with the relatively recent philosophy of Optimised Production Technology (OPT - definition of bottleneck resources, capacity planning, detailed scheduling, batch production, etc.).

12. The adoption of a CAPM system will impose a more 'regimented'
approach to the functions of foundry production planning and control, if it is properly employed.

13. The foundry industry is primarily a service industry (i.e. 'single-level' component makers, mainly to customers' orders) with a primary objective of satisfying customer requirements.

14. The sophistication of the functions of foundry planning and scheduling, within CAPM, is dependent on the accurate feed-back of information from the shop-floor and the existence of standard times and resource information.

15. The dynamic nature of foundry production together with the lack (in general) of 'standard' information has led to the development of CAPM systems which are information-based, enabling production planners to exercise their experience on the 'suggestions' provided by the system.

16. The principle of 'information provision' has been extended by the work presented here, which incorporates labour saving computer-assistance (sorting and collating of information into a pre-digested form) and introduces the concept of on-line 'manual interaction' for the purposes of foundry production planning and scheduling.

17. The design of packaged software which is applicable to a wide range of foundries is considered feasible by incorporating flexibility into the design of system software (i.e. 'parameter-
driven' software).

18. The 'key' factors in the successful implementation of a CAPM system are the PEOPLE who are to use the system on a day-to-day basis (which require adequate training and education).
APPENDICES
APPENDIX 1
Appendix 1

Foundries Participating in the Research

The following foundry personnel were contacted during the course of the research and subsequently agreed to participate in an evaluation of the software proposals which were developed.

Pages removed due to Confidentiality reasons
Pages removed due to Confidentiality reasons
Appendix 2

Foundry Statistics

The following charts and tables describe some of the changes in the foundry industry between 1967/68 to 1983/84. The information is reproduced with kind permission from Mr P. J. Cave – Director of the EITB.

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APPENDIX 3
Appendix 3

A Review of some of the Packages providing CAPM

The following review briefly describes fourteen companies who market software packages for the Manufacturing Industry. Whilst the review is biased towards software packages running on micro-computers, a few mini- and mainframe systems have been included. Where possible, up-to-date prices are quoted for each system in pounds sterling, unless otherwise stated.

--------------------------------------------------------------------------------

Company : British Cast Iron Research Association
Address : Alvechurch Birmingham B48 7QB
Telephone: 0527 66414
Package : Production Planning
Hardware : Z80 microprocessor units and the CP/M operating system

Modules/Facilities

. Planning of up to 40 work centres and 20 metal grades
. Loading up to 40 weeks in advance
. Summary and detailed loading of each resource
. Weekly work instructions for each work centre
. Differentiation between priority, firm and tentative orders or enquiries
. Arrears reported and re-scheduled
. Information on options available as a result of overloading

Cost : 300.00 (software only)

--------------------------------------------------------------------------------

Company : Computerline Production Management Systems Ltd
Address : 118 Church Road, Addlestone, Weybridge, Surrey, KT15 1SG
Telephone: 0932 55757
Package : MAN-TRAC (Management by Time, Resource And Cost)
Hardware : Machines operating under PC-DOS, MS-DOS and CP/M

Modules/Facilities

1. MAN-TRAC 1 Inventory Control 600.00
2. MAN-TRAC 2 Workshop Scheduling 1200.00

- 205 -
3. MAN-TRAC 3  
4. MAN-TRAC 4  
5. MAN-TRAC 5  

Job-Costing  
Purchase Order Progress  
Shop Documentation  

500.00  
300.00  
300.00  

Cost: 7500.00 (software, hardware and implementation - 1984's prices)  
1950.00 - first year licence fee  
500.00 - Annual licence renewal fee  

---------------

Company: Concept Computer Systems Ltd  
Address: Princess House, High St, Bagshot, Surrey GU19 5AF  
Telephone: 0276 76303  
Package: CONCEPT II - Production Control System  
Hardware: DEC  

Modules/Facilities  
1. Data Base Management  
3. Forecasting and Planning  
5. Production Costing  
7. Capacity planning and loading  
2. Sales Order Processing  
4. Inventory Management  
6. Purchase Order Control  
8. Works Order Management  

---------------

Company: Davy Computing Ltd  
Address: Moorfoot House, 2 Clarence Lane, Sheffield S3 7UZ  
Telephone: 0742 71201  
Package: PRODUX (for jobbing manufacture)  
Hardware: Burroughs B25 and XF520 range, IBM PC, ALTOS Multi-user systems, SANYO range of micros.  

Modules/Facilities  

PRODUX 1 - Financial Accounts  
1. Sales  
2. Purchase Ledger  
3. Nominal Ledger  
4. Payroll  
5. Invoicing  
6. Production Interface  

PRODUX 2 - Material Control  
1. Stock Control  
2. Bill-of-Materials  
3. Routing  
4. Nett MRP  
5. Sales Order Processing  
6. Purchase Order Processing  
7. Works Order Processing  
8. Order Scheduling  
PRODUX 3 - Shop Floor Control

1. Shop Floor Documentation
2. Infinite Scheduling
3. Rough Cut Capacity Planning and Analysis
4. W-I-P Valuation and Added Value
5. W-I-P Tracking
6. Load Statements
7. Labour Analysis
8. Material Control Interface

PRODUX 4 - Job Costing Control

1. Estimating
2. Actual Costing
3. Variance Reporting and Job Profitability
4. Time Sheet Entry and Analysis
5. Purchase Order Processing
6. Sales Order Processing
7. Stock Control
8. Work Load Reporting

Company: Dewtec Computer Systems Ltd
Address: 36, Holloway Circus, Queensway, Birmingham B1 1EQ
Telephone: 021 643 8003
Package: DEWTEC Multi-User
Hardware: IBM PC, AT and compatibles, Sirius/Victor, Apricot Xi/Xen Olivetti M24/28, COMPAQ, RML

Modules/Facilities

Standard Module
Production Control 7250.00

Optional Modules
- Report Generator 1500.00
- Works Documentation 1500.00
- Production & Despatch Records 1500.00
- Price Maintenance 500.00
- Advice Notes & Invoicing P.O.A.
- Customer Order Acknowledgement 1000.00

Weight Estimating 500.00
Costing & Estimating 5500.00

Quotation Module 1000.00
Job Costing Module 4500.00
Routing Module 500.00
Cost of Sales Reporting 1000.00
Company: IBM UK Ltd.
Address: Manufacturing Industry Support Centre, PO Box 31, Birmingham Road, Warwick CV34 5JL
Telephone: 0926 32525
Package: COPICS - Communications Oriented Production Information and Control System
Hardware: IBM Mainframes

Modules/Facilities

1. Customer Order Servicing - Data Management
2. Customer Order Servicing - Order Management
3. B-O-M Utilities II
4. B-O-M On-line II
5. Inventory Accounting II
6. Inventory Planning and Forecasting II
7. Advanced Function/MRP II
8. Shop Order Release II
9. Plant Monitoring and Control
10. On-line Routing
11. Facilities Data Control
13. Purchasing
14. Receiving
15. Product Cost Calculations
16. CORMES - Communications Oriented Message System

* Finite Capacity. Schedules activities for due dates based on priority rules and capacity limitations.

Company: Kewill Systems Limited
Address: Clive House, Queens Road, Weybridge, Surrey KT13 9XB
Telephone: 0932 52046
Package: MICROSS Manufacturing System
Hardware: IBM Mainframes

Modules/Facilities

1. Stock Control 950.00
2. Bill-of-Materials 950.00
3. Requirements Planning 950.00
4. Purchase Order Printing 750.00
5. Sales Order Printing 1150.00
6. Production Control 2500.00
7. Shop Floor Documentation 750.00
8. Shop Floor Data Collection 1950.00
9. Job Costing 1500.00
Company: Marcus Software Systems  
Address: 26 Albion Place, Leeds, West Yorks LS1 6JS  
Telephone: 0532 434488  
Package: MARCOUNT - Accounting Suite and MARFACT - Production Suite  
Hardware: Machines running MS-DOS, CP/M-86, CP/M 2.2

Modules/Facilities

<table>
<thead>
<tr>
<th>MARCOUNT</th>
<th>MARFACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sales Purchase/Nominal Ledgers</td>
<td>1. MRP</td>
</tr>
<tr>
<td></td>
<td>450.00</td>
</tr>
<tr>
<td>2. Sales Invoicing</td>
<td>2. B-O-M</td>
</tr>
<tr>
<td></td>
<td>450.00</td>
</tr>
<tr>
<td>3. Stock Control</td>
<td>3. Capacity Planning</td>
</tr>
<tr>
<td>4. Job Contract Costing</td>
<td>4. M/C Scheduling</td>
</tr>
<tr>
<td>5. Pareto Analysis</td>
<td>5. Stock Control</td>
</tr>
<tr>
<td>7. Project Planning</td>
<td>7. Purchase Order Processing</td>
</tr>
<tr>
<td></td>
<td>8. Statistics</td>
</tr>
</tbody>
</table>

----------------------------------------------------------

Company: MIS Ltd.  
Address: 38, Albert Road North, Reigate, Surrey RH2 9EQ  
Telephone: 07372 45854  
Package: PC-FORUM  
Hardware: IBM PC and compatibles, Alpha Micro, Olivetti, ICL, Apricot Apple, DEC, Wang

Modules/Facilities

1. Foundry Management Package  
2. Production Control  
3. Financial Control  
4. Payroll and Personnel  
5. Stock Control

----------------------------------------------------------

Company: MSS Services Ltd  
Address: PO Box 31, Worthing, West Sussex  
Telephone: 0903 34755  
Package: Various Packages  
Hardware: Machines running PC-DOS, MS-DOS, CP/M-86, CP/M 2.2, EPSON QX-10, APPLE II and APPLE III
Modules/Facilities

1. Stock Recording and Control 300.00
2. Bill-of-Materials 450.00
3. MRP 500.00
4. Production Control 800.00
5. Kitting 400.00
6. Estimating 400.00
7. Standard Costing 400.00
8. Product Costing 400.00
9. Employment Agencies Record Systems 400.00
10. Personnel Manpower Management 400.00
11. Accountatnts Incomplete Record System 800.00

(Module Costs from 1984)

Company : NCR Limited
Address : 206 Marylebone Road, London NW1 6LY
Telephone: 01 723 7070
Package : IMCS II - Interactive Manufacturing Control System
Hardware : NCR Minicomputers

Modules/Facilities

2. Purchasing and Receiving 7. Routing
3. Order Processing 8. Master Production Scheduling
4. Sales Analysis 9. MRP
5. Capacity Planning 10. Inventory Management

Company : Safe Computing Limited
Address : 89-91 High Street, Leicester LE1 4JB
Telephone: 0533 29321
Package : MICRO-SafeS
Hardware : Machines running BOS operating system

Modules/Facilities

1. Part Master 8. Factory Paperwork
2. Part List 9. Trial Kitting
3. Stock Control 10. Master Manufacturing Schedule
4. Basic Costing 11. Purchase Order
5. ABC Analysis/Perpetual Audit 12. Work-in-Progress
7. Extended Costing 14. MRP 15. CRP
Company : SCICON Manufacturing Systems
Address : Sanderson House, 49 Berners Street, London W1P 4AQ
Telephone: 01 580 5599
Package : MANMAN
Hardware : Hewlett-Packard, HP 3000 Minicomputers

Modules/Facilities

1. Purchase Ledger
2. Nominal Ledger
3. Sales Order Processing and Accounting
   - Order Entry
   - Invoicing
   - Sales Ledger
   - Sales Analysis
4. Manufacturing Management
   - Inventory Control
   - BOM/Engineering Design
   - WIP/Shop Floor Control
   - Purchasing
   - MRP
   - Capacity Requirements Planning
   - Cost Accounting

-------------------------------------------------------------------

Company : Sheffield Micro (Business Systems) Ltd
Address : Victoria House, Rutland Park, Sheffield S10 2PB
Telephone: 0742 680256
Package : PLANIT/UNIPLAN
Hardware : ICL CBS series of microcomputers and ICL PC's

Modules/Facilities

1. PARTPLAN
   - Material Control and Requirements Planning
   - Sales Order Processing
   - Purchase Order Processing
   - Works Order Processing
   - Stock and BOM
   - MRP
2. JOB PLAN
   - Job Costing
   - Estimating
   - Scheduling
   - Analysis
   - Exception Reporting

3. LEDGERPLAN - ACCOUNTS
   - Sales Ledger
   - Invoicing Analysis
   - Purchase Ledger
   - Nominal Ledger
   - Payroll and SSP
   - Multi-Company Option
4. WIPPLAN
   - Work-in-Progress
   - Routing
   - Shop Floor Loading
   - Capacity Planning
   - Tracking
   - Shop Floor Documentation

5. INFOPLAN - Report Generator - Links to the above modules

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Appendix 4

Program Listings

The following program listings are contained within this Appendix:

A4.1 Calendar Maintenance Program
A4.2 Production/Delivery Schedule Program
A4.3 Production Planning/Programmes Program
A4.4 Resource Maintenance Program
A4.5 Resource Loading Program
A4.1 Calendar Maintenance Program
5 REM $INCLUDE:'SHARE'
10 REM ####### CALENDAR UPKEEP PROG #######
15 DEF FCN$#(ROW, COL) = CHR$(127) + "" + CHR$(34 + ROW) + CHR$(32 + COL)
19 IF NME$="" OR DTE$="" THEN CHAIN "LOGON"
60 EL$=""8H85BC3D87EB8H8H8RA9B1C792F4A5F41573889F00M": AFLAG=0:BFLAG=0
90 DIM
MN$(12), M$(12), M$(12), LOG$(5), XY$(1,7,6), SEY$(1,7,6), WX$(200), TM$(200), SET$(5), T
EE$(5), DEL$(200)
100 REM ** START **
110 YE=FIX(DTE/10000):COUN$=0
115 L<INSTR(ELS,MIDS|InST$(YE),2,2)):L<STR$(ELS,L<2,1)
120 ON ASC$(L<)-84 GOTO 130,135,140,145,150,155,160,130,135,140,145,150,155,160
130 JO=1:GOTO 170
135 JO=2:GOTO 170
140 JO=3:GOTO 170
145 JO=4:GOTO 170
150 JO=5:GOTO 170
155 JO=6:GOTO 170
160 JO=7
170 IF AFLAG=99 THEN RETURN
175 M$(1)=31:M$(2)=28:M$(3)=31:M$(4)=30:M$(5)=31:M$(6)=30:M$(7)=31:M$(8)=31:M$(9)=30:M$(10)=31
M$(12)=31:M$(12)=31
180 MN$(1)="JANUARY"; MN$(2)="FEBRUARY" 
181 MN$(3)="MARCH"; MN$(4)="APRIL" 
182 MN$(5)="MAY"; MN$(6)="JUNE" 
183 MN$(7)="JULY"; MN$(8)="AUGUST" 
184 MN$(9)="SEPTEMBER"; MN$(10)="OCTOBER" 
185 MN$(11)="NOVEMBER"; MN$(12)="DECEMBER" 
190 M$(1)="January"; M$(2)="February"; M$(3)="March"; M$(4)="April"; M$(5)="May"; M$(6)="June"; M$(7)="July"; M$(8)="August"; M$(9)="September"; M$(10)="October"; M$(11)="November"; M$(12)="December";
194 LOG$(1)="0":YES:IF:NOT:LOG$(1)="":"" (range on/off):LOG$(1)="" (e=END)
on/off:LOG$(1)="0":LOG$(1)="E":END
199 REM ** START OF CALENDAR PRINT **
200 C=Yes:DEL$="":COUN$=0:FLAG$=0:LOG$=0
202 GOSUB 00000:GOSUB 10000
203 AFLAG=0:PRINT FCN$#(1,1)"000":"Enter year (eg."YE"):";
205 BKGD$="MAXL=2:MINL=0:COL=C=1:GOSUB 60780:IF VAL$(1)>84 OR VAL$(1)<99 THEN 203
206 IF VAL$(1)=YE THEN 205 ELSE AFLAG=99:YE=VAL$(1):GOSUB 115:AFLAG=0
205 PRINT FCN$#(1,1,"CSRIGHT":""+STR$(YE-1900),1):IF FIX(YE/4)=YE/4 THEN
210 M$(2)=29 ELSE M$(2)=28
215 J=30:DEL$="":C=1:J=2:J=1:M=0:C=1
210 CLOSE:GOSUB 40000:IF BFLAG=99 THEN RETURN
215 M$(1)=FLA$="F";FLA$=17;GOSUB 1700;CS="(J1-2)1":RS="R" 
216 M=1
212 GOSUB 700
FCN$#(2,1,"CSPC$(27)=NEXT 2
220 IF FIX(M$(2)=M=2 THEN I=25:GOTO 225 ELSE I=0:PRINT FCN$#(1,
21,1",BKGD$="UNLON$:MN$(1)=PRINT FCN$#(R-2,C=35):MN$(1)="ULOFF"
225 FLA$=0:J=1
227 IF I=M$(100)=WX$(1+1):I+1:THEN FLA$=9;J=2+:GOTO 230
230 IF FLA$=" THEN PRINT FCN$#(R+1,"CSRIGHT":""+STR$(1,1):GOSUB 234
231 IF FIX(M$(2)=M=2 THEN SEY$(1,1,FIX(CS-17)4-1),RS=2=9 ELSE SEY$(1,1,FIX(CS-
217)4-1),RS=2)=9
215
220 PRINT FCNP$(AS, CS)FRG$(ROM\#RIGHT\#" **STR$(I_I, 2)RGFF\#SKGD\#
234 FLAG=0
235 IF FIX(M/2)=M/2 THEN X=FIX(CS-35)/4-1:Y=RS/2:XY(I, X, Y)=1 ELSE X=FIX(CS/4-
1/2:Y=RS/2:XY(I0, X, Y)=1
240 I=I+1:IF I>M:M THEN 300
250 CS=CS+I2:J2+1:IF FIX((J2-1)/7)=(J2-1)/7 THEN CS=CS+RS=RS+2
260 GOTO 227
300 REM # NEW MONTH #
315 IF FIX(M/2)=M/2 THEN GOSUB 500
319 IF CS>35 THEN CS=CS-35
320 J2=FIX(CS/4):IF J2=1 THEN J2=1
330 IF FIX(M/2)=M/2 THEN C=44 ELSE C=9
335 IF C=9 THEN FOR Z=1 TO 6:FOR Z1=1 TO 7:XY(0, I1, Z)=0:XY(I1, I1, Z)=0:NEXT
340 Z=1
345 GOTO 200
500 REM # ENTER HOLS #
505 M1=M-1
510 GCT=0:TCT=0:YES=0:PRINT FNCP$(R+11, CB)FRG$("UPDATE "M1$(M1)" non-work":PRINT
515 FNCP$(R+14, 01)"day status (Y/N) ?;" "CUP$n=MAX#1:MIN#1:RDWR=14:CDL=C$30:GOSUB 600:IF YES<>"Y" AND YES<>"N" THEN
520 IF YES="Y" THEN 530
520 IF M1=M THEN I9=1:NO$="N":GOTO 650 ELSE I9=0:NO$="N":GOTO 650
530 PRINT FNCP$(R+11, CB)"see instructions ----> " "PRINT
535 FNCP$(R+14, CS)"SPACE$(27)
540 IF FIX(M1/2)=M1/2 THEN X=68 ELSE X=73
550 PRINT FNCP$(R+11, CB)"ROM#" "RGFF#
555 YD=8:10:IF I9=1 THEN I9=1:15:55 ELSE I9=0:15=0
560 X=I0:Y1=YD
565 YES=0
570 PS$=INPUT$(1)
570 IF PS$="E" THEN GOSUB 800:IF EFLAG=0 THEN GOTO 650 ELSE GOTO 550
572 IF PS$="I" THEN GOSUB 6000:GOTO 560
574 IF PS$="2" THEN GOSUB 1000:GOTO 559
576 IF PS$="4" THEN GOSUB 1100:GOTO 559
578 IF PS$="6" THEN GOSUB 1200:GOTO 559
580 IF PS$="8" THEN GOSUB 1300:GOTO 559
582 IF PS$="0" THEN GOSUB 1400:GOTO 560
584 IF PS$="*" THEN GOSUB 1500:GOTO 560
590 IF PS$="A" THEN GOSUB 1600:GOTO 560
592 GOTO 560
595 IF NO$="N" THEN 690
655 FOR I=1 TO 7:FOR Z1=1 TO 6
665 IF SEY%(I9, 2, Z1)=9 THEN
670 COUNT=COUNT+1:TIM$(COUNT)=XY(I9, Z1, Z1):TIM$(COUNT)=TIM$(COUNT)+(M1\#1000)
680 IF SEY%(I9, 2, Z1)=8 THEN DELX=DELX+1:DEY(DELX)=XY(I9, Z1, Z1)+(M1\#1000)
695 NEXT Z1:NEXT Z
690 FOR I=1 TO 7:FOR Z1=1 TO 6:SEY%(I9, Z1, Z1)=0:NEXT Z1:NEXT Z
695 NO$="--"
699 IF M1=M THEN GOSUB 1750:RETURN ELSE M1=M+1:GOTO 510
700 REM ?? CURRENT MONTH'S HOLS ??
710 M=M+1:C=0:CTS=0
720 FOR Z=1 TO 200:X3=FIX(MX(2)/100)
730 IF M1/M2 THEN 750
740 IF C=0 THEN CTS=Z
745 CT=CT+1
750 NEXT Z
799 RETURN
800 REM # BLANK OUT BLOCK #
805 FOR I=1 TO 5:IF SETX(I)<99 AND TESY(I)<99 THEN 807
806 IF SETX(I)=99 AND TESY(I)=99 THEN EFLAG=0:ELSE EFLAG=9:RETURN
807 NEXT Z
810 IF VAL(YY$)=0 THEN YY$=""
820 PRINT FNCP$(YI+1,XI)"":IF YI+1=R+11 THEN PRINT
830 PRINT CHR$(196)CHR$(196)CHR$(196)
840 IF Z=2 AND LAG=0 THEN EFLAG=9:RETURN
850 IF (SEXY(Z,2,XI))<1 AND SEXY(Z,1,XI)<2 THEN 890
860 IF SEXY(Z,2,XI)<1 THEN 880
870 WHILE SEXY(Z,2,XI)<2:SEXY(Z,1,Z)=9:LAG=Z=Z+1
890 IF Z=7 THEN Z=1:GOTO 865 ELSE GOTO 880
900 REM ** FORMAT DISPLAY **
910 IF XY=0 THEN XY$="" ELSE XY$=RIGHT$(""+STR$(XY),2)
920 IF XY=0 THEN XY$="" ELSE XY$=RIGHT$(""+STR$(XY),2)
930 RETURN
1000 REM ** DOWN **
1010 YI=YI+2:IF YI=1+10 THEN YI=10+1
1020 XY=XY+2,FIX((X1-ZB)/4-1),Y1/2:XY=XY+2,FIX((X1-ZB)/4-1),(Y1-2)/2
1030 GOSUB 900
1040 PRINT FNCP$(YI-1,XI)"*:PRINT FNCP$(YI+1,XI)"
1099 RETURN
1100 REM ** LEFT **
1110 XI=XI-1:IF XI<CB+ZB THEN XI=CB+ZB
1120 XY=XY+2,FIX((X1-ZB)/4-1),Y1/2:XY=XY+2,FIX((X1-ZB)/4-1),(Y1-2)/2
1130 GOSUB 900
1140 PRINT FNCP$(YI+1,XI-1)"*:PRINT FNCP$(YI+1,XI)"
1199 RETURN
1200 REM ** RIGHT **
1210 XI=XI+1:IF XI>CB+ZB THEN XI=CB+ZB
1220 XY=XY+2,FIX((X1-ZB)/4-1),Y1/2:XY=XY+2,FIX((X1-ZB)/4-1),(Y1-2)/2
1230 GOSUB 900
1240 PRINT FNCP$(YI+1,XI-1)"*:PRINT FNCP$(YI+1,XI)"
1299 RETURN
1300 REM ** UP **
1305 YI=YI-1:IF YI<1 THEN YI=1
1310 XY=XY+2,FIX((X1-ZB)/4-1),Y1/2:XY=XY+2,FIX((X1-ZB)/4-1),(Y1+2)/2
1320 GOSUB 900
1330 PRINT FNCP$(YI+1,XI)"*:PRINT FNCP$(YI+1,XI)"
1399 RETURN
1400 REM ** TOGGLE **
1405 IF XY+2,FIX((X1-ZB)/4-1),Y1/2=0 THEN RETURN
1407 IF SEXY(Z,9,FIX((X1-ZB)/4-1),Y1/2)=1 OR SEXY(Z,9,FIX((X1-ZB)/4-1),Y1/2)=2 THEN RETURN
1410 YES=YES+1:IF FIX(YES/2)=YES/2 THEN HS=ROFF$ ELSE HS=RON$  
1420 IF HS=RON$ AND SEXY(9,FIX((X1-ZB)/4-1),Y1/2)=9 THEN PRINT
1430 FNCP$(R+13,CB+50)"yes"*:GOTO 1499  
1430 IF HS=RON$ AND SEXY(9,FIX((X1-ZB)/4-1),Y1/2)=9 THEN PRINT
1430 FNCP$(R+13,CB+50)"yes"*:GOTO 1499  
1499 RETURN
1500 REM ** START RANGE **
1505 IF SY% (79, FIX ((X1-18)/4-1), Y1/2) = 9 THEN RETURN
1510 IF XY% (79, FIX ((X1-18)/4-1), Y1/2) = 0 THEN RETURN
1520 X2 = X1-18-1: IF X2/2+3 THEN RETURN
1530 Y2 = Y1: X2 = X1-1
1535 IF SY% (79, FIX ((X1-28)/4-1), Y1/2) <= 1 THEN 1535
1533 SY% (79, FIX ((X1-28)/4-1), Y1/2) <= 0: SCT = SCT + 1: PRINT FNCP$(Y2, X2) "*" 
1534 IF SCT = 0 THEN SCT = 0: SCT + 1: IF SCT > 5 THEN SCT = 5: RETURN
1540 PRINT FNCP$(Y2, X2) FRGD$ (*"SKGS"
1550 SET(SCT) = 99: SY% (79, FIX ((X1-28)/4-1), Y1/2) = 1
1559 RETURN
1600 REM ** END RANGE **
1605 IF SY% (79, FIX ((X1-28)/4-1), Y1/2) = 9 THEN RETURN
1610 IF XY% (79, FIX ((X1-28)/4-1), Y1/2) = 0 THEN RETURN
1620 X2 = X1+2: Y2 = Y1
1622 IF SY% (79, FIX ((X1-28)/4-1), Y1/2) >= 2 THEN 1625
1623 SY% (79, FIX ((X1-28)/4-1), Y1/2) <= 0: TCT = TCT + 1: PRINT FNCP$(Y2, X2) "*"
1624 IF TCT = 0 THEN TCT = 0: TESS(TCT) = TESS(TCT) + 0: RETURN
1625 TCT = TCT + 1: IF TCT > 5 THEN TCT = 5: RETURN
1630 PRINT FNCP$(Y2, X2) FRGD$ (*"SKGS"
1640 TESS(TCT) = 99: SY% (79, FIX ((X1-28)/4-1), Y1/2) = 2
1659 RETURN
1700 REM ** ENTER A MONTH **
1705 IF FIX(FLAG/17/2) = FLAG/17/2 THEN RETURN
1710 PRINT FNCP$(R+13, CB)$FRGD$ *Enter month (1-12):
1713 "*"CB1$ = CB1$: CB1$ = CB1$: PRINT FNCP$(R14, CB)*" TO
1719 ABORT*SPACE(15): MAXL = 2: MINL = 1: ROW = R+13: COL = CB1$+20: GOSUB 60980: IF VAL(I$) < 0 OR
1719 VAL(I$) > 12 THEN 1710
1715 IF VAL(I$) = 0 THEN GOTO 1796
1720 M0 = MAXL: IF FM((MO+2)-MO) THEN M0 = M0 + 1 ELSE M0 = M0
1725 J2 = (J2-1)/7: J2 = J2 + 1: FOR I = 72 TO M0: J2 = J2 + 1: IF FIX((J2-1)/7) = (J2-1)/7 THEN J2 = 1
1735 NEXT I
1740 NEXT I
1750 M = M1: RETURN
1770 REM ** SAVE CHANGES **
1780 IF COUNT = 0 THEN RETURN ELSE PRINT FNCP$(R+14, CB)$SPACE(127): GOSUB 3500
1785 PRINT FNCP$(R+13, CB)*Save changes (Y/N) ?
1787 "*"MAXL = MINL = 1: ROW = R+13: COL = CB1$+22: GOSUB 60980: IF I$ = "Y" AND I$ = "N" THEN 1793
1789 IF I$ = "N" THEN 1795 ELSE GOSUB 41000: PRINT FNCP$(R+13, CB)*Calendar file updated -
1793 "*"PRINT FNCP$(R+14, CB)*hit any key to continue *GOSUB 20020
1795 COUNT = 0: DELETE = 0: CLOSE = GOSUB 40000: RETURN
1796 PRINT FNCP$(R+13, CB)*Another Year (Y/N) ?:
1797 "*"PRINT FNCP$(R+14, CB)$SPACE(126)
1798 ROW = R+13: COL = CB1$: MINL = 1: MAXL = 1: GOSUB 60980: IF I$ = "Y" AND I$ = "N" THEN 1798
1799 IF I$ = "N" THEN X = 241: GOSUB 6150
1800 GOSUB 3000: BFLAG = 99: GOSUB 200: BFLAG = 0
1810 GOTO 200
2090 REM **** SORT ( STRING TYPE ) ****
2100 SW1 = COUNT: IF COUNT = 0 THEN RETURN
2120 POX = 0: SW1 = SW1 : 2: IF SW1 = 0 THEN RETURN
2130 POX = POX + 1
2140 IF (POX + SW1) = COUNT THEN 2090
2150 IF IX X (POX) = M0 (POX + SW1) THEN 2090
2170 SWAP (IX X (POX), M0 (POX + SW1)) $GOSUB 2090
2180 POX = POX - 1
2190 IF POX < SW1 THEN 2090
2190 IF IX X (POX) = M0 (POX + SW1) THEN 2090
2190 - 218 -
2120  SWAP X(P02),X(P01-XM2);GOTO 2080
3000  REM ** CLEARDOWN FOR ANOTHER YEAR **
3010  FOR Z=0 TO 2;FOR Z1=1 TO 7;FOR Z2=1 TO 6
3020  K1=(Z0-1,Z1,Z2)=0;SEY=(Z0-1,Z1,Z2)=0;NEXT Z2;NEXT Z1;NEXT Z0
3030  FOR Z=1 TO 200;TIMZ(1)=0;WXZ(1)=0;NEXT Z
3040  RETURN
3500  REM ** MX ARRAY SORT II **
3510  Z=0
3520  Z=Z+1:IF WXZ(1)=0 OR Z=200 THEN 3530
3525  GOTO 3520
3530  IF Z=200 THEN RETURN
3540  FOR Z1=1 TO Z;COUNT=1;WXZ(1)=(TIMZ(Z1-I+1):NEXT Z1
3550  COUNT=I+COUNT-1;GOSUB 2000
3552  IF DEL=0 THEN 3560
3554  Z1=0:FOR Z=1 TO DELZ
3555  Z1=Z1+1:IF Z1>200 THEN 3559
3556  IF WXZ(1)=DEZ(1) THEN 3558
3557  GOTO 3555
3558  WXZ(1)=9999;DEZ(1)=0
3559  Z1=0:NEXT Z
3560  GOSUB 4000
3570  RETURN
4000  REM ** SORT OUT MX ARRAY **
4010  FOR Z=1 TO 199:IF WXZ(1)=WXZ(1+1) THEN WXZ(1)=9999
4015  NEXT Z
4020  GOSUB 2000
4030  FOR Z=1 TO 200:IF WXZ(1)=9999 THEN WXZ(2)=0
4035  NEXT Z
4040  RETURN
20000  REM **** ANY KEY ROUTINE ****
20010  PRINT FCNP(-21,0)*" Hit any key to continue"
*CSUS*
20020  SS=INKEY$:IF SS="*" THEN 20020
20030  IF ASC(SS)=190 THEN GOSUB 61230
20040  RETURN
30000  REM ** SCREEN CLEAR **
30010  WIDTH 255
30020  PRINT NOLIN;NOCAP;NOCUR;EKGDECLS*
30030  PRINT FCNP(-2,01);RON$;FACES;180;ROFFB*
30040  PRINT FCNP(-2,17);"*FUNCTION; CALENDAR UPKEEP **
30050  PRINT FCNP(-2,01);RON$;USER;*ROFFB*
30060  PRINT FCNP(-2,56);RON$;DATE;*ROFFB*
30070  PRINT FCNP(-2,2);RON$;MKE;*ROFFB*:PRINT FCNP(-2,71);RON$;DATE;*ROFFB*
30080  RETURN
31000  REM ** DRAW BOXES **
31010  FOR Z=C TO C+26;PRINT FCNP(R-3,Z);CHR$(195):PRINT FCNP(R-3,I+35);CHR$(195);PRINT FCNP(R-3+123);CHR$(195);PRINT FCNP(R-3+123);CHR$(195);PRINT
31020  PRINT FCNP(R+3,C+27);CHR$(191):PRINT FCNP(R-3,C+27);CHR$(191);PRINT FCNP(R+3,C+27);CHR$(191);PRINT FCNP(R+3,C+27);CHR$(191);PRINT
31030  PRINT FCNP(R+11,C+27);CHR$(192):PRINT FCNP(R+11,C+27);CHR$(192);PRINT FCNP(R+11,C+27);CHR$(192);PRINT FCNP(R+11,C+27);CHR$(192);PRINT
31040  PRINT FCNP(R-3+2,C-1);CHR$(179);PRINT FCNP(R-3+2,C-1);CHR$(179);PRINT FCNP(R-3+2,C-1);CHR$(179);PRINT FCNP(R-3+2,C-1);CHR$(179);PRINT
31040  PRINT FCNP(R+3+2,C-1);CHR$(179);PRINT FCNP(R+3+2,C-1);CHR$(179);PRINT FCNP(R+3+2,C-1);CHR$(179);PRINT FCNP(R+3+2,C-1);CHR$(179)
31044  PRINT FCNP(R-1,C)UL0$"Sun Mon Tue Wed Thu Fri Sat":PRINT FCNP(R-1,C+35)"Sun Mon Tue Wed Thu Fri Sat*UL0F$
31045  GOSUB 32000
31050  RETURN
32000  REM ** DRAW FUNCTIONS BOX **
60150 RETURN
60160 REM INPUT STRING ROUTINE
60170 IF A=""
60180 PRINT FNCP$(ROW, COL) $FNCP$SPACE$(MAXL-LEN(A)) ROFF$CUP$
60190 GOSUB 61110
60200 IF X=8 THEN GOTO 61060
61070 IF X<13 AND LEN(A$)<MINL THEN GOTO 61080 ELSE IF X=13 GOTO 61000
61040 IF LEN(A$)>MAXL THEN A$=A$+"\n"
61050 GOTO 61000
61060 IF LEN(A$)>0 THEN A$=LEFT$(A$, LEN(A$)-1)
61070 GOTO 61000
61080 A$=LEFT$(A$, MAXL-MAXL)+"
"
61090 PRINT FNCP$(ROW, COL) $FNCP$CUP$
61100 RETURN
61110 REM SET VALID CHARACTER
61120 A$=INKEY$: IF A="" THEN GOTO 61120
61130 X=ASC$(A$)
61140 IF X>127 AND X<97 AND X>90 AND X<126 OR X<8 OR X>13 THEN RETURN
61150 IF X=185 OR X=27 THEN CLEAR:CHAIN "CAPMENU"
61160 IF X=190 THEN GOSUB 61200
61170 IF X=186 THEN GOSUB 62000:LPRINT
61180 IF X=189 THEN GOSUB 62000:FOR L=1 TO 10:LPRINT:NEXT L
61190 GOTO 61120
61200 GOSUB 62000
61210 REM
61220 REM
61230 DEF SES=$B$FO00
61240 FOR I2 = 0 TO 23
61250 WES=""
61260 FOR J2 = 0 TO 158 STEP 2
61270 WES=WES+CHR$(ABS(PEEK(I2*160+J2)-64))
61280 NEXT J2
61290 LPRINT WES
61300 NEXT I2
61310 WIDTH 255
61320 RETURN
62000 RETURN
62010 PRINT CURPOS$CHR$(55)$CHR$(32)"
62020 REM ON "CHR$(7)$CUP"
62030 A$=INKEY$: IF A="" THEN 62020
62040 X=ASC(A$): IF X=241 THEN 61150
62050 PRINT CURPOS$CHR$(155)$CHR$(32)"
62060 "CUP"
62070 RESUME
62080 END
63999 REM "CAL" (APRICOT CRE 07/08/85)
A4.2 Production/Delivery Schedule Program
12 DIM MD(36),MPD(22),MD$(2),MD$(20)
13 GOSUB 55000:MAC=L$(TD$(36),17,1)
15 DIM Y(7),L(12),WE(14),PO(14),STO(14),GTG(14)
16 IF MAC="1" THEN 18
17 WIDTH LPRINT 255:GOTO 19
18 WIDTH "LPT",255
19 IF NME="" OR DTE="" THEN CHAIN "PPP"
20 GOSUB 62000
21 GOSUB 16000
22 CUM=0:SE=WAL(MD$(TD$(36),15,1))
23 YL=53:SD=3:SN=1:RN=1:CM=4:SM=10
25 FOR I=1 TO 12:READ L(I):NEXT I
26 FOR I=1 TO 7:READ Y(I):NEXT I
27 DATA 31,29,31,30,31,30,31,30,31,30,31,30
28 DATA 5,6,7,1,2,3,4
29 DEF NME=$(ROM$4,5)+CHR$(27)*ROM$4*CHR$(34)+ROM$4*CHR$(32)+ROM$4
30 GOSUB 39000
31 ROM$=ROM$4:COL$=46:MAXL=16:MINL=1
32 GOSUB 29000:KEY=1:KEY1=1
33 IF IS=SPACE$(16) THEN 58
35 ROM$=ROM$4:COL$=46:GOSUB 68700
36 GOSUB 22500
38 IF FLAG THEN 59
39 DMY=COMDAT:GOSUB 28000
40 DTE=INT(Y*10000)+(Y*100)+01
41 REM ** CALC. FOR DATES **
42 DIF=7-DIFF=DD+1:DIFF=DD+1
43 IF Y1=1998 THEN Y1=Y1-1998
44 IF INT(Y1/4)=Y1/4 THEN L(2)=29
45 IF WED(L(1)) THEN GOSUB 486
46 CW=(Y1*10000)+(M+100)+WED:REM ** CURRENT W/END DATE
47 WE(2)=CW
48 REM ** ARRAYS W/END DATE **
49 GOSUB 486
53 WE(1)=42
54 REM ** NEXT 12 W/ENDS CALC. **
56 FOR I=3 TO 14
57 WED=WE+7
58 IF WED(L(1)) THEN GOSUB 485
59 WE(1)=(Y1*10000)+(M+100)+WED
60 NEXT I
62 REM ** WE(1)=D"WWARD **
63 REM ** MAIN PART OF PROG. **
64 GOSUB 26800:REM ** KEY & PROCESS **
65 GOSUB 16000:REM ** PRINT HEADERS **
66 GOSUB 49900:REM ** OPEN FILES **
67 GOSUB 42900:REM ** NO. ON FILE? **
68 GOSUB 27900:REM ** READ & VALIDATE **
69 GOSUB 20000:REM ** SORT-STRING TYPE **
70 GOSUB 99000:REM ** COLLATING & PRINTING **
71 GOSUB 92900
72 REM:SA=** Total Quantities --->**:SPACE$(15)
73 REM:FOR I=1 TO 14:SG=S$+RIGHTS$**:STR$(GTG(13))***:6:NEXT 13
74 REM:LPRINT STRING$(126,="*"):LPRINT S$:LPRINT STRING$(126,"*":LPRINT:LPRT
76 GOTO 688
78 REM ** 1ST W/END DATE CALC. **
79 Y2=Y1:ME=M+1
410 IF M2>12 THEN M2=M2-12; Y2=Y2+1
420 WED=WED-7-(M1)
430 M1=M2; Y1=Y2
440 RETURN
460 REM ** CALL FOR D/DUE DATE **
465 Y2=Y1; M2=M1
470 DIF=WED-7; IF DIF>8 THEN GOTO 500
480 M2=M1-1; IF M2=0 THEN M2=12; M2=12-M2; Y2=Y1-1
490 DIF=(M2)2-(7-WED)
500 AWD=(Y2+10000)+(M2*100)+DIF
510 RETURN
560 X=27; GOTO 6150
1680 REM ** PRINTING HEADERS **
1685 IF MID$(KEY$,1,1)="*" THEN KEY1=LEFT$(TX$(5),11) ELSE KEY1=KEY$
1690 LPRINT; LPRINT
1695 LPRINT STR$(156,"**")
1700 IF PROG=2 THEN GOSUB 1690; GOTO 1670
1720 LPRINT; LPRINT; LEFT$(TX$(9),79); LEFT$(TX$(7),25)
1740 LPRINT; LPRINT; MID$(TX$(6),36,43); LEFT$(TX$(9),23)
1750 LPRINT; LPRINT; RHS$(TX$(10),28); DLEMID$(TX$(10),29,58); LEFT$(TX$(11),21)
1760 LPRINT; LPRINT; LEFT$(TX$(12),37)
1770 LPRINT; LPRINT; STR$(156,"**")
1780 RETURN
1960 REM ** PRINT LPRINT **
1965 LPRINT; LPRINT; "**"; KEY1; MID$(TX$(15),36,43); LEFT$(TX$(16),27)
1970 LPRINT; LPRINT; LEFT$(TX$(17),28); DLEMID$(TX$(17),29,58); LEFT$(TX$(18),27)
1975 LPRINT; LPRINT; LEFT$(TX$(19),79); LEFT$(TX$(19),27)
1980 RETURN
2000 REM *** SORT ( STRING TYPE ) ***
2010 SWZ=COUNT: IF COUNT=0 THEN SZ=LEFT$(TX$(26),26); LPRINT S$: GOTO 600
2020 PDX=0; SWZ=SWZ+2; IF SWZ=0 THEN RETURN
2080 PDX=PDX+1
2080 IF (PDX=SWZ) THEN COUNT THEN 2020
2090 IF AR$(PDX,1)=AR$(PDX+SWZ,1) THEN 2020
2095 SWAP AR$(PDX,1), AR$(PDX+SWZ,1)
2100 SWAP AR$(PDX,1), AR$(PDX+SWZ,1): GOTO 2090
2085 PDX=PDX+1
2086 IF SWZ=0 THEN 2040
2086 IF AR$(PDX,1)=AR$(PDX+SWZ,1) THEN 2030
2090 SWAP AR$(PDX,1), AR$(PDX+SWZ,1)
2090 SWAP AR$(PDX,1), AR$(PDX+SWZ,1): GOTO 2090
2095 REM *** CHECK SUFFIX ***
2100 FOR K=16 TO 1 STEP -1
2100 IF K=1 THEN FL=1: RETURN
2130 IF MID$(TX$(2),K,1)="" THEN 2590
2140 IF MID$(TX$(2),K,1)=MID$(TX$(32),28,1) THEN FL=1: RETURN
2150 FL=0: RETURN
2150 NEXT K
2160 REM *** KEY & PROCESSING ***
2160 KEY=LEFT$(KEY$+SPACE$)(KEYLEN)
2160 PRINT FNP$(4218); LEFT$(TX$(34),79); CUPS
2160 PRINT; INSTR$(KEY$,"*");1; IF MATCH=0 THEN MATCH=KEYLEN
2160 RETURN
2160 REM *** READ & VALIDATE ***
2170 PRINT FNP$(17,40); LEFT$(TX$(37),23): PRINT FNP$(17,56): RECO
2170 160=160+1; IF 160=RECO THEN RETURN
2170 160=160: SET #2,596
2170 IF F2=2=SPACE$(16) OR INSTR$(F2,CHR$(8))=0 THEN 2785
2170 GOSUB 18800: REM 0SUB 2500
2725 REM IF Fl=1 THEN 2795
2726 REM=DP(22);GOSUB 25880
2727 IF D(23)=0 THEN 2785
2728 CM:=FOR AB=12 TO 11;SE:=CM+DP(ABX):NEXT ABX
2729 IF PROB=2 AND CM=8 THEN 2785
2730 IF PROG=1* AND DP(3)-DP(1)>8 THEN 2785
2731 IF LEXT*(KEY+MATCH-1)=LEFT*(D(3),MATCH-1) THEN
2732 COUNT:=COUNT+1:
2733 Lاري=COUNT,1:=LEFT*(SPACE*(7)+STR*(DP(1),7)+D(1))
2734 PRINT FNCP(17,2816&)*CUP*GOTO 2785
9290 REM ** PRINTOUT PART NUM. & SUB-TOT FOR CUST.CHANGE **
9210 GOSUB 9180
9220 S=LEFT*(TAX*(21),1B)+SPACE*(21)
9230 LPRINT STRING*(156,"-"
9240 FOR I=1 TO 14:*FT=STR*(STOT(I))
9250 IF STOT(I)>99999999 THEN FT=STR*(INT(STOT(I)/1000))++κ]
9260 S=S+RUGHT*(SPACE*(7)+FT**",",8):NEXT 13
9270 PRINT FNCP(21,8)+SPACE*(7)&*CUP*
9280 LPRINT STRING*(156,"-");LPRINT
9290 FOR I=1 TO 14:*STOT(I)=STOT(I)+STOT(I):STOT(I)=0
9295 RETURN
9300 REM ** PRINT OUT PART NUMBER DETAILS **
9310 S=" **FDo** ++"DD** "
9320 FOR I=1 TO 14:*FT=STR*(POT(I))
9330 IF POT(I)>99999999 THEN FT=STR*(INT(POT(I)/1000))++κ]
9340 S=S+RUGHT*(SPACE*(7)+FT**",",8):NEXT 13
9350 IF PROG=2 THEN 9330 ELSE FT=STR*(CDMS)
9360 IF CDMS>99999999 THEN FT=STR*(INT(CDMS/1000))++κ]
9370 S=S+RUGHT*(SPACE*(7)+FT**",",8)
9380 LPRINT:LPRINT S#
9390 FOR I=1 TO 14:*STOT(I)=STOT(I)+POT(I):POT(I)=0
9400 CDMS=0
9405 RM=1:RETURN
9400 REM ** PROGC=2 OPTION FOR LEAD TIME OFFSET **
9400 A=VAL(MID*(STR*(D(23)),6,2));B=VAL(MID*(STR*(D(23)),4,2));C=VAL(MID*(STR*(D(23))
2,2,2))
9415 IF INT(C/4)<>C/4 THEN L(2)=32
9420 REM + USE EITHER 9420 OR 9440 FOR LEAD TIME IN WKS. OR DAYS, RESPECTIVELY #
9430 MD24=INT(MD(24));IF MD(24)>MD24 THEN MD24=INT(MD(24)+7)+1 ELSE MD24
9440 =INT(MD(24)+7)
9440 REM + MD24=INT(MD(24));IF MD(24)>MD24 THEN MD24=MD24+1
9450 AI=4-MD24
9460 IF AI>0 THEN GOTO 9580
9465 C=CA
9467 B=B
9470 B1=B1-1:IF B1<>0 THEN B1=C1:C1=1
9480 MD1=MD24-4;AI=L(B1)-MD24:IF AI<>8 THEN A=A+L(B1):GOTO 9470
9490 C=C1-B1
9500 D(23)=C*10008+(B*100)+A1
9510 8(2)=28
9520 RETURN
9580 REM ** PRINTING & SUCH LIKE **
9580 FOR I=1 TO COUNT
9590 S=RAN=AR(18,1)
9600 GOSUB 10008
9608 REM=DP(22)
9608 GOSUB 25800
9608 IF I<1 THEN GOTO 9580*CD=DP(1):CD=CD*(3):GOSUB 45000
9889: REM **SUB-TOT ON CHANGE OF CUST.**
9890 IF PAM=1 THEN PD$=OK(1):OD$=D(4) ELSE 9899
9899 IF D(1)=PD$ THEN 9900 ELSE GOSUB 9388:GOTO 9888:REM ** DETAILS ON PART
9900 NUM. CHANGE **
9901 12=1
9905 IF PROG$="2" THEN GOSUB 9488
9906 IF PROG$="1" THEN CUM=D(3)-DP(10):GOTO 9918 ELSE 9907
9907 FOR TI=12 TO 11+SE:CUM=CUM+DP(TI):NEXT TI
9910 IF X(23)=AE(12) THEN POT(12)=POT(12)+CUM:GOTO 9945
9920 12=12+1:IF 12>13 THEN GOTO 9949
9930 IF X(23)=AE(12-1) AND X(23)=AE(12) THEN POT(12)=POT(12)+CUM:GOTO 9945
9940 GOTO 9920
9943 POT(14)=POT(14)+CUM
9945 CUM=1:REM+RH+1
9946 T2%=1:FOR TI=1+SE+1 TO SD/:CCMS=CUM+DP(11+SE+T2%):T2%=T2%+1:NEXT TI%
9947 NEXT 1B
9950 REM ** FOR ORDER STATUS **
9950 GET #1,SRNC:GET #2,SRNC:GET #7,SRNC:
9978 GOTO 10008
10000 REM *** READ ORDER ***
10002 GOTO 9908
10003 FOR J1%=1 TO 3
10005 GET #J1%,SRNC:
10007 NEXT J1%
10009 GET #7,SRNC:
10010 BC%=1:CD%=1:GH%=1:H=1
10020 FOR J1%=1 TO 3
10023 D$(J1%)=F$(J1%)%
10030 NEXT J1%
10035 FOR J1%=18 TO 20
10038 D$(J1%)=MID$(CORD$,BC%,8)
10040 BC%=BC%+8
10048 NEXT J1%
10050 FOR J1%=3 TO 22
10070 DP(J1%)=D$(MID$(PCT$,GH%,4))
10110 GH%=GH%+4
10120 NEXT J1%
10130 FOR J1%=23 TO 24
10140 D(J1%)=D$(MID$(SPT$,GH%,4))
10150 GH%=GH%+4
10160 NEXT J1%
10170 FOR J1%=27 TO 36
10180 D(J1%)=D$(MID$(SPT$,GH%,4))
10190 GH%=GH%+4
10200 NEXT J1%
10210 RETURN
16000 REM **** GET SPECIALS FROM SCREENS FOR DELSCHED ****
16010 OPEN "R",#15,"MAIN.FIL",80
16020 FIELD #15,80 AS MF$1
16030 GET #15,12
16040 ID$(MF$)=MID$(MF$,6,12)
16050 ID$(MF$)=MID$(MF$,45,12)
16060 CLOSE #15
16080 RETURN
22500 REM ************ GET YES OR NO ANSWER ************
22510 MAXXY=1:MINXY=1:ROW%=21:COL%=45
22520 GOSUB 68998
22530 IF ID$(MF$)=TX$(2,2,1) THEN FLAG=1:RETURN
22540 IF ID$(MF$)=TX$(2,4,1) THEN FLAG=9:RETURN
22550 GOTO 22500

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25805 REM **** TO READ METHODOING FILE ****
25806 GET #6,RLC10:*=F(!.6):REM AFORE GET INSERT IF TYPE$="F" THEN
25818 GET #8,RLC2
25820 DK(4) = F(8)
25828 BK=1:DS=1;1X=1:PM=1
25868 FOR J1X = 5 TO 17
25878 DK(J1X) = MID$(ROFS,BK,3)
25888 BK = BK + 8
25998 NEXT J1X
25968 FOR J1X = 1 TO 2
25918 DK(J1X) = CVS(MID$(INRS,BK,4))
25928 BK = BK + 4
25938 NEXT J1X
25948 FOR J1X = 1 TO 22
25958 DK(J1X) = CVS(MID$(FPT$,BK,4))
25968 BK = BK + 4
25978 NEXT J1X
25980 FOR J1X = 1 TO 2
25988 DK(J1X) = CVS(MID$(OPT$,PB,8))
25998 PX = PX + 8
25908 NEXT J1X
25928 FOR J1X = 7 TO 8
25928 DK(J1X;18) = CVS(GA$(J1X))
25948 NEXT J1X
25925 IF PROGS="2" OR PROGS="1" THEN GOSUB 26800
25925 RETURN
26000 REM **** dd/mn/yy --> d/mm/yy ****
26010 DMY$=RIGHT$(STR$(DMY$),6)
26028 YM=VAL(MID$(DMY$,4,2));YM=1=VAL(MID$(DMY$,3,2));MD1=VAL(MID$(DMY$,5,2))
26038 Y2=Y1
26048 IF Y2>99 THEN GOTO 26800
26058 Y1=1+1900
26068 JD=101=JM=1;YM=Y1;GOSUB 26500;UN=NO
26078 D1=Y1(U-7)+INT(U/7)+1
26088 UN=8;GOSUB 26780
26098 RETURN
26000 REM ** SOLVING FOR DAY NO. **
26018 ND=DF-1
26028 FOR 11=1 TO MF-1:ND=ND+L(11):NEXT 11
26058 11=INT(YF/100)
26048 IF YF(4)*INT(YF/4) GOTO 26598
26058 IF YF/100=11 GOTO 26598
26068 IF ND=59 GOTO 26598
26078 IF MF=3 GOTO 26598
26088 ND=NO-1
26098 ND=NO+36524;411+INT(365.25*(YF-100*11))
26088 RETURN
26000 REM ** SOLVING FOR WEEK NO. **
26018 IF YF=SY THEN 26748
26028 FOR IS=1 TO (Y2-1)-SY1)
26038 IF SY1+SY1=4*INT((SY1+1)5)/4 THEN UN=UN+1
26048 NEXT 15
26048 IF Y2+INT(Y2/4) AND M1>2 THEN UN=UN+1
26058 UN=UN+L(SM1)-5(1-1)+511
26068 IF Y2(SY1 THEN 26798
26078 FOR SI=SM1+1 TO MI-1:UN=UN+L(11):NEXT 11
26078 GOTO 26800
26078 ME=12-SM1+1=SM1+1
26088 FOR IS=1 TO (Y2-(SY1+1)):ME=ME+12:NEXT 15
26088 FOR IS=1 TO ME=UN=UN+L(11)
24628 11=11+1
24630 IF 11>12 THEN 11=1
24640 NEXT 15
24650 FOR 15=1 TO M1-1:WHEN=WH+L15:NEXT 15
24660 REM **
24664 IF D1(1)7 THEN WH=WH+7-D1
24664 WHEN=WH+1:REM ** ALLOWING FOR 1 OF JAN 83 **
24668 WHEN=INT(WH/7.824)+1
24670 IF WHEN=52 THEN WHEN=WH-52 ELSE GOTO 24680
24675 IF M1=12 AND WHEN=53 THEN Y2=Y2+1
24677 GOTO 24678
24680 RETURN
24684 REM **** READ METHOD2.FIL ****
24704 REM **** MAIN REPORT OPTIONS ****
24710 IF PROG=2 THEN INS9=36 ELSE INS9=29
24720 PRINT H0CUR$&KG$&CLS$,
24728 PRINT FNCP$(-
2,3)RQ4LEFT$(TX$(3),13)10OFFM1DS$(TX$(3),14,58)RQ4RIGHT$(TX$(3),17)17CUP$
24730 PRINT FNCP$(-2,7)RQ4NAME$ROFF4CUP$
24740 PRINT FNCP$(-15,2)RQ4DATE$ROFF4CUP$
24750 PRINT FNCP$(-2,3)RQ4LEFT$(TX$(3),28)CUP$
24760 PRINT FNCP$(-,15)RQ4LEFT$(TX$(22),18)1094* 1CUP$
24770 PRINT FNCP$(-15,15)RQ4LEFT$(TX$(25),21)CUP$
24780 PRINT FNCP$(-15,15)RQ4LEFT$(TX$(28),14)CUP$
24790 PRINT FNCP$(-15,15)RQ4LEFT$(TX$(29),25)CUP$
24800 PRINT FNCP$(-15,15)RQ4LEFT$(TX$(35),25)CUP$
24810 PRINT ROFF4FGD$CUP$
24820 RETURN
24868 REM ** FORMATTING ROUTINE **
24870 SDF=NP+1
24878 IF $AB3$(5)=5*18('-SDF);MS=RIGHT$(SPACE$(12)+STR$(SIGN(M1)INT(Q)),DP)
24880 MS=MS","*H1DS$(STR$(1-O-INT(Q))"**00000",4,NP):RETURN
44660 REM *****ENQUIRY SUBROUTINE***
44680 REM OPENING FILES 1,2,3 & 4
44820 FOR J1%=1 TO 3
44830 FILENAME$= PROG*R$+.ST$(J1%)+.FIL",5"
44840 OPEN "R",J1%,FILENAME$,14
44850 FIELD 1016 AS P$(J1%)  
44860 NEXT J1%
44880 FOR J1%=4 TO 6:FILENAME$=PROG*R$+.ST$(J1%)+.FIL",5"
44880 OPEN "R",J1%,FILENAME$,14:FIELD #116 AS P$(J1%)  
44880 NEXT J1%
44870 OPEN "R",7,000*"ORDR.FIL",152
44980 OPEN "R",#7,24 AS COR$0,88 AS PCT$,48 AS SPT$
44990 OPEN "R",#9,044*"RECORD.FIL",2
44800 FIELD #9,2 AS REC$
44810 OPEN "R",#8,MOD$"METHOD.FIL",249
44820 FIELD #8,16 AS FS$(8),184 AS ROPE$,16 AS DPT$,88 AS PFT1,8 AS INP$,4 AS
DA$(7), 4 AS DA$(8)
48108 OPEN "R", #18, MD$="METH02.FIL", 178
48110 FIELD #18, 3 AS DA$(1), 58 AS DA$(2), 58 AS DA$(3), 58 AS DA$(4), 4 AS DA$(5), 4
   AS DA$(6), 4 AS DA$(7)
48118 OPEN "R", #11, MD$="CTMETH.FIL", 2
48120 FIELD #11, 2 AS MREC$
48123 GET #11, 1
48126 RECV=CVI(MREC$)
48129 RETURN
42990 REM **** ESTABLISH NUMBER OF RECORDS ON ORDER FILE ****
42998 GET #9, 1
43000 RECV = CVI(RECV$)
43003 RETURN
45065 REM ** TO PRINT OUT CUST. NAME HEADING **
45070 LPRINT LPRINT ID$ : ":CD$
45078 LPRINT "-----------------------------------------------"'
45080 LPRINT
45088 S1$= "*1026"** "*1046**"" +LEFT$(TX$(26),5)""*"
45090 FOR I=2 TO 13: S1$=S1$+MID$(STR$(WE(1)),6,2)+"" +MID$(STR$(WE(1)),4,2)"" +NEXT I4
45098 S1$=S1$+CHR$(32)+LEFT$(TX$(27),4)
45105 IF PROG$="1" THEN S1$=S1$+ "" +LEFT$(TX$(28),4)""*"'
45108 LPRINT S1$
45110 LPRINT STRINGS$(156, ""--")'
45118 RETURN
46990 REM DISMANTLE A DATE
46998 A=INT(C/10000): C=C-A*10000
47000 B=INT(C/100): C=C-B*100
47003 D=LEFT$(STR$(C)+STR$(B)+STR$(A)+")"", ?,
47010 RETURN
50000 REM *** MATCH SUBROUTINE ***
50008 RX$ = RX$ + 1
50018 IF RX$ = RED$: THEN FLAG = 0: RETURN
50026 GET #KFX, RX$
50030 RX$ = F$(KFX$)
50038 IF LEFT$(KEY$, H) = LEFT$(RX$, H) THEN GOTO 58878
50046 GOTO 58818
50050 FLAG = 1
50058 RETURN
55008 REM *** Read Text File Routine ***
55015 VLE$="1978011827419242942542424254262742425434234244443454343743843844144144265616666666674661800909307"
55018 OPEN "R", #1, "MAIN.FIL", 88
55020 FIELD #1, 88 AS MUC$
55028 CTX$=8
55038 FOR I=1 TO LEN(VLE$): STEP 3
55040 EL=HALL(MIDS$(VLE$, I, 3))
55048 CTX$=CTX$+1
55050 GET #1, EL
55058 TX$(CTX$)=MUC$
55068 NEXT I2
55076 CLOSE #1
55118 RETURN
68778 MAXL=8: MINL=0: REM *** DATE CHANGE ROUTINE ***
68780 GOSUB 68998: IF VAL(1$)=0 THEN COMBAT=0: DAT$="0": GOTO 68010
68782 A=INSTR(1$, ":"): IF A<>0 THEN A=INSTR(A+, ":")
68789 IF A=0 THEN 68778 ELSE P$=LEFT$(1$, A-1)
68797 B=INSTR(A+1$, ":"): IF B<>0 THEN B=INSTR(A+1$, ":")
68795 IF B<>0 THEN 68780 ELSE P$=MIDS$(1$, A+1$, B-(A+1))
68758 CS=MID$(I$,B$+1,2)
68768 A=VAL(P$);B=VAL(B$);C=VAL(C$)
68768 IF B$<12 OR D$<12 OR A$<1 OR A$>31 OR C$<99 OR C$>31 THEN 68780
68770 COMAT=(I$+1000)+(B$*100)+A
68770 D$=P$+"/"+B$+"/"+C$
68780 GOTO 68828
68818 I$=GET$;GOTO 68728
68828 PRINT FNC$;"/A(XX,CC,LL)";D$+"C1$"
68830 RETURN
68898 REM INPUT STRING ROUTINE
68898 I$=""
68908 PRINT FNC$;"/A(XX,CC,LL)";I$;"[SPACE$]";MAXL$("";LEN(I$))";ROFF$";CUP$
68918 GOSUB 61118
68920 IF X$="" THEN GOTO 61668
68930 IF X$="13" AND LEN(I$)>MINLY THEN GOTO 61800 ELSE IF X$="13" GOTO 61800
68940 IF LEN(I$)>MAXL$ THEN I$=I$+"H$
68950 GOTO 61800
68960 IF LEN(I$)<0 THEN I$=LEFT$(I$;LEN(I$)-1)
68970 GOTO 61800
68980 I$=LEFT$(I$;SPACE$(MAXL$-MAXL$))
68990 PRINT FNC$;"/A(XX,CC,LL)";CUP$
69000 RETURN
69010 REM GET VALID CHARACTER
69020 A$=INKEY$;IF A$="" THEN GOTO 61210
69030 X$=ASC(A$)
69040 IF X$>31 AND X$<127 OR X$="" OR X$>13 THEN RETURN
69050 IF X$=185 OR X$=127 THEN CLOSE:IF PROG$="2" THEN CHAIN"P8-00" ELSE CHAIN"P82-00"
69060 IF X$=247 THEN GOSUB 61280
69070 IF X$=186 THEN GOSUB 62000:LPARAM
69080 IF X$=159 THEN GOSUB 62000:FOR L=1 TO 10:LPARAM:NEXT L
69090 RETURN
69100 REM
69110 REM
69120 REM
69130 REM
69140 REM
69150 DEF SEG = &HFFFF
69160 FOR J$ = 0 TO 22
69170 WE$=""
69180 IF J$ = 0 TO 7 STEP 2
69190 WE$=WE$+CHR$(ABS(PEEK(J$+160)+J$-100))
69200 NEXT J$
69210 LPRINT WE$
69220 NEXT J$
69230 WIDTH 255
69240 RETURN
69260 REM "**** GENERAL ERROR ROUTINE ****"
69270 PRINT FNC$;"/A(XX,CC,LL)";FNC$;"(21,25)";ERR$;FNC$;"(21,49)";ERL$;CUP$
69280 A$=INKEY$:IF A$="" THEN 62829
69290 X$=ASC(A$):IF X$=27 THEN 61136
69300 GOTO 62440
69310 PRINT FNC$;"/A(XX,CC,LL)";SPACE$(77);CUP$
69320 RESUME
69330 END
69340 REM "P82-0 (IBM - 86F81 - CRE 29/04/1986)"

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A4.3 Production Planning/Programmes Program
5 REM $INCLUDE;'SHARE'
12 16=0:TYPE$="";OPT$="" 
13 GOSUB 55000:MAC$=MID$(TX$(48),17,1) 
14 AFLAG=0 
15 IF MAC$="I" THEN 17 
16 WIDTH LPRINT 255:GOTO 18 
17 WIDTH "LPT1",255 
18 DIM MD$(36),MD$(22),MD$(2),MD$(20),YX$(7),LX$(12) 
19 IF NAME$="**" OR DTE$="**" THEN CHAIN *PCC* 
20 GOSUB 15000 
21 JS=5:SD=3:SM=1:PV=VAL(MID$(TX$(48),7,5)):MV=VAL(MID$(TX$(48),1,5)):REM 
22 "PV=PRICE PER : MV=WEIGHT PER" 
23 FOR IS=1 TO 12:READ LX$(IS):NEXT IS 
24 FOR IS=1 TO 7:READ YX$(IS):NEXT IS 
25 DATA 31,26,31,30,31,30,31,30,31,30,31,31: 
26 DATA 5,6,7,1,2,3,4: 
27 DEF FCNP$(ROW$,COL$)=CHR$(27)*"\"+CHR$(34+ROW$)+CHR$(32+COL$) 
28 OPT$="" 
29 IF PROG$"">" THEN 700 
30 GOSUB 30000 
31 SEX=VAL(MID$(TX$(48),15,1)):ROW$=21:COL$=31:MAXL%=2:MINL%=1:GOSUB 60980 
32 OP$=VAL(IS):IF OP$>8 OR OP$<1 THEN 50 
33 IF OP$=0 THEN CHAIN*PO$-A* 
34 IF OP$=1 THEN SEX=VAL(MID$(TX$(48),15,1)) 
35 IF OP$=7 THEN 200 
36 GOSUB 32500 
37 RGX$:=21:COL$=39:MAXL%=2:MINL%=1:GOSUB 60980 
38 SEX=VAL(IS) 
39 IF SEX<1 OR SEX >10 THEN 150 
40 STRNK$=VAL(FILENAME$(OP$)): 
41 GOSUB 41000 
42 IF OP$=7 THEN IDENTI$=LEFT$(PROC$(SEX)+SPACE$(14),14) ELSE IDENTI$="" 
43 GOSUB 35000 
44 IF OP$=4 THEN AFLAG=1 
45 GOSUB 17000 
46 IF FR$ THEN 270 ELSE GOSUB 44000 
47 IF OP$=1 THEN 1100 
48 IF OP$=6 THEN 1300 
49 IF OP$=3 THEN 1200 
50 IF OP$=2 THEN 1400 
51 GOTO 1000 
52 X=27:GOTO 61150 
53 REM *** WHERE PLANNING & PROGRAMME ARE ACCESSED *** 
54 OP$=0:SEX=VAL(MID$(TX$(48),15,1)) 
55 IF PROG$="1" THEN 400 
56 IF PROG$="2" THEN 800 
57 END 
58 REM *** FOR PLANNING PROG *** 
59 SEI$=VAL(MID$(TX$(48),15,1)) 
60 GOSUB 31000:REM *** PLANNING SCREEN *** 
61 ROW$=6:COL$=55:MAXL%=1:MINL%=1:GOSUB 60980:IF ASC(1$)<65 OR ASC(1$)>67 THEN 
62 ELSE TYPE$="" 
63 OPT$=TYPE$ 
64 ROW$=B:COL$=55:GOSUB 60700:START=COMDAT:START=SAP$ 
65 ROW$=10:COL$=55:GOSUB 60700:FINISH=COMDAT:FINISH=SAP$ 
66 ROW$=21:COL$=44:MAXL%=1:MINL%=1:GOSUB 60980:IF ASC(TX$(2),4,1) AND 
67 IF IS=MOD$(TX$(2),2,1) THEN 445 
68 IF IS=MOD$(TX$(2),2,1) THEN 405 
69 FOR IIB=14 TO 16:PRINT FCNP$(IIB$,10):SPC(50):CUP$=NEXT IIB$ 
70 KEY$="";SPACE$(15)
460 STRX$=127
470 GOSUB 41000:AFLAG=1
480 GOSUB 17000
490 GOSUB 44000
500 GOSUB 26000:REM ### KEY & PROCESSING ###
510 I%=0:COUNT%=0
520 GOSUB 40000:REM ### OPEN ALL FILES ###
530 GOSUB 42000:REM ### HOW MANY ON FILE ###
540 GOSUB 27000:REM ### VERIFY ###
550 GOSUB 20000:REM ### SORT ( STRING TYPE ) ###
560 GOSUB 98000:REM ### PRINTING & SUCH LIKE ###
570 S$=LEFT$(TI$(7),79)
580 IF ST$='0' THEN GOSUB 9200
585 S$=LEFT$(TI$(8),79)
590 GOSUB 34000:REM ### TOTAL PRINT & ZERO VARIABLES ###
600 T%=27:SOTO 6150
610 REM ### FOR PROGRAMME PROG ###
620 GOSUB 31500:REM ### SCREEN FOR PROGRAMME OPTION ###
630 ROW%=21:COL%=38:MAX%=1:MIN%=1:GOSUB 60980:IF VAL(I$(1))<1 OR VAL(I$(1))>3 THEN
640 S$(1)=X$(1)
650 REM ### DOREMAKING FROM PROGRAMME PROG (600-870) ###
660 TYPES$="E";"KEY$=?";"SPACE$(15)
670 START%=0:START$="0":ROWS%=11:COL%=47:GOSUB 60700:FINISH=COMDAT:FINISH$=DAT#
680 STRX$=841
690 GOTO 470

1000 REM ### MAIN BODY OF NORMAL PROGRAM ###
1100 TYPES$="*":GOSUB 26000:REM ### KEY & PROCESSING ###
1200 I%=0:COUNT%=0
1300 GOSUB 40000:REM ### OPEN ALL FILES ###
1400 GOSUB 42000:REM ### HOW MANY ON FILE ###
1500 GOSUB 27000:REM ### READ & VALIDATE ###
1600 GOSUB 35000:REM ### SORT ( NORMAL TYPE ) ###
1700 GOTO 560

1100 REM ### METAL TYPE ( PART OF NORMAL PROGRAM OPTION ) ###
1110 TYPES$="G"
1120 GOTO 500

1200 REM ### WORK-IN-PROGRESS SUMMARY ( PART OF NORMAL PROGRAM OPTION ) ###
1210 TYPES$="F":GOSUB 26000:REM ### KEY & PROCESSING ###
1220 I%=0:COUNT%=0
1230 GOSUB 40000:REM ### OPEN ALL FILES ###
1240 REM CLOS E #5:REM ### TO GET METHOD CUSTOMER NAME ###
1250 REM OPEN "R","S","S.FIL","M:FIELD #6,15 AS F$(3)
1260 GOTO 550

1300 REM ### CUSTOMER ORDERS ( PART OF NORMAL PROGRAM OPTION ) ###
1310 GOTO 1210

1400 REM ### JOB STATUS ###
1410 TYPES$="H":GOSUB 26000:REM ### KEY & PROCESSING ###
1420 GOTO 1220

2000 REM ### SORT ( STRING TYPE ) ###
2100 SWX%=COUNT$:IF COUNT%=0 THEN S$=LEFT$(TI$(6),26):LPRINT S$:SOTO 600
2200 POC%=S$:SWX%=SWX$:2:IF SWX<0 THEN RETURN
2300 POC%=POC+1
2400 IF (POC+SWX>)COUNT$ THEN 2020
2500 IF AR$(POC,1)=AR$(POC+SWX,1) THEN 2030
2600 SWAP AR$(POC,1),AR$(POC+SWX,1)
2700 SWAP AR$(POC,1),AR$(POC+SWX,1):GOTO 2090
2800 POC%=POC-1
2900 IF POC-SWX<1 THEN 2040

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2100 IF AR$(PDY,1))=AR$(PDY-SWY,1) THEN 2030
2110 SWAP AR$(FDY,1),AR$(PDY-SWY,1)
2120 SWAP AR$(FDY,1),AR$(PDY-SWY,1):GOTO 2080
2500 REM *** CHECK SUFFIX ****
2510 FOR K=1 TO 1 STEP -1
2520 IF K=1 THEN FL1=1:RETURN
2530 IF MID$(D$(2),K+1,1)="/" THEN 2590
2535 IF TYPE$=MID$(TX$(40),1,1) OR TYPE$=MID$(TX$(40),2,1) OR
2540 TYPE$=MID$(TX$(40),3,1) THEN IF MID$(D$(2),K+1,1)=MID$(TX$(40),20,1) THEN
2545 FL1=1:RETURN
2550 IF TYPE$=MID$(TX$(40),5,1) OR OP%1 THEN IF
2555 MID$(D$(2),K+1,1)=MID$(TX$(40),16,1) THEN FL1=1:RETURN
2560 IF TYPE$=MID$(TX$(40),6,1) AND TYPE$=MID$(TX$(40),7,1) THEN IF MID$(D$(2),K+1,1)=MID$(TX$(40),20,1) THEN FL1=1:RETURN
2580 IF TYPE$=MID$(TX$(40),6,1) AND OP%3 THEN IF
2590 MID$(D$(2),K+1,1)=MID$(TX$(40),20,1) THEN FL1=1:RETURN
2570 FL1=0:RETURN
2590 NEXT K
2600 REM *** KEY & PROCESSING ***
2610 KEY$=LEFT$(D$(1),5):SPACE$(1):KEYLEN$=KEYLEN$+LEN(KEY$)
2620 PRINT FNCPS$(17,0,LEFT$(TX$(9),7),7):CUPS=$2
2630 MATCH$=INSTR$(KEY$,"**"):IF MATCH$=0 THEN MATCH$=KEYLEN$
2640 RETURN
2700 REM *** READ & VALIDATE ***
2710 PRINT FNCPS$(17,40):LEFT$(TX$(49),23):PRINT FNCPS$(17,56):RECZ
2740 I%=I%+1:IF I%>RECZ THEN RETURN
2760 SRNZ$=$E$:SET Z=E:,SRNZ$
2780 IF F$(2)=SPACE$(16) THEN 2705
2720 GOSUB 10000:GOSUB 2500:IF FL=1 THEN 2705
2721 PSSZ%=SEX
2722 IF PROG$="1" THEN SEX=VAL(MID$(TX$(49),15,1))
2723 CUMP=0:FOR TIX=12 TO 11+SEX:CUMP=CUMP+DP$(TIX):NEXT TIX
2724 SEX=PSSZ
2725 IF (PROG$="2" OR PROG$="1") AND CUMP=0 THEN 2705
2729 IF OP%=1 AND DP$(19)=DP$(3) THEN 2705
2730 RM%=DP$(22)
2740 GOSUB 25000
2741 IF TYPE$=MID$(TX$(40),5,1) AND D$(6+SEX)=SPACE$(1) THEN 2705
2742 IF TYPE$=MID$(TX$(40),6,1) AND D$(6)="0" THEN 2705
2743 IF (TYPE$=MID$(TX$(40),5,1) AND ((SEX=2 OR SEX=3) AND
2750 YN$=LEFT$(TX$(11),1) OR SEX=1) AND (D$(7)=LEFT$(TX$(12),8) OR
2755 D$(7)=LEFT$(TX$(13),7) OR D$(7)=LEFT$(TX$(14),5) OR D$(7)=SPACE$(8)) THEN 2705
2754 IF TYPE$=MID$(TX$(40),5,1) AND (SEX=2 OR SEX=3) AND YN$=LEFT$(TX$(14),4) AND
2760 (D$(7)=LEFT$(TX$(12),8) AND D$(7)=LEFT$(TX$(13),7) AND D$(7)=SPACE$(8)) THEN 2705
2750 IF TYPE$=MID$(TX$(40),5,1) OR TYPE$=MID$(TX$(40),7,1) THEN GOSUB 3000:GOTO
2760 ELSE 2755:REM ** SET DEFAULT DATE (PROG)**
2755 IF SR$(ITEMS,2)=37 THEN GOSUB 4500:GOTO 2705
2757 IF PROG$="$1" THEN 2760
2760 GOSUB 23000
2760 REM
2761 IF (BSR$(ITEMS,2)=0) AND (BSR$(ITEMS,2)="START") AND
2766 IF TYPE$=MID$(TX$(40),1,1) OR TYPE$=MID$(TX$(40),2,1) OR
2770 TYPE$=MID$(TX$(40),3,1) OR TYPE$=MID$(TX$(40),4,1) OR TYPE$=MID$(TX$(40),B,1)
2775 THEN DMY=D$(23):GOSUB 27000:DTEMP=$(Y$(10000)+($W100+1))
2776 IF TYPE$=MID$(TX$(40),7,1) THEN DMY=D$(26)+SEX$:GOSUB
2780 DTIME=$(Y$(10000)+($W1000+1))
2785 IF TYPE$="$*" OR TYPE$=MID$(TX$(40),5,1) THEN DMY=BSR$(ITEMS,2):GOSUB
2769 IF PROG="1" THEN DMY=0(23);GOSUB
2770: SRT$=RIGHT$(STR$(Y2),2)+RIGHT$(STR$(WN),2)
2770: IF TYPE$=MIDS$(TX$(40),1,1) THEN
2771: AR$(COUNT,1)=RIGHT$(SPACE$(4)+SRT$,4)+D$(9)
2772: IF TYPE$=MIDS$(TX$(40),2,1) THEN
2773: AR$(COUNT,1)=D$(9)+RIGHT$(SPACE$(8)+STR$(DTMP),8)
2774: IF TYPE$=MIDS$(TX$(40),3,1) THEN
2775: AR$(COUNT,1)=D$(5)+RIGHT$(SPACE$(8)+STR$(DTMP),8)
2776: IF TYPE$=MIDS$(TX$(40),5,1) THEN
2777: AR$(COUNT,1)=D$(5)+RIGHT$(SPACE$(6)+STR$(DTMP),6)
2778: IF TYPE$=MIDS$(TX$(40),6,1) THEN
2779: AR$(COUNT,1)=RIGHT$(SPACE$(7)+STR$(DP(1)),7)+D$(1)+RIGHT$(SPACE$(6)+STR$(DTMP)
2800: IF TYPE$=MIDS$(TX$(40),7,1) THEN
2801: AR$(COUNT,1)=D$(5)+RIGHT$(SPACE$(6)+STR$(DTMP),6)
2823: IF TYPE$=MIDS$(TX$(40),8,1) THEN 2840
2825: NP=2;DF=7;MS=OFF(26);GOSUB
3750: AR$(COUNT,1)=MS$+RIGHT$(SPACE$(7)+STR$(DP(1)),7)+D$(1)+RIGHT$(SPACE$(6)+ST
3950: D=DTMP),6)
2840: IF TYPE$="" THEN AR$(COUNT,2)=DTMP
2855: PRINT M$(17,28);"&CHO;GOTO 2705
3000 REM ** FOR PROGRAMME (1,2,3) DATES **
3010 IF D$(6+SEX)<>0 THEN DIS$(ITEMS,2)="02";FLG=0;GOTO 3050 ELSE 3020
3020 IF D$(9+SEX)<>0 THEN DIS$(ITEMS,2)="03";FLG=0;GOTO 3050 ELSE 3030
3030 DIS$(ITEMS,2)="05";FLG=1;GOTO 3050
3050 RETURN
3400 REM *** TOTAL PRINT & ZERO VARIABLES ***
3410 FOR II = 1 TO TOTS
3415 DO TOT(II,2) GOTO 3440,3420,3430
3417 GOTO 3440
3420 II=II+1:BP=II:NP=2;GOSUB 3750:IF FK=1 THEN MS$=LEFT$(MS$,8)="N"
3425 SS=LEFT$(SS$,TOT(II,1))+M$=""
3426 "GOTO 3440
3430 II=II+1:IF S$>999999999 THEN S$=INT(S$(1000))FK=1 ELSE FK=0
3432 MS$=RIGHT$(SPACE$(7)+STR$(S$,7))IF FK=1 THEN MS$=RIGHT$(MS$","",7)
3435 SS=LEFT$(SS$,TOT(II,1))+RIGHT$(""
3440 NEXT II
3450 LPRINT STRING$(LEN(HDB$(6))+2,"*"),LPRINT LEFT$(SS$,LEN(HDB$(6))):LPRINT
3460 FOR II=1 TO TOTS
3470 TOT(II,1)=0:TOTAL(II)=0:STOTAL(II)=0
3480 NEXT II
3490 S$="";RETURN
3500 REM *** SDRT ( NORMAL TYPE ) ***
3510 SW=COUNT$;IF SW=0 THEN S$=LEFT$(TX$(6),26):LPRINT S$;GOTO 600
3520 P0Z=0;SW=SW$;2:IF SW=0 THEN RETURN
3530 FOZ=P0Z+1
3540 IF (P0Z+SW$)<>COUNT$ THEN 3520
3550 IF AR(P0Z,2)<>AR(P0Z+SW$) THEN 3530
3560 SWAP AR(P0Z,2),AR(P0Z+SW$)
3570 SWAP AR(P0Z,1),AR(P0Z+SW$)
3590 P0Z=P0Z+1
3600 IF P0Z=SW$+1 THEN 3540
3610 IF AR(P0Z,2)<>AR(P0Z+SW$) THEN 3530
3620 SWAP AR(P0Z,2),AR(P0Z+SW$)
3630 RETURN
4010 S$="";RETURN
4500 REM *** CHECK FOR DATE 37 I.E. USER SELECTED (SEX) ***
4505 IF OPF=7 AND D(L6+SEXY)=0 THEN D(L6+SEXY)=D(L23)
4510 IF (L(26+SEXY)<>0 AND (D(L6+SEXY)=START) AND (D(L6+SEXY)=FINISH)) AND
(LEFT$(KEY, MATCHI-1)=LEFT$(SEXY(1+KEY), MATCHI-1)) THEN
COUNTZ=COUNTZ+1; AR(COUNTZ, 1)=15; DHY=D(L6+SEXY); GSUB
27000; DTEMP (Y210000) + (WNH100) + D1; AR(COUNTZ, 2)=DTEMP
4515 PRINT FNC#5(17, 28) &scps
4520 RETURN
4600 REM ** START DATE FOR PROD. PLAN. **
4610 A=VAL(MID$(STR$(D(23)), 4, 2)); B=VAL(MID$(STR$(D(23)), 4, 2)); C=VAL(MID$(STR$(D(123))
, 2, 2))
4615 IF INT(C/4)=C/4 THEN LX(2)=29
4620 REM * USE EITHER 9430 OR 9440 FOR LEAD TIME IN WKS. OR DAYS, RESPECTIVELY *
4630 MD24=INT(MID$(D(24))); IF MD24=0 THEN MD24=INT(MID$(D(24)+1)); ELSE MD24
=INT(MD(24)+7)
4640 REM * MD24=INT(MID$(D(24))); IF MD24=0 THEN MD24=MD24+1
4650 A=AR-MD24
4660 IF A=0 THEN GOTO 4710
4670 C=1; C
4675 B=8
4680 B=B+1; IF B=0 THEN B1=12: C1=C1-1
4690 MD24=MD24-A1; A1=LX(1)+MD24; IF A1=0 THEN A1=A+LX(1); GOTO 4680
4700 C=C1:B1=A1
4710 D(23)=(C1+10000)+(B1*100)+A1
4715 LX(2)+29
4720 RETURN
5000 END
6000 REM ******************************************* STRING ELEMENTS *******************************************
6003 IF (TYPE$=MID$(TXT$(40),5,1) OR PROGS$="1") AND SR(I1S,2)=7 THEN 6030
6005 IF (TYPE$=MID$(TXT$(40),5,1) AND PROGS$="2") AND SR(I1S,2)=7 THEN
S=S+"LEFT$("+LEFT$(SR(I1S,2)+8)+")",9;RETURN
6007 IF PROGS$="1" AND SR(I1S,2)=2 THEN GOTO 6020
6100 IF SR(I1S,2)<4 THEN S=S+"RIGHT$("+SR(I1S,2)+")",9;RETURN
6107 :RETURN
6200 S=S+"LEFT$("+SR(I1S,2)+")",9;RETURN
6300 S=S+"RIGHT$("+SR(I1S,2)+")",9;RETURN
6400 REM *** CAUSE IS NEED SECTION SEX-1 ***
6700 REM ******************************************* FLOATING ELEMENTS *******************************************
7010 IF D(P)=0 THEN D(P)=1
7020 IF SR(I1S,2)=37 OR SR(I1S,2)=38 THEN M=D4(SR(I1S,2)-36);NF=2; DF=7; GSUB
77500; S=S+"**": RETURN;REM PRINT OUT CASTING WEIGHTS
7030 IF SR(I1S,2)<38 THEN M=DSR(I1S,2); NF=2; DF=7; GSUB 37500; S=S+"**": RETURN;REM PRINT OUT FLOATING POINT NUMBERS
7050 ON SR(I1S,2)-78 GOTO
7060,7070,7080,7090,7100,7120,7130,7140,7150,7160,7170,7180
7070 GSUB 8800; M=D(P+D(2))/WV; GOTO 7800; REM [sigas/0101]ID(12)
7075 GSUB 7800; M=(SIGMA(I1))/PV; GOTO 7800; REM [sigas/0141]
7080 M=(D(P)+D(1))/PV; GOTO 7800; REM [D(05)+D(14)]
7090 M=(D(P)+D(1))/PV; GOTO 7800; REM [D(05)+D(14)]
7100 M=(D(P)+D(1))/PV; GOTO 7800; REM [D(1)+D(0)]
7110 M=2;SEX=10; GSUB 7900; R=SIGMA; SEX=R; GSUB 7900; M=(((1-R-
SIGMA(I1))/PV); GOTO 7800; REM [everything after castdo(14)]
7120 M=0; D(2)*D(0)+D(2)*SEX); GOTO 7800; REM [D(017)+0(32) ... 0(32) ... 0(32) ... 0(75) ... 0(75)]
7140 GSUB 8800; M=(D(P)+D(2))*D(2)*SEX); GOTO 7800; REM [sigas 1 (0(27) or 0(32) ... 0(32) ... 0(72)]
7150 GSUB 7800; M=(SIGMA(I1))/WV; GOTO 7800; REM [sigas 1 (0(11)]
7160 GSUB 7800; M=(SIGMA(I1))/PV; GOTO 7800; REM [sigas 1 (0(14)]
7170 GSUB 7800; M=D(15)+SIGMA; GOTO 7800; REM [D(017)+sigas]
7180 M=(D(P)+D(1))*D(15); GOTO 7800; REM [D(30)+D(27) total core tines ]

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7190 PSS%:SE%:SE%=2:GOSUB 7900: M=SIGMA(D(4)):SE%=P%SIGMA:GOTO 7800: REM (sigma 
D(37))
8000 NP=2:DP=7:GOSUB 37500:S$=S+%M$" "RETURN
8900 END
7900 REM SIGMA QUANTITIES IN PROCESS STAGES
7905 SIGMA=0
7110 FOR SI=1:SI=11 TO 12 STEP -1
7220 SIGMA=SIGMA+DP(SI)
7330 NEXT SI
7440 RETURN
8000 REM******************* INTEGER ELEMENTS *******************
8005 IF DP(2)=0 THEN DP(2)=1
8010 IF SR(15%,2)<23 THEN DP=DP(SR(15%,2)):GOTO 8900
8020 DP(12)=GOTO 8900:DP(0)=SIGMA:DP(2):SE%=P%SIGMA:GOTO 7900
8030 GOSUB 8800:GOTO 8900:REM (sigma/O(101) rounded up 
[everything after cast]
8050 DP=DP(1)+SE%=GOTO 8900:REM (D(30) or D(35) ... D(75))
8060 GOSUB 8800:DP=DP(2):GOTO 8900:REM (sigma)
8070 PSS%=SE%=2:GOSUB 7900:DP=SIGMA/DP(2):SE%=P%SIGMA:GOTO 7900
8080 DP(12)=DP(2):GOTO 8900
8090 GOSUB 7900:DP=(SIGMA/DP(2)):IF DP=(SIGMA/DP(2))<0 THEN 
DP=(SIGMA/DP(2))+5:GOTO 8900 ELSE 8900:REM (sigma/O(101) rounded up 
8100 GOSUB 7900:DP=(SIGMA/DP(2)):IF DP=(SIGMA/DP(2))<0 THEN 
DP=(SIGMA/DP(2))+5:REM (sigma/O(101) rounded up 
8210 RETURN
8900 IF DP<0 THEN DP=0
9000 S=INT(DP+0.5):IF S<9999999 THEN S=INT(S/1000):FK=1 ELSE FK=0
9002 M$=RIGHT$(SPACES(7)+STR(S,7)):IF FK=1 THEN M$=RIGHT$(M$+"k",7)
9004 $=S$+M$=""":RETURN
9000 REM ********** DATE ELEMENTS **********
9002 IF TYPE()=MID$(TX$(40),5,1) THEN FGL=3
9003 IF SIGF<0 THEN C=D(2):GOSUB 46000:GOTO 9041
9007 IF TYPE()=MID$(TX$(40),5,1) AND SR(15%,2)=7 THEN GOSUB 30000:DISR(ITEMS,2):GOTO 9020 ELSE 9010
9010 IF SR(15%,2)>36 THEN DP=SR(15%,2)-36 GOTO 9030
9020 =DISR(15%,2):GOSUB 46000:S$=S*$:RETURN
9030 IF DP<7 AND D(1)+SE%=0 THEN D(2)+SE%=D(32):FLG=1 ELSE 9040
9040 C=9(2)+SE%=GOSUB 46000
9041 REM
9042 IF FGL<0 THEN D$=LEFT$(D$,9)+"*"
9043 IF FLE=1 THEN D$=LEFT$(D$,3)+"R"
9044 IF FLE=2 THEN D$=LEFT$(D$,3)+"C"
9045 S$=S*$:RETURN:REM BIT BRTS BY OPTION NUMBER
9050 STOP
9100 REM *** SUBTOT STRING BIT ***
9110 IF IB$=1 THEN ORI=ORI($SBT)
9120 IF ORI($SBT)=ORI THEN RETURN
9130 ORI=$SBT:GOSUB 29000:RETURN
9200 REM *** PRINT OUT SUB TOTALS ***
9205 S$=LEFT$(TX$(7),79)
9210 FOR TB=1 TO TOTS
9215 ON TOT(TB,2) GOTO 9240,9220,9230
9220 GOTO 9240
9220 M=TOTAL(TB):DP=7:NP=2:GOSUB 37500:IF FK=1 THEN 
M$=LEFT$(M$,8)+"k":S$=LEFT$(S$,TOTAL(TB,11)+M$"
9225 S$=LEFT$(S$,TOTAL(TB,11))+M$"
9230 S=TOTAL(TB):IF S<999999 THEN S=INT(S/1000):FK=1 ELSE FK=0
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2272 MS=RIGHT$(SPACE$(7)+STR$(6),7):IF FK=1 THEN MS=RIGHT$(MS+" ",7)
2275 S#=LEFT$(S#,TOT$(TB,1))+RIGHT$(': 
"+MS+ ",0)"
3
2400 NEXT TB
2500 LPRINT STRING$(LEN(HD#(6))+2,"-"):LPRINT LEFT$(SA,LEN(HD#(6))):LPRINT STRING$(LEN(HD#(6))+2,"-"):IF TYPE$="E" AND (SEC=2 OR SEC=3) AND IEX=COUNTZ THEN GOSUB 44635
2525 IF TYPE$="MID$$(TX$(401,0,1)) AND IEX=COUNTZ THEN GOSUB 45000
2530 S$=" 
2700 FOR TB=1 TO TOTS:TOTAL(TB)=0: NEXT TB
2800 RETURN
3000 REM ### SUBTOT INTEGER BIT ###
3100 IF IEX=1 THEN ORIG=DP(SBT)
3200 IF DP(SBT)=ORIG THEN RETURN
3300 ORIG=OR(SBT):GOSUB 9200:RETURN
3400 REM ### SUBTOT FLOATING POINT BIT ###
3500 IF IEX=1 THEN ORIG=0(SBT)
3600 IF IEX=1 THEN GOSUB 45000:REM ## JOB STATUS PRINT HEADERS ##
3700 IF D(SBT)=ORIG THEN RETURN
3800 ORIG=OR(SBT):GOSUB 9200:RETURN
3900 REM ### SUBTOT DATE BIT ###
4000 RDAT=0(SBT)
4100 IF PROG$="I" THEN GOSUB 29000
4200 DMY=RD(SBT):GOSUB 27000: DTEMP=(Y2+10000)+(W+100)+D1
4300 IF IEX=1 THEN ORIG=VALUE(LEFT$(STR$(DTEMP),5))
4500 IF VAL(LEFT$(STR$(DTEMP),5))=ORIG THEN D(SBT)=RDAT:RETURN ELSE 9530
4530 ORIG=VALUE(LEFT$(STR$(DTEMP),5)):GOSUB 9200: D(SBT)=RDAT:RETURN
4600 REM ### ITEM MANIPULATOR ###
4710 FOR IS$=1 TO ITEMS
4720 ON SR$(IS$,1) GOSUB 6000,7000,8000,9000
4730 IF S$=" " THEN RETURN
4740 NEXT IS$
4800 RETURN
4900 REM ### TOTAL MANIPULATOR ###
4910 FOR I=1 TO TOTS
4920 IF TOT$(I,2)=0 THEN EA$=MID$(A4,TOT$(I,1)+1,3):GOTO 9750
4930 IF TOT$(I,2)=2 THEN EA$=MID$(A4,TOT$(I,1)+1,100):GOTO 9750
4940 GOTO 9770
4950 IF INSTR$(EA$,"=")>0 OR INSTR$(EA$,"=")<0 THEN EA$=VALUE(EA$)
4960 TOTAL$(I,9)=TOTAL$(I,9)+EA$:STOTAL$(I,9)=STOTAL$(I)+EA
4970 NEXT I
4980 RETURN
9000 REM ### PRINTING & SUCH LIKE ###
9005 PRINT FNC$$(21,0)RD$$(LEFT$(TX$(97),79))ROFS$CUP$$
9100 FOR ISI=1 TO COUNT$2
9200 SRNZ=AR$(ISI,11)
9300 GOSUB 10000
9400 RNX=DP$(22)
9500 GOSUB 25000
9600 S$=" 
9844 REM IF PROG$("I" THEN GOSUB 9870
9845 REM GOSUB 4600
9847 ON ST GOSUB 9100,9400,9300,9200
9880 GOSUB 9600:REM ### ITEM MANIPULATOR ###
9881 IF PROG$("I" THEN 9880
9882 GOSUB 29000
9883 C=0(22)
9884 GOSUB 46000
9885 IF SIG$=1 THEN D$=D$** 5
9886 IF SIF=2 THEN D$=D$+" P"
9887 IF SIF=3 THEN D$=D$+" P"
9888 S$=S$+D$
9890 IF S$=" " THEN 9920
9900 LPRINT S$
9905 REM IF TYPE$="E" AND SEX=1 THEN LPRINT MD$(18)
9910 EGSUB 9700: REM *** TOTAL ** BUILDING ***
9920 NEXT I$B
9920 RETURN
9950 REM *** FOR ORDER STATUS ***
9960 SET #1,SRH%;GET #2,SRH%;SET #7,SRH%
9970 GOTO 10010
10000 REM *** READ ORDER ***
10001 IF (TYPE$=MID$(TX$(40),5,1) OR TYPE$=MID$(TX$(40),4,1)) AND PROG$="2" THEN
10003
10002 GOTO 9950
10003 FOR J1%=1 TO 3
10006 SET #J1%,SRH%
10007 NEXT J1%
10009 SET #7,SRH%
10010 EZ%=1:CH%=1:CH%=1:IZ%=1
10020 FOR J1%=1 TO 3
10025 IF J1%=5 AND (TYPE$=MID$(TX$(40),5,1) AND TYPE$=MID$(TX$(40),4,1)) AND
PROG$="2" THEN D$(3)$=F$(J1%)
10030 D$(J1%)=F$(J1%)
10040 NEXT J1%
10050 FOR J1%=18 TO 20
10060 D$(J1%)=MID$(CARD$,85,8)
10070 EZ%=EZ%+1
10080 NEXT J1%
10090 FOR J1%=3 TO 22
10100 D$(J1%)=CVS(MID$(PCT$,CH%,4))
10110 CH%=CH%+4
10120 NEXT J1%
10130 FOR J1%=23 TO 24
10140 D$(J1%)=CVS(MID$(SPT$,EZ%,4))
10150 EZ%=EZ%+4
10160 NEXT J1%
10170 FOR J1%=27 TO 36
10180 D$(J1%)=CVS(MID$(SPT$,EZ%,4))
10190 EZ%=EZ%+4
10200 NEXT J1%
10210 RETURN
16000 OPEN "A",#15,"MAIN.FIL",80
16010 FIELD #15,80 AB MS$
16020 SET #15,14
16030 ID$=MID$(MS$,6,12)
16040 CLOSE #15
16990 RETURN
17000 REM #### DISASSEMBLE REPORT SEQUENTIAL INFORMATION ####
17005 ST=VAL(LEFT$(SUBTOT$,11));SET=VAL(RIGHT$(SUBTOT$,2))
17007 IF TYPE$="E" THEN SET=(SET+SEX)
17010 KEY=VAL(RIGHT$(KEYPTR$,2));KEYLEN=VAL(LEFT$(KEYPTR$,2));SEX=0:IF KEY>6
17015 AND KEY<17 THEN SEX=SEX
17020 ITEMS=VAL(LEFT$(ITEMPTR$,2));TOTS=VAL(LEFT$(TOTALS$,2))
17030 FOR IS%=0 TO ITEMS-1
17035 SR(15%+1,1)=VAL(MID$(ITEMPTR$,3+15%+3,1));SR(15%+1,2)=VAL(MID$(ITEMPTR$,4+15%+3
17040 NEXT IS%
17040 FOR IS%=0 TO TOTS-
17045 TOT(IS%+1,1)=VAL(MID$(TOTALS$,3+IS%+4,3));TOT(IS%+1,2)=VAL(MID$(TOTALS$,6+IS%+4,
17045 IF KEYLEN=0 THEN 17000
17047 IF DPX=4 THEN GOSUB 28000
17050 IF AFLAGS=1 THEN RETURN
17100 ROWX=7:COLX=39:GOSUB 60700:START=COMDAT:START$=DAT$
17110 ROWX=9:GOSUB 60700:FINISH=COMDAT:FINISH$=DAT$
17120 ROWX=9:MINL$=1:MAXL%=KEYLEN:GOSUB 60980:KEYS=1$
17130 PRINT FNC#(21,0):SPACE$(17):LEFT$(TX$(5),23):CUP$
17140 GOSUB 22500:RETURN
22500 REM ********** GET YES OR NO ANSWER *************
22510 MAXL%=1:MINL%=1:DOMZ=21:COLX=39
22520 GOSUB 60980
22530 IF I$=MID$(TX$(2),2,1) THEN FLAG=1:RETURN
22540 IF I$=MID$(TX$(2),4,1) THEN FLAG=0:RETURN
22550 GOTO 22500
25000 REM **** TO READ METHODING FILE ****
25002 IF (TYPE$="E" OR TYPE$="O") AND PROG$="2" THEN 25010
25005 GET $6,RM$:DOM$(3)=F$(6):REM AFORE GET INSERT IF TYPE$="F" THEN
25010 GET $8,RNZ
25020 DI$(4) = F$(8)
25030 BX%=1:CX%=1:TX%=1:PX%=1
25060 FOR J%=5 TO 17
25070 DI$(J%) = MID$(RM$,BX%,B)
25080 BX%=BX% + 8
25090 NEXT J%
25100 FOR J%=1 TO 2
25110 DP$(J%) = CVS(MID$(RM$,CX%,41))
25120 CX%=CX% + 4
25130 NEXT J%
25140 FOR J%=1 TO 22
25150 DI$(J%) = CVS(MID$(FPT$,TX%,41))
25160 TX%=TX% + 4
25170 NEXT J%
25180 FOR J%=1 TO 2
25190 DI$(J%) = CVS(MID$(OPT$,PX%,81))
25200 PX%=PX% + 8
25210 NEXT J%
25220 FOR J%=7 TO 8
25230 B$(J%*16)=CVS(DA$(I%))
25240 NEXT J%
25245 GOSUB 26000
25250 RETURN
26000 REM **** READ BLOODY METHOD2,FIL ****
26010 GET #10,RNZ
26020 MDP$(3)=CVS(DA$(5))
26030 FOR J%=18 TO 20
26040 MD$(J%)=DA$(J%-16)
26050 NEXT J%
26060 MD$(23)=CVS(DA$(5))
26070 MD$(24)=CVS(DA$(6))
26080 GET $5,RNZ
26090 GET $6,RNZ
26100 MD$(2)=F$(5)
26110 MD$(3)=F$(6)
26120 RETURN
27000 REM **** dd/mm/yy --> d/w/y ****
27010 DMY$=RIGHT$(STR$(DMY$,6))
27020 Y1=VAL(MID$(DMY$,1,2)):M=VAL(MID$(DMY$,3,2)):D=VAL(MID$(DMY$,5,2))
27030 Y2=Y1
27040 IF Y1>99 THEN GOTO 27060

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27059 Y1=Y1+1000
27060 DF=DF+1:MF=M1:VF=Y1:GOSUB 27100:U=ND
27070 D1=Y2(U-7)*INT(U/7)+1
27080 WH=0:GOSUB 27210
27090 RETURN
27100 REM # SOLVING FOR DAY NO. ##
27110 ND=DF-1
27120 FOR II=1 TO MF-1:ND=ND-LX(II):NEXT II
27130 II=INT(YF/100)  
27140 IF YF<>INT(YF/4) GOTO 27190
27150 IF YF/100=II GOTO 27190
27160 IF ND<>9 GOTO 27190
27170 IF MF=3 GOTO 27190
27180 ND=ND-1
27190 ND=ND+365241:II=INT(365.25*(YF-100+1))
27200 RETURN
27210 REM # SOLVING FOR WEEK NO. ##
27220 IF Y2=SY1 THEN 27260
27230 FOR IS1=1 TO ((Y2-1)-SY1)
27240 IF SY1+IS1<>INT((SY1+IS1)/4) THEN WN=WN+1
27250 NEXT IS1
27260 IF Y2=INT(Y2/4) AND M1>2 THEN WN=WN+1
27270 WN=WN+4*L(SM1)-(IS1-1)+D01
27280 IF Y2<SY1 THEN 27290
27290 FOR II=SM1+1 TO M1-1:WN=WN+LX(II):NEXT II
27300 GOTO 27380
27310 ME=12-SM1+II=SM1+1
27320 FOR IS1=1 TO (Y2-(SY1+1)):ME=ME+12:NEXT IS1
27330 FOR IS1=1 TO ME:WN=WN+LX(II)
27340 II=II+1
27350 IF II=12 THEN 11=1
27360 NEXT IS1
27370 FOR IS1=1 TO M1-1:WN=WN+LX(IS1):NEXT IS1
27380 REM #
27390 IF D1<>7 THEN WN=WN+7-D1
27400 WN=WN+1:REM # ALLOWING FOR 1 OF JAN '83 ##
27410 WN=INT(WN/7.024509)+1
27420 IF WN>52 THEN WN=WN-52 ELSE GOTO 27450
27430 IF M1<12 AND WN>53 THEN Y2=Y2+1
27440 GOTO 27420
27450 RETURN
28000 REM # PRINT DATE WHERE EVER I WANT IT ###
28010 START=0:START=0:FINISH=QTE:FINISH=QTE
28020 PRINT FCNP$(7,39):START#CUP$
28030 PRINT FCNP$(8,39):FINISH#CUP$
28040 ROWN=9:COL=39:MINL=1:MAXL=1:KEYLEN=1:GOSUB 60980:KEY=1#
28050 REM PRINT FCNP$(21,2)*DO YOU WISH TO CHANGE THE DATES ?*CUP#:GOSUB
28060 IF FLAG THEN RETURN
28080 RETURN
28090 RETURN
29000 REM # SUFFIX CHECK FOR PLANNING ######
29010 IF INSTR$(21,":F" )<> THEN SIF=1:GOSUB 4600:RETURN
29020 REM IF INSTR$(21,":F" )<> AND D(28)<>0 AND TIFE="A" THEN
29030 IF D(23)<D(28):RETURN
29040 IF INSTR$(21,":F" )<> AND D(26)<SEI<>0 THEN SIF=3:D(23)=D(26)+SEI:RETURN
29050 GOSUB 4600:SIF=1
29060 RETURN
30000 REM # MAIN REPORT OPTIONS ####
30010 WIDTH 225
30030 PRINT NOLIN$NDCAR$  
30040 PRINT NOCUR$BKG$CLS$  
30060 PRINT FNCP$:-  
    2,0)RNLLEFT$(TX$(3),13)ROFF$MID$(TX$(3),14,50)RNLRIGHT$(TX$(3),17)CUP$ROFF$  
30070 PRINT FNCP$:-2,35)LEFT$(TX$(47),12)CUP$  
30090 PRINT FNCP$:(3,25)LEFT$(TX$(16),32)CUP$  
30100 PRINT FNCP$:(5,25)LEFT$(TX$(17),16)CUP$  
30110 PRINT FNCP$:(7,25)LEFT$(TX$(18),30)CUP$  
30120 PRINT FNCP$:(9,25)LEFT$(TX$(19),20)CUP$  
30130 PRINT FNCP$:(11,25)LEFT$(TX$(20),26)CUP$  
30140 PRINT FNCP$:(13,25)LEFT$(TX$(21),40)CUP$  
30150 PRINT FNCP$:(15,25)LEFT$(TX$(22),26)CUP$  
30155 PRINT FNCP$:(17,25)LEFT$(TX$(50),20)CUP$  
30160 PRINT FNCP$:(21,21)LEFT$(TX$(41),20)CUP$  
30170 PRINT FNCP$:-2,69)RNL$TE$ROFF$CUP$  
30180 PRINT FNCP$:-2,7)RNL$HE$ROFF$CUP$  
30190 PRINT ROFF$FRED$  
30200 RETURN  
31000 REM *** SCREEN FOR PLANNING OPTION ***  
31005 PRINT NOCUR$BKG$CLS$  
31010 PRINT CURPOS$CHR$(32)$CHR$(32)$RNL$"*ROFF$CUP$"  
31020 PRINT FNCP$:-  
    2,0)RNLLEFT$(TX$(3),13)ROFF$MID$(TX$(3),14,50)RNLRIGHT$(TX$(3),17)CUP$ROFF$  
31030 PRINT FNCP$:-2,35)LEFT$(TX$(44),16)CUP$  
31050 PRINT FNCP$:(6,20)LEFT$(TX$(23),33)CUP$  
31060 PRINT FNCP$:(8,20)LEFT$(TX$(24),30)CUP$  
31070 PRINT FNCP$:(10,20)LEFT$(TX$(25),30)CUP$  
31080 PRINT FNCP$:(14,18)LEFT$(TX$(26),16)CUP$  
31090 PRINT FNCP$:(15,18)LEFT$(TX$(27),5)CUP$  
31100 PRINT FNCP$:(16,18)LEFT$(TX$(27),3)CUP$  
31110 PRINT FNCP$:(21,21)LEFT$(TX$(5),23)CUP$  
31120 PRINT FNCP$:-2,7)RNL$HE$ROFF$CUP$  
31130 PRINT FNCP$:-2,69)RNL$TE$ROFF$CUP$  
31140 PRINT ROFF$FRED$CUP$  
31150 RETURN  
31500 REM *** SCREEN FOR PROGRAMME OPTION ***  
31505 PRINT NOCUR$BKG$CLS$  
31510 PRINT CURPOS$CHR$(32)$CHR$(32)$RNL$"*ROFF$CUP$"  
31520 PRINT FNCP$:-  
    2,0)RNLLEFT$(TX$(3),13)ROFF$MID$(TX$(3),14,50)RNLRIGHT$(TX$(3),17)CUP$ROFF$  
31530 PRINT FNCP$:-2,35)LEFT$(TX$(45),20)CUP$  
31550 PRINT FNCP$:(6,29)"(01)" "PROC$(1)" "CUP$  
31560 PRINT FNCP$:(7,29)"(02)" "PROC$(2)"CUP$  
31565 PRINT FNCP$:(8,29)"(03)" "PROC$(3)" "CUP$  
31570 PRINT FNCP$:(21,21)LEFT$(TX$(41),15)CUP$  
31575 PRINT FNCP$:(11,30)LEFT$(TX$(29),11)CUP$  
31580 PRINT FNCP$:-2,7)RNL$HE$ROFF$CUP$  
31590 PRINT FNCP$:-2,69)RNL$TE$ROFF$CUP$  
31600 PRINT ROFF$FRED$CUP$  
31610 RETURN  
32500 REM *** SCREEN FOR OPTION SEVEN ***  
32510 PRINT NOCUR$BKG$CLS$  
32540 PRINT CURPOS$CHR$(32)$CHR$(32)$RNL$"*ROFF$  
32550 PRINT FNCP$:-  
    2,0)RNLLEFT$(TX$(3),13)ROFF$MID$(TX$(3),14,50)RNLRIGHT$(TX$(3),17)CUP$ROFF$  
32560 PRINT FNCP$:-2,35)LEFT$(TX$(46),14)CUP$  
32580 OPEN "R",#15,\"MAIN.FIL",80
32590  FIELD #15,80 AS OS$
32600  FOR I2 = 1 TO 10
32610  GET #15, Tx+42
32620  PRT$="*+MID$(STR$(I2),2,2)+*+MID$(OS$,1,12)
32630  PRINT FNCP$(I2+4,25) PRT$@CUP$
32640  NEXT I2
32680  PRINT FNCP$(21,18) LEFT$(TX$)(30,16) CUP$
32690  PRINT FNCP$(-2,7) RTN@ME&ROFF$ CUP$
32700  PRINT FNCP$(-2,6)RTN@DE&ROFF$ CUP$
32710  PRINT ROFF$#K60@CUP$
32720  RETURN
35000  REM **** GET KEY & DATE SCREEN ****
35010  PRINT NOCUR$#K0@CLS$
35020  PRINT CURPOS$#CHR$(32)CHR$(32)ROFF$ "ROFF$"
35030  PRINT FNCP$(-2,0)RTN@LEFT$(TX$)(33,12)ROFF&MID$(TX$)(3,14,50)RTN@RIGHT$(TX$)(13,17)CUP$
35060  PRINT FNCP$(-2,7)RTN@ME&ROFF$ CUP$
35065  PRINT FNCP$(-2,35)LEFT$(TX$)(47,12)CUP$
35070  PRINT FNCP$(-2,6)RTN@DE&ROFF$ CUP$
35080  PRINT FNCP$(17,29) LEFT$(TX$)(10) CUP$
35090  PRINT FNCP$(9,28) LEFT$(TX$)(32,8) CUP$
35100  PRINT FNCP$(9,28) LEFT$(TX$)(33,6) CUP$
35102  IF OP$=1 THEN KY$=LEFT$(TX$)(34,13): GOTO 35108
35105  REM ** IF OP$=2 THEN KY$="Casting Section ": GOTO 35108 **
35108  IF OP$=7 THEN KY$=LEFT$(TX$)(36,15): GOTO 35108
35109  KY$=LEFT$(TX$)(37,14): GOTO 35108
35110  PRINT FNCP$(3,28) LEFT$(TX$)(33,7) RTN@KY&ROFF$ CUP$
35110  PRINT ROFF$#FRED@CUP$
35112  RETURN
36000  REM **** DISPLAY ALL INFO ROUTINE ****
36010  FOR J1X = 1 TO 51
36020  ROWX = MMAX(J1X,1): COLX = MMAX(J1X,6): ELE = MMAX(J1X,3): TYPE = MMAX(J1X,2)
36030  MAXL = MMAX(J1X,4): MMLX = MMAX(J1X,5)
36040  IF TYPE = 1 THEN I$=#E(ELE)
36050  IF TYPE = 2 THEN MAXL = 7: I$="RIGHT$"$" *STR$(D(ELE)).MAXL$"
36060  IF TYPE = 3 THEN IF MMLX = 8 THEN GOTO 36100 ELSE M=#E(ELE): NP=3: DP=5: GOSUB 37500: I$=#M$
36070  IF TYPE = 4 THEN M=#E(ELE): NP=3: DP=5: GOSUB 37500: I$=#M$
36080  PRINT FNCP$(ROWX, COLX): I$=
36090  GOTO 36140
36100  I$=RIGHT$(STR$(D(ELE))): LEN$(STR$(D(ELE)))-1)
36110  DT(1)=VAL(MID$(I$(5,2))): DT(2)=VAL(MID$(I$(3,2))): DT(3)=VAL(MID$(I$(1,2))
36120  DAT$=RIGHT$(STR$(DT(1)),2)+"*/RIGHT$(STR$(DT(2)),2)+"*/RIGHT$(STR$(DT(3)),2)
36130  PRINT FNCP$(ROWX, COLX): DAT$@CUP$
36140  NEXT J1X
36150  RETURN
37500  REM ** FORMATTING ROUTINE **
37501  HMS="999999999999"
37502  IF M$ THEN M=0
37503  IF M=0 THEN H=0: H=M/1000: FK=1 ELSE FK=0
37505  SDP=NP$+1
37510  G=ABS(M$)+S$10": (SDP): M$=RIGHT$(SPACE$(12)+STR$(GNNM)+INT(Q)),BP$"
37520  M$=M$+".*MID$(STR$(1)+Q-INT(Q)*000000",4,NP$): RETURN
40000  REM ****OPENING FILES****
40010  REM OPENING FILES 1,2,3 & 4
40020  FOR J12 = 1 TO 2
40030  FILENAME$ = D$1*RIGHT$(STR$(J12)+"*.FIL",5)
40040  OPEN "R",#J12, FILENAME$, 16
40050 FIELD #J1X,16 AS F$(J1X)
40060 NEXT J1X
40062 FOR J1X=4 TO 6:FILENAME=MDS+RIGHT$(STR$(J1X)+".*.FIL",5)
40064 OPEN "R",#J1X,FILENAME,16:FIELD #J1X,16 AS F$(J1X)
40066 NEXT J1X
40070 OPEN "R",#7,ODS+"ORDER.FIL",152
40080 FIELD #7,24 AS CORDS,80 AS PCT$,43 AS SPT$
40090 OPEN "R",#9,ODS+"RECORD.FIL",2
40100 FIELD #9,2 AS REC$
40110 OPEN "R",#0,MD+"METHOD.FIL",240
40120 FIELD #8,16 AS F$(B),104 AS ROPE$,16 AS DPT$,88 AS FPT$,8 AS INR$,4 AS
40130 DA$(7),4 AS DA$(8)
40140 OPEN "R",#3,ODS+"J.FIL",16
40140 FIELD #3,16 AS F$(3)
40150 OPEN "R",#10,MD+"METHOD2.FIL",170
40160 FIELD #10,B AS DA$(11,50) AS DA$(13),50 AS DA$(14),4 AS DA$(15),4
40170 AS DA$(6),4 AS DA$(9)
40170 OPEN "R",#11,MD+"CMETH.FIL",2
40180 FIELD #11,2 AS MREC$
40193 GET #11,1
40196 REG=CVI(MREC$)
40190 RETURN
41000 REM #### OPENING SEQUENTIAL DATA FILES ####
41005 CURR=*
41010 OPEN "R",#1.,"MAIN.FIL",BO
41015 FIELD #1.,80 AS UCK$
41020 GET #1.,STR$(1):GOSUB 57000:HD$(1)=TX$
41030 GET #1.,(STR$(1)+1):GOSUB 57000:HD$(1)=TX$
41035 GET #1.,(STR$(1)+2):GOSUB 57000:HD$(1)=TX$
41040 IF TYPES="D" AND TYPES="E" THEN CURR=CURR+1:STRM%=STRM%+1:GET
41050 #1.,STR$(1)+1:GOSUB 57000:HD$(1)=TX$
41055 PX=STRM%+2
41060 FOR IN=1 TO 6:PX=PX+1
41065 GET #1.,PX:IF INX\2/INT(IN\2/2) THEN S$=LEFT$(UCK$,79) ELSE GOSUB
41060 57000:S$=S$\+TX$:HD$(S$$)=S$:CURR=CURR+1
41065 NEXT IN$
41065 IF TYPES="D" AND TYPES="E" THEN STRM%=STRM%+1
41067 IF STRM%=841 THEN STRM%=STRM%+1
41070 GET #1.,(STRM%+101):KEYPTRS=LEFT$(UCK$,4)
41080 GET #1.,(STRM%+11):ITEMPTRS=LEFT$(UCK$,23):LEFT$(UCK$,23)+2
41090 GET #1.,(STRM%+12):TOTALS=LEFT$(UCK$,23)+2
41100 GET #1.,(STRM%+13):SUBTOTS=LEFT$(UCK$,7)
41120 CLOSE #1
41199 RETURN
42000 REM #### ESTABLISH NUMBER OF RECORDS ON ORDER FILE ####
42010 GET #9,1
42020 REC= CVI(REC$)
42030 RETURN
44000 REM PRINT OUT HEADERS
44033 LPRINT STRINGS(LEN(HD$(6))+2,*"*)
44055 IF BD$=7 THEN LPRINT HD$(11):IDENT$:SPC(23):LEFT$(TX$+(42),7):GOTO 44020
44060 ELSE 44010
44010 LPRINT HD$(1)
44015 IF (PROSS="**" AND DPT$="**") OR TYPES="E" THEN LPRINT HD$(2) 2,8,"-")
44030 ELSE 44020
44020 LPRINT HD$(2) 2,8,"*KEYS"
44030 LPRINT HD$(3) 2,8,"*DTES"
44033 IF TYPES="E" THEN LPRINT STRINGS(LEN(HD$(6))+2,*"*)
44045 IF TYPES="E" AND (SEX=2 OR SEX=3) THEN GOTO 44027
44055 IF TYPES="E" THEN LPRINT HD$(4) 2,8,44050 ELSE GOTO 44040
44058 GOTO 44050
44040 LPRINT HD$(4)*" START" TO "FINISH"
44045 LPRINT STRINGS$(LEN(HD$(6))+2,"-")
44047 IF OPX=2 AND TYPE$="W" THEN RETURN
44050 LPRINT HD$(5)
44060 LPRINT HD$(6)
44062 IF TYPE$="E" THEN 44070
44065 LPRINT HD$(7)
44070 LPRINT STRINGS$(LEN(HD$(6))+2,"-")
44080 RETURN
45000 REM *** TO PRINT OUT A JOB STATUS AND HEADING ***
45010 NP=2:DP=#0:DR=1:GOSUB 37500:BD#=N#
45020 LPRINT:LEFT$(TX$(47),21):MID$(TX$(143),32,16)
45030 LPRINT "-----------------------------"
45040 GOSUB 40445
45050 RETURN
46000 REM DISMANTLE A DATE
46010 A=INT(C/10000):C=C-A*10000
46020 B=INT(C/100):C=C-B*1000
46030 D=RIGHT$(SPACE$(2)+STR$(C,2),"*/=RIGHT$(SPACE$(2)+STR$(B,2),2)="/=RIGHT$(SPACE$(2)+STR$(A,2),2)"
46040 RETURN
50000 REM *** MATCH SUBROUTINE ***
50100 RNZ = RNZ + 1
50200 IF RNZ = REC%+1 THEN FLAG = 0:RETURN
50300 GET #K$,RNZ
50400 RN$ = F$(#K$)
50500 IF LEFT$(#KEY$,HX) = LEFT$(#RN$,HX) THEN GOTO 50070
50600 GOTO 50010
50700 FLAG = 1
50800 RETURN
55000 REM *** Read Text File Routine ***
55005 VLEX=#07007107207A10B15127328636B8B930939132239309439393973973994000140240
3404030406047040940914112434414415416606122541741861761862006307904*
55010 OPEN "+",#1, "MAIN.FIL",BO
55020 FIELD #1,BO AS MUC#
55030 CT$=0
55040 FOR I%=1 TO LEN(VLEX$) STEP 3
55050 EL=VAL(MID$(VLEX$,I%,3))
55060 CT$=CT$+1
55070 GET #1,EL
55080 TX$(CT$)=MUC#
55090 NEXT I%
55100 CLOSE #1
55110 RETURN
57000 REM *** strip down IF$ routine to text only ***
57010 CT%=79:FLAE2=0
57020 WHILE FLAE2=0
57030 IF MID$(UCK$,CT%,1)<" > OR CT%=1 THEN FLAE2=1
57040 CT%=CT%+1
57050 WEND
57060 TX$=LEFT$(UCK$,CT%+1)
57070 RETURN
60700 MAIL#=#1:MINL%=1:REM *** DATE CHANGE ROUTINE ***
60710 GOSUB 69990:IF VAL(I%)=0 THEN CDAT$="0":GOTG 60810
60720 A=INSTRI$,"/":IF A=0 THEN A=INSTRI$","")
60730 IF A=0 THEN 60700 ELSE P$=LEFT$(I%,A-1)
60740 B=INSTR(A+1,I$,"/");IF B=0 THEN B=INSTR(A+1,I$,"-")
60750 IF B=0 THEN 60790 ELSE B=MOD((I$,A+1,B-(A+1))
60760 CS=MOD(I$,B+1,2)
60770 A=VAL(F$)+B=VAL(B$)+C=VAL(C$)
60780 IF B(1 OR B(2 OR A(1 OR A(31 OR A(99 OR B(81 THEN 60700
60790 COMENT=(B(10000)+(B(1)+A
60800 DATA=P$="/"+B$="/"+C$
60810 PRINT FNCP$(ANDW, COLS, DATACUPS
60830 RETURN
60890 REM INPUT STRING ROUTINE
60990 IS="**
61000 PRINT FNCP$(ANDW, COLS, I*)&ANDS*SPACE*(MAX%-LEN(IS)) Remove$CUP$
61010 GOSUB 61110
61020 IF X=8 THEN GOTO 61060
61030 IF X=13 AND LEN(IS)<MINL THEN GOTO 61080 ELSE IF X=13 GOTO 61000
61040 IF LEN(IS)<MAXL THEN IS=IS+A$
61050 GOTO 61000
61060 IF LEN(IS)>THEN IS=LEFT$(IS, LEN(IS)-1)
61070 GOTO 61000
61080 IS=LEFT$(IS))*SPACE*(MAXL, MAXL)
61090 PRINT FNCP$(ANDW, COLS, I*)&CUP$
61100 RETURN
61110 REM GET VALID CHARACTER
61120 AS=INKEY$;IF AS="**THEN GOTO 61120
61130 X=ASC(A$)
61140 IF (X>31 AND X<127) OR X=B OR X=13 THEN RETURN
61150 IF X=185 OR X=27 THEN CLOSE:CHAIN "PO-00"
61160 IF X=247 THEN GOSUB 61200
61170 IF X=186 THEN GOSUB 62000:LPRINT
61180 IF X=189 THEN GOSUB 62000:FOR L%=1 TO 10:LPRINT:NEXT L%
61190 RETURN
61200 GOSUB 62000
61230 DEF SES = $FH000
61240 FOR J2 = 0 TO 22
61250 WE="**
61260 FOR J2 = 0 TO 159 STEP 2
61270 WES=WES+CHR$(SES$PEEK((J2*160+J2)-100))
61280 NEXT J2
61290 LPRINT WES
61300 NEXT J2
61310 WIDTH 255
61320 RETURN
62060 RETURN:REM "##### GENERAL ERROR ROUTINE #####"
62070 PRINT FNCP$(21,0);X$$(I$);FNCP$(21,25)ERK;FNCP$(21,49)ERL;CUP$
62080 AS=INKEY$;IF AS="**" THEN 62020
62090 X=ASC(A$);IF X=27 THEN 61150
62040 PRINT FNCP$(21,0)*SPACE*(79)*CUP$
62050 RESUME
63998 END
63999 REM *PO5-00 (86F01 - CRE - 01/05/1986)IBM
A4.4 Resource Maintenance Program
5 REM "$INCLUDE 'SHARE'"
10 REM **** PDL-C :RESOURCE UPKEEP ****
13 GDOSUB 55000
15 DEF FNCP$(ROW$(,COL$)=CHR$(27)+"Y"+CHR$(34+ROW$)+CHR$(32+COL$))
19 IF NAME="" OR BHE="" THEN CHAIN "PPC"
20 GDOSUB 40000
25 DIM WC$(7),MS$(7)
30 KEY$ = SPACE$(8)
110 GDOSUB 10000
120 A$ = "PA";
121 ROW$ = 21:COL$ = 17:MAXL$ = 8:MINL$ = 1
125 GDOSUB 30000
130 PRINT FNCP$(21,0)LEFT$(TX$(6),16)CUP$
140 GDOSUB A0980
142 PRINT FNCP$(12,26)"CUP$
145 KEY$ = LEFT$(1+SPACE$(2),8)
150 RN$ = 0
160 GDOSUB 50000
165 IF RN$ = SPACE$(8) AND FLAG = 1 THEN 160
170 IF FLAG <> 1 THEN SJ$ = LEFT$(TX$(7),21)+" +":LEFT$(TX$(1),22): GDOSUB 9000: GOTO 30
180 GDOSUB 25000
191 GDOSUB 35000
195 PRINT FNCP$(14,26): RN$ = 0
200 GDOSUB 60000
210 IF EL$ = "0" THEN 200
220 GDOSUB 1000
230 SJ$ = LEFT$(TX$(12),20)+" +":LEFT$(TX$(11),22): GDOSUB 9000
245 GDOSUB 30000
250 GOTO 30
1000 REM *** WRITE METHOD ***
1010 LSET W$ = NCD$
1020 FOR I = 1 TO 7: LSET MS$(I) = MK$(WC$(I)): NEXT I
1030 LSET WC$ = MK$(0)
1040 LSET W$ = KEY$
1250 PUT #1, RN$
1263 PUT #2, RN$
1270 RETURN
9000 REM "HIT SPACE BAR ROUTINE"
9005 MESS$ = SPACE$(79): MID$(MESS$, INT((79-LEN(MESS$))/2)): LEN(MESS$) = S$
9010 PRINT FNCP$(21,0) MESS$ CUP$
9020 MAX$ = 1: MINL$ = 1: ROW$ = 21: COL$ = INT((79-LEN(MESS$))/2)+LEN(MESS$)+2: GDOSUB 6110
9030 IF A$ <> " " THEN 9020
9040 PRINT FNCP$(21,0) SPACE$(79) CUP$
9050 RETURN
10090 WIDTH 255
10100 REM DRAW SCREEN 1.1.1/2/3/4
10100 PRINT "NO"CH4NDCCP$
10130 PRINT "NO"CH4EKGS$
10140 PRINT "CL$"
10150 PRINT FNCP$(-2,7) CH4 "NO"CH4RDCCP$
10160 PRINT FNCP$(-2,2) CH4 "NO"CH4RDCCP$
10170 PRINT FNCP$(-2,2) CH4 "NO"CH4RDCCP$
10180 PRINT FNCP$(-2,2) CH4 "NO"CH4RDCCP$
10190 PRINT FNCP$(2,2) CH4 "NO"CH4RDCCP$
10190 PRINT FNCP$(2,2) CH4 "NO"CH4RDCCP$
10190 PRINT FNCP$(2,2) CH4 "NO"CH4RDCCP$
10190 PRINT FNCP$(2,2) CH4 "NO"CH4RDCCP$
10190 PRINT FNCP$(2,2) CH4 "NO"CH4RDCCP$
10190 PRINT FNCP$(2,2) CH4 "NO"CH4RDCCP$
10190 PRINT FNCP$(2,2) CH4 "NO"CH4RDCCP$
10190 PRINT FNCP$(2,2) CH4 "NO"CH4RDCCP$
10190 PRINT FNCP$(2,2) CH4 "NO"CH4RDCCP$
10400 REM RETURN
25000 REM ** READ CAPACITY FILE **
25010 GET #2,RNZ
25020 FOR I=1 TO 7;MC(I)=CVS(WS(I)):NEXT I
25030 WCD$=WS0$:WCC$=CVI(WCD$)
25040 RETURN
30000 REM ** BLANK OUT ALL ENTRIES **
39010 WS$="**
*:WCD$=SPACE$(40);WCC$=0:MC(1)=0:MC(2)=0:MC(3)=0:MC(4)=0:MC(5)=0:MC(6)=0:MC(7)=0
30040 RETURN
35000 REM ** DISPLAY ALL INFO **
39010 COL%=26:RDW%=2
39020 PRINT FNCP$(ROWX, COL%):KEY$;
39025 ROWX=ROWX+1
39030 PRINT FNCP$(ROWX, COL%):WCD$
39035 ROWX=ROWX+1
39040 PRINT FNCP$(ROWX, COL%):RIGHT$("**STR$(WCC$),2)
39045 ROWX=ROWX+2
39050 FOR I=1 TO 7
39060 M=MC(I):NP=2:DP=6:GSUB 37500
39070 PRINT FNCP$(ROWX, COL%):MC$;
39080 ROWX=ROWX+1:NEXT I
39090 RETURN
37500 REM ** FORMATTING ROUTINE **
37505 SDP=NP+1
37510 D=ABS(M)+5*10^-(-SDP):MS=RIGHT$(SPACE$(12)+STR$(SGN(M):INT(D)),DP)
37520 MS$="*",MID$(STR$(1+INT(D))+"000000",4,4),NP):RETURN
40000 REM ** ENQUIRY SUBROUTINE **
40020 OPEN "R",#1,MD$="CAP1.FIL",B
40030 FIELD #1,3 AS MS#
40040 OPEN "R",#2,MD$="CAP2.FIL",70
40050 FIELD #2,40 AS MS$,N AS WSN$,4 AS WS$(1),4 AS WS$(2),4 AS WS$(3),4 AS WS$(4),4 AS WS$(5),4 AS WS$(6),4 AS WS$(7)
40100 OPEN "R",#3,MD$="CTCAP.FIL",2
40120 FIELD #3,2 AS REC$
40130 GET #3,1
40140 REC$ = CVI(REC$)
40150 RETURN
50000 REM *** MATCH SUBROUTINE ***
50010 RNZ = RNZ + 1
50020 IF RNZ = REC$+1 THEN FLAG = 0:RETURN
50030 GET #1,RNZ
50040 RNZ = WS$
50050 IF KEY$ = RNZ THEN GOTO 50070
50060 GOTO 50010
50070 FLAG = 1
50080 RETURN
55065 VLE$="07007107207497222427228222923023123593660461"
55060 OPEN "R",#1,MAIN.FIL",80
55060 FIELD #1,50 AS MUC$
55060 CNT=0
55060 FOR IX=1 TO LEN(VLE$) STEP 3
55060 EL=VAL(MID$(VLE$,IX,3))
55060 CNT=CNT+1
55060 GET #1,EL
55060 TS$(CNT$)=MUC$
55090 NEXT IX
55100 CLOSE #1
55110 RETURN
A4.5 Resource Loading Program
5 REM $INCLUDE 'SHARE'
18 REM **** C2 ****
16 DIM ORDI(1888),ORDI(178),SPS(108,4),LBS(52),PFX(1888)
17 DIM MDF(24),MDF(3),YK(7),LX(12),W(7),WS(7),BLK(7),WE(31),CHR(38),DATUM(18,2)
19 DEP FNCPS(ROW, COL)=CHR$(27)"*"CHR$(34+ROW)+CHR$(32+COL)
22 PRINT FNCPS(17,17)"Loading data blocks .......
23 SY=83;SD=3;SM=1;SY=83;SD=3;SM=1: AFLAG=8: PROG$="*"*
25 FOR I=1 TO 12:READ LX(I):NEXT I
24 FOR I=1 TO 7:READ YK(I):NEXT I
27 DATA 31,28,31,30,31,30,31,30,31,30,31,31:
28 DATA 5,6,7,1,2,3,4:
29 FOR I=1 TO 19:READ LBS(I):NEXT I
32 DATA 4,3,2,1,1,-2,-3,-4,1,0,0,1,-2,-4,-5,1,0,0,-2,-3,-4
35 OPEN "R",#1,MD$*RECDUI,FIL$,2:FIELD #1,2 AS RECDU$*
48 FOR I=1 TO BP(2):GET #1,1;ORD(12)=CUJ$(RECDU$):NEXT I
50 MY=#B(1):GOSUB 27000:TART=(Y2+10800)+(W1+1080):GOSUB
150:GND=$(T+4000):(MID$(STR$(TART),2,2)),2),2)
95 RHE$="**REM CREATE CHR CLOCKS**
110 H=1:FOR I=128 TO 142:IF I=1 THEN 4:CHR$(M)=CHR$(M)+CHR$(I):NEXT I:NEXT M=1:NEXT I
128 FOR I=144 TO 159:IF I=1 THEN 4:CHR$(M)=CHR$(M)+CHR$(I):NEXT I:NEXT M=1:NEXT I
138 CHR$="#DH$=""**#DH$=""
148 FOR I=1 TO 4:CHR$(M)=CHR$(143):DH$=DH$+CHR$(32):NEXT I
141 FOR I=1 TO 18:RANS=RANS+CHR$(143):NEXT I
146 REM * NB! NOT THAT YOU MUST ./ INTO YLEN-1 EXACTLY **
149 YLEN=16:XLEN=61:START=0:YSTART=0:YXUNITY=6:YUD=3:FTIM=9:CTI%=8:CDM$="**
158 CLOSE:KEYLEN=61;KEYCRT=COUNT(BP(2)):YSTART=YLEN/2;YLAG=8;AGB=8;SSB=6;FB=8;LEN=8;HEO$="**XXYX=KEYLEN+8:FIRST=FTIM:HEOS="**:GAL=8;SAB=8
288 IF CBD$="YES" THEN 77:ELSE CTI%=0
278 GOSUB 40000:REM *OPEN FILES*
298 GOSUB 11899:IF FLG($)=1 THEN CLOSE:GOTO 159
308 IF FTIM=0 THEN RS=17:CS=17 ELSE RS=1:CS=0
219 PRINT FNCPS$(CS,CS)"Sorting data "*SFC(21)
315 IF FTIM=0 THEN 286 ELSE 308
308 GOSUB 28688:REM *SORT DATA*
308 GOSUB 9099:REM *PROC DATA*
332 PRINT FNCPS$(1,0)"SPACE$(58)
348 RS=1:GOSUB 468;GOSUB 888;REM XOR Graf)*
368 GOSUB 11855:REM *BROWSER*
378 GOSUB 1899:REM *SAVE GRAPH*
371 PRINT FNCPS$(1,0)"SPACE$(58)
375 FTIM=99=GOTO 150
388 X=27:GOTO 61158
408 REM **** DRAW GRAPH FROM WORK ****
428 PRINT FNCPS$(1,0)"SPACE$(58)BKGD$*
485 AFLAG=8
486 IF HA$="8" THEN 418
487 IF FTIM=99 THEN FOR 2=-1 TO 15:PRINT FNCPS$(2,7)"SPACE$(72):NEXT 2:GOTO 498
419 PRINT NOLINNOCARR*
428 PRINT NODUR$BKGD$CLS$*
438 PRINT FNCPS$(2,0)"ROM$*
448 PRINT FNCPS$(2,17)"*FUNCTION: LOADING CHART *CUPS*
458 PRINT FNCPS$(2,0)"ROM$*USER: *ROPP$CUPS*
468 PRINT FNCPS$(2,66)"ROM$*DATE: *ROFP$CUPS*
476 PRINT FNCPS$(2,0)"ROM$*M$E$ROPP$CUPS*
488 PRINT FNCPS$(2,71)"ROM$*DATE$ROPP$CUPS*
488 IF AFLAG=99 THEN RETURN
498 X=YK(9);X=X:YXK(7);YK(18):Y=0:GOSUB 648:REM ** DRAW BOX **
510 PRINT FNCP$(YX-8,0,0)"FUNCTIONS"ULOFF$  
511 PRINT FNCP$(YX-7,0)"GRAPH"  
512 PRINT FNCP$(YX-6,0)"1" = "--"  
513 PRINT FNCP$(YX-5,0)"2" = "--"  
514 PRINT FNCP$(YX-4,0)"7""PRINT"  
515 PRINT FNCP$(YX-3,0)"*""INWEEK"  
516 PRINT FNCP$(YX-2,0)"R""RESET"  
517 PRINT FNCP$(YX-1,0)"*""E" = "END"  
518 PRINT FNCP$(YX+1,0)"WS = 18""CUP$  
520 FOR I=1 TO YLEN$:PRINT FNCP$(I,XSTART$CHR$(179):NEXT I  
530 FOR I=1 TO YLEN$:PRINT FNCP$(I,YLEN-1+1):CHR$(190):NEXT I  
540 PRINT FNCP$(YLEN,XSTART$CHR$(192)  
560 UNIT=(XCENTR/180)/(YLEN-1)  
565 DIV2=UNIT+YDIV  
570 UNIT2=UNIT/16  
580 IF CCC=8 THEN PRINT FNCP$(21,0):CHR$(7):FRG$"Enter a Capacity Figure :
"  
590 "BGDC"CUP$:R1=21:COL=26:MINL=1:MAXL=5:GOSUB 6898:IF VAL(R1)=8 THEN 580 ELSE  
600 CCCC=WAL(19):PRINT FNCP$(21,0):SPACE$(58):CUP$:GOTO 560  
610 DIV=DIV2+(UNIT/2)  
630 FOR I=YLEN-YDIV-I TO YDIV STEP -YDIV  
670 IF I=DIV1999999 THEN DIV=RIGHT$"  
680 "STR$(FIX(DIV/1000)),4)"*"+STR$(GOTO 685  
690 DIV=1 THEN DIV=9"+STR$(DIV),2,4):GOTO 685  
700 IF INSTR(STR$(DIV),",",")>0 THEN I=STR$(DIV),",",")=0 ELSE  
710 THEN DP=S:NP=8 ELSE  
720 DP=3:NP=2  
730 M=DIV2:GOSUB 7598:DIV=LEFT$(M$)  
750 PRINT FNCP$(I-1,I-1):CHR$(198):DP=DIV+DIV2:NEXT I  
760 FOR I=XSTART$XUNIT$:TO XLEN-1-XUNIT$:STEP XUNIT$:PRINT  
770 FNCP$(XLEN,1)CHR$(194):NEXT I  
780 I=1:FOR I=XSTART$1 TO XLEN$:STEP XUNIT$:PRINT  
790 FNCP$(XLEN-1,1)CHR$(194):FIND+STR$(WE(V),4,2)"+"9+STR$(WE(V),4,2):CUPS:U=V1:NEXT I  
800 PRINT FNCP$(XLEN-1,XSTART$1)"/""/="  
810 GOSUB 710:REM ** DRAW RANGE FINDER **  
820 PRINT FRGDC"CUP$  
830 RETURN  
840 REM ***** PRINT BOX *****  
860 FOR I=1 TO YMC:PRINT FNCP$(R,X,C)+1):CHR$(196):CUP$:PRINT  
870 FNCP$(R,X,C)+1):CHR$(196):CUP$:NEXT IX  
890 FOR I=1 TO YMC:PRINT FNCP$(R,X,C)+1):CUP$:PRINT  
900 FNCP$(R,X,C)+1):CHR$(191):CUP$:NEXT IX  
910 PRINT FNCP$(R,X,C)+1):CHR$(192):CUP$:PRINT  
920 PRINT FNCP$(R,X,C)+1):CHR$(217):CUP$  
940 RETURN  
950 REM ***** DRAW RANGE FINDER *****  
970 R2=YX+2:COL=XSTART$COL=38:MOD=2:GOSUB 640  
980 R2=YX+2:COL=43:MOD=34:MOD=2:GOSUB 648  
990 FOR I=1 TO 2(PRINT FNCP$(YX+2,1,5)):CHR$(179):NEXT I  
778 PRINT FNCP$(YX+4,1):CHR$(195):"6" = "--"  
788 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
798 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
808 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
818 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
828 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
838 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
848 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
858 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
868 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
878 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
888 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
898 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
908 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
918 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
928 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
938 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
948 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
958 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
968 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
978 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
988 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
998 PRINT FNCP$(YX+4,1):CHR$(195):="-"  
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868 IF NORG=0 AND BL(1)=0 THEN BLC=2:GOTO 890
865 IF BL(1)=0 THEN BLC=1:GOTO 890
874 IF NORG=NOT THEN BLC=0 :GOTO 890
896 IF BL(1)=0 AND NORG=NOT THEN BLC=2:GOTO 890
899 IF NORG=0 THEN II=1:F=BL(1):GOTO 759
895 IF NORG=YLB=1 THEN BLC=1
948 FOR II=1 TO NORG
918 PRINT FCNP(1,1):C'H'='CUP$'
930 NEXT II
948 F=BL(1)-UNIT+NORG;
950 F=INT(F/UNIT2)
952 IF F=UNIT THEN F=0
954 IF F= THEN F=1
955 IF NORG=YLB=1 THEN F=0
968 FOR J=1 TO F:PRINT FCNP(1-F:PRINT FCNP(1,1):C'H'='NEXT J
978 FOR I=(YLB=(NORG+BLC)) TO 0 STEP -1:PRINT FCNP(14,C)': "CUP$"=NEXT I
972 IF BL(1)=0 THEN PRINT FCNP(14,(NORG+BLC),C)': "CUP$"=GOTO 976 ELSE IF BL(1)=0 THEN PRINT FCNP(14,(NORG+BLC),C)'"=RIGHT$("**STR$(F(1+BLC)):4)"="CUP$"=GOTO 976
975 COD=(BLC) *GOSUB 2688:IF COD=0 THEN PRINT FCNP(14,(NORG+BLC),C)'"=RIGHT$("**STR$(COD):4)"="CUP$"=GOTO 976
976 IF FLAIL THEN RETURN
978 C=C+UNIT:NEXT I
979 GOSUB 1358:REM ** DRAW CAP LINE **
980 RETURN
1008 REM **** WEEK LOOK UP *****
1081 RH=RS
1082 PRINT FCNP(14,3,XO)RQS"="WEEK:RFFS"=PRINT FCNP(14,2,XO)SPACE$(9)
1083 PRINT FCNP(14,7,XO):"RBOOK"=PRINT FCNP(14,1,XLB=9)"WEEK "=RIGHT$("**STR$(RH),2):"CUP$"
1084 PRINT FCNP(14,4,XSTART:RH)RQS"=PRINT FCNP(14,1,7,(RH-8),6):"RQMN"="STR$(WE(RH)):4)"="HID$(STR$(WE(RH)):4)"="WFFS"=IF RH=1 THEN PRINT FCNP(14,1,7,(RH-8),6):"ROM=0:OUE"="RFFS"
1085 H=INPUT$(1)
1086 IF (H="?" OR H="*") THEN RETURN ELSE IF H="7" THEN GOSUB 9999:GOTO 1005
1087 IF H="1" THEN GOSUB 1018:GOTO 1005 ELSE IF H="2" THEN GOSUB 1015:GOTO 1005
1088 IF (H="8" AND BL(RH)) THEN GOSUB 1028:GOSUB 4999:GOSUB 1199:GOTO 1002
1089 GOTO 1005
1089 GOTO 1005
1091 RH=RH+1:IF RH>9 THEN RH=RS
1092 PRINT FCNP(14,9,XSTART:RH)RQS="RFFS"=GOSUB 1011
1093 PRINT FCNP(14,1,XLB=9S)RIGHT$("**STR$(RH),2)
1094 RETURN
1095 REM ** MOVE HAT LEFT **
1096 RH=RH+1:IF RH>9 THEN RH=RS+9
1097 PRINT FCNP(14,4,XSTART:RH=1)RQS="RFFS"=GOSUB 1011
1098 PRINT FCNP(14,1,XLB=9S)RIGHT$("**STR$(RH),2)
1099 RETURN
1102 REM ***** DISPLAY ORDERS *****
1103 PRINT NOLINE:NOCAP:NOCUR=KGD"OKS"CLS"
1105 FOR PR=1 TO 2:PRINT FCNP(-3+PR,8)VCLH*$
1183 PRINT FCNP(4,2,14)* Section: "FRG04=OKS" Wk.Ending:
1184 PRINT FRG04+MID$(STR$(WE(RH),6,2)="/MID$(STR$(WE(RH),4,2):"CUP$
1184 IF RH=8 AND RS=1 THEN PRINT FCNP(-257):"O/U=***
1185 PRINT FCNP(-28,8)OKG"=USER:
1186 PRINT FCNP(-2,67):"DATE:CUP$"
**RIGHT**  
+STR$(COD),10)" 
1863 AR$(02,1)=AR$(02,1)++ "PDS++ "RDS  
1864 IF PD>9 THEN MID$(AR$(02,1),72,1)="s"  
1865 DOD=0:NEXT 02  
1866 COUNTER=ORDI(X,RH):IF COUNTER=0 THEN GOTO 1867 ELSE GOSUB 35##  
1867 PRINT FNCPS$(21,27)BKGD$: "RIGHT"  
+STR$(COUNTER),5":  
"FRGD$"1"CUP$  
1870 RETURN  
1871 REM ***** MOVE UP *****  
1872 ST=ST-1:IF ST<1 THEN ST=1  
1874 GOTO 1804  
1891 REM ***** MOVE DOWN *****  
1892 ST=ST+1:IF ST>LENR THEN ST=ORDI(X,RH)  
1894 PRINT FNCPS$(21,35)RIGHT$:  
+STR$(ST),5"CUP$=RETURN  
1895 REM ***** HOLD POS of 's' WHILE PRINTING *****  
1896 LN=LNZ=1:SPS$(LN,0)=VAL(MID$(AR$(02,9),9,5)):SPS$(LN,1)=L:SPS$(LN,2)=VAL(MID$(AR$(02,11),78,2))*1000+VAL(MID$(AR$(02,11),67,2))*100+VAL(MID$(AR$(02,1),64,2)):SPS$(LN,4)=02  
1898 RETURN  
1899 REM ***** MOVE DATE BLOCK *****  
1902 IF H#=1 THEN PRINT FNCPS$(YY,1,7+9+(RH-  
R$=1)*6)BKGD$MID$(STR$(WE(RH)),6,2):*/"MID$(STR$(WE(RH)),4,2)FRGD$ ELSE IF  
H#=2 THEN PRINT FNCPS$(YY,1,7+(RH-R$=1)*6)BKGD$MID$(STR$(WE(RH)-  
1),6,2):*/"MID$(STR$(WE(RH)),4,2)FRGD$  
1903 PRINT FNCPS$(YY,1,7+(RH-  
R$=6)*6)BKGD$MID$(STR$(WE(RH)),6,2):*/"MID$(STR$(WE(RH)),4,2)ROFF$  
1904 IF (R$=1 AND RH=1 AND H$=1") THEN PRINT FNCPS$(YY,1,7)RED$0/Due*ROFF$  
ELSE IF (R$=1 AND RH=2 AND H$="2") THEN PRINT FNCPS$(YY,1,7)BKGD$0/Due*FRGD$  
1905 RETURN  
1906 REM ***** DISPLAY *****  
1907 PRINT FNCPS$(-1,0)ULONW6BKGD$SPC(18)ULOFF$FRGD$: FOR 02=1 TO  
LN:SPS$(02,0)=0:SPS$(02,1)=0:SPS$(02,2)=0:SPS$(02,3)=0:SPS$(02,4)=0:NEXT  
02:LN=0:ME=LEFT$(AR$(ST,8),8):CT=0:0=ST-1  
1908 WHILE LEFT$(AR$(0,8),8)=ME$  
1909 CT=CT+VAL(MID$(AR$(0,1),51,18)):0=0-1:NEXT  
1910 GOSUB 1835:AS=0  
1914 RETURN  
1915 REM ***** BROWSING *****  
1108 RS=1  
1128 V$=INPUT$(1)  
1129 IF V$="B" THEN GOSUB 1190:G$=0  
1130 IF V$="I" THEN GOSUB 1178:G$=9  
1148 IF V$="2" THEN GOSUB 1298:G$=9  
1145 IF V$="7" THEN GOSUB 6688  
1147 IF V$="9" AND G$=0 THEN GOSUB 1886:GOTO 1165  
1148 IF V$="9" AND G$=9 THEN PRINT FNCPS$(-1,0)*Re=GRAPH*CHR$(7)  
1149 IF V$="R" THEN GEND=6:GOSUB 3400  
1158 IF V$="E" THEN GOSUB 3190:RETURN  
1168 GOTO 1128  
1165 IF H$="E" THEN GOSUB 3190:RETURN ELSE PRINT FNCPS$(YY,1,3,XXC)BKGD$**9'  
"WEK$":PRINT FNCPS$(YY,1,3,XXC)""'"GRAP$":PRINT FNCPS$(YY,1,XXC)""""WKS  
*RIGHT$"**+STR$(RS,2),2)"**"RIGHT$**+STR$(RS+9,2)  
1166 PRINT FNCPS$(YY,2,XXX)BKGD$:" RESET"FRGD$  
1167 PRINT FNCPS$(YY,4,XXR)BKGD$:PRINT FNCPS$(YY,1,7+(RH-  
RS)*6)MID$(STR$(WE(RH)),6,2):*/"MID$(STR$(WE(RH)),4,2)FRGD$  
1168 IF RS=1 THEN PRINT FNCPS$(YY,1,7)BKGD$0/Due*FRGD$CUP$  
1169 GOTO 1128  
1178 REM ** MOVE TO LEFT **  
1188 RS=RS-1:IF RS=0 THEN RS=1:RETURN
1181 PRINT FNCPS(YY%+4,XSTART%+RS)BKGD$&BM#* "FRG$"
1182 RETURN
1187 REM ** RE-DRAW GRAPH **
1198 CX=UNITX%+1:PRINT FNCPS(-1,0)SPC(12)
1199 IF LIN=LIN THEN PRINT FNCPS(YY%-LIN%-7,SPACE*(XLEN%)) ELSE PRINT FNCPS(YY%-LIN%-7,SPACE*(XLEN%))
1200 PRINT FNCPS(YY%+1,XLEN%+13)RIGHT$="**STR$(RS),2"="RIGHT$="**STR$(RS)+2,CUP$=1286 FOR I=RS TO RS+9
1288 PRINT FNCPS(YY%+1,CX)BKGD$&BM#*"STR$(WE(1)),6,2)+"*/"+MID$(STR$(WE(1)),4,2)FRG$&CUP$=1289 FLC=1:GOSUB 840
1297 DX=CX:XUNIT%=NEXT 1
1298 IF RS=1 THEN PRINT FNCPS(YY%+1,7)BKGD$&Ou"+$FRG$&CUP$=1299 GOSUB 1358:RETURN
129A REM ** MOVE TO RIGHT **
1306 RS=RS+1:IF RS=21 THEN RS=21:RETURN
1307 PRINT FNCPS(YY%+4,XSTART%+RS)-1)BKGD$&"* RAN&FRG$"
1308 RETURN
130F REM ***** DRAW CAPACITY LINE *****
1328 LIN%=INT(CCC%/UNIT%):LIN=CCC%/UNIT%:IF LIN=YY%-LIN%-1 THEN LIN%=YY%-LIN%-1:LIN%=YY%-1
1329 IF LIN-LIN%=0 THEN DIFF=CCC-(UNIT-LIN%):DIFF=INT(DIFF/UNIT2) ELSE DIFF=0
132F IF LIN=LIN THEN 12=YY%-LIN%+3 ELSE 12=YY%-LIN%+3-2
1331 DEF SEG=8
1332 PLOC(DIFF%+2):PVAL%=5152+(47*32)
1334 FOR 1%=PLOC():PVAL%=TD PLOC():PVAL%=STEP 32
1336 POKE 1%,35
1338 POKE 1%+1,1
1339 NEXT 1%
133A DEF SEG=6:F$=0
133A WE="**
1406 FOR J=8 TO 158 STEP 2
1417 WE=WE+$CHR$(W$)
1418 NEXT J2
1423 FOR J=2 TO XSTART%+2 TO XSTART%+XLEN%:ASC$(MID$(WE$,J2,1))
1425 IF (W$)27 AND W$(144) THEN W$=16
1429 IF W$=32 THEN W$=16
1438 IF LIN=LIN THEN PRINT FNCPS(YY%-LIN%+J2-1)CHR$(W$) ELSE PRINT FNCPS(YY%-LIN%+1,J2-1)CHR$(W$)
1458 NEXT J2
1466 RETURN
1518 REM ***** CALC. FOR DATES *****
1528 W$1%=8:DIFF=7-D1:WED=DD1+DIFF
1538 IF Y1=1988 THEN Y1=1-1988
1548 IF INT(Y1/4)=Y1/4 THEN L%2=29
1558 IF WED(16#) THEN GOSUB 1678
1568 GUE=(Y1*1000)+161000+WE:REM ** CURRENT W/END DATE
1578 W$2)=GUE
1618 REM ** NEXT 29 W/ENDS CALC. **
1628 FOR I=3 TO 36
1636 WED=WED+7
1638 IF WED(16#) THEN GOSUB 1680
1658 WE1=(Y1*1000)+161000+WE
1668 NEXT I
1662 L%2=28
1665 RETURN
1678 REM ** 1ST W/END DATE CALC. **
1688 Y2=Y1:M2=M1+1
1698 IF M2)12 THEN M2=M2-1;Y2=Y1+1
1708 WED=WED-LX(M1)
1710 M1=M2;Y1=Y2
1728 RETURN
1808 REM **** SAVE GRAPH ****
1858 CLOSE
1888 OPEN "R",#12,"GRAPH.FIL",278
1881 FIELD #12,8 AS KE$,2 AS SE$,2 AS COD$,4 AS GR$,4 AS GDAT$,18 AS LAB$,128 AS
GR1,128 AS GR2
1883 OPEN "R",#13,"GRAPH.FIL",2
1884 FIELD #13,2 AS GREC$
1885 SET #13,1
1886 GREC$=CVI(GREC$)
1980 PRINT FNCP$(1,8)"Save chart (Y/N):"
* 1985 ROW$=1;COL=22;MINL=1;MAXL=1:GOSUB 89980:IF I$="Y"AND I$="N" AND I$="?" THEN
1985 1986 IF I$="N" THEN RETURN
1987 IF I$="?" THEN GOSUB 89980:GOTO 1980
1915 I$=1
1928 IF I$=2 THEN 1980
1938 SET #12,1 IF KE$=SPACE$(8) THEN 1951 ELSE I$=I$+1:GOTO 1920
1948 PRINT FNCP$(<1,6)"$CHAR$(7)"File full - Hit any key to continue
*CUP$=GOSUB 20828:RETURN
1951 GREC$=1:LET KE$=CON$:LET COD$=MK1$(4CCUC):LET GR$=MK2$(1CCUC):LET
GDAT$=MK3$(OP1):LET LAB$=MK4$(10CCUC):LET SE$=MK5$(10OP)
1952 TEMP$=**:TEM$"**"FOR I$=1 TO
38:TEM$=TEM$+MK5$(8LC1))**TEM$=MK5$(WEI1):NEXT I
1954 LSET GR$=TEM$:LSET GR2=TEM$
1956 PUT #12,GREC$
1960 PRINT FNCP$(<1,8)"Load chart saved - Hit any key
*CUP$
1962 GOSUB 20828
1969 CLOSE:RETURN
2008 REM ***** SORT ( STRING TYPE ) *****
2018 SDW=COUNT:IF COUNT=0 THEN SS="No matching orders on file":LPRINT
SS="$:241:BOTO $1158
2028 POX=POX+1
2038 IF (POX=SDW) COUNT THEN 2028
2048 IF AR(POX,0)=AR(POX,SDW,0) THEN 2030
2068 SWAP AR(POX,0),AR(POX,SDW,1)
2068 SWAP PPX(POX),PPX(POX,SDW)
2068 SWAP ORDX(POX),ORDX(POX,SDW)
2068 SWAP AR(POX,2),AR(POX,SDW,2)
2078 SWAP AR(POX,0),AR(POX,SDW,1):BOTO 2986
2088 POX=POX-1
2098 IF POX=SDW(1 THEN 2048
2100 IF AR(POX,0)=AR(POX,SDW,0) THEN 2030
2109 SWAP PPX(POX),PPX(POX,SDW)
2109 SWAP ORDX(POX),ORDX(POX,SDW)
2118 SWAP AR(POX,1),AR(POX,SDW,1)
2118 SWAP AR(POX,2),AR(POX,SDW,2)
2128 SWAP AR(POX,0),AR(POX,SDW,1):BOTO 2988
2208 REM ***** CONFIRM PLANNED DATES *****
2218 ANS="**PRINT FNCP$(28,51)FRSD*"=yes/no **CUP**PRINT FNCP$(21,51)"5=
Change"CUP$
2219 NL=1;PRINT FNCP$(SPOS(NL,1),63)RLNL=MID$(AR$(SPOS(NL,4),1),64,3)ROFF$
2217 SRO=VAL(MID$(AR$(SPOS(NL,4),8),9,5)):GOSUB 10888

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2210 PRINT FNC#(-1,38)BKGD$!ULON$*Order Ref: "$$(2)ULOFF$FRGDS#
2220 DT$=INPUT$(1)
2230 IF DT$="9" THEN PRINT FNC#(21,51)FROGS$"$BKGD$"=P.Dates; "$FRGDS$CUPS:PRINT
FNC#(28,51)"8$BKGD$"=display"FRGDS$GOSUB 2480:RETURN
2240 IF DT$="7" THEN LAG=1:GOSUB .88888:LAG=0:GOTO 2220
2250 IF DT$="2" THEN GOSUB 2380;YE=0:GOTO 2220
2260 IF DT$="1" THEN GOSUB 2380;YE=0:GOTO 2220
2270 IF DT$="8" THEN GOSUB 2380;GOTO 2220
2272 IF DT$="5" THEN GOSUB 2900:GOSUB 2380;YE=0:GOTO 2220
2275 GOTO 2220
2280 REM ***** confirm y/n *****
2281 IF MID$(AR$(SPOS(NL,4),1),72,1)="S" THEN RETURN
2282 YE=YE+1:IF YE=2=INT(YE/2) THEN ANS="N" ELSE ANS="Y"
2284 IF ANS="Y" THEN PRINT
FNC#(SPOS(NL,1),63)ULON$MD$=AR$(SPOS(NL,4),1),64,8)ULOFF$PRINT
FNC#(28,51)FROGS$=yes " ELSE PRINT
FNC#(SPOS(NL,1),63)RMD$MD$=AR$(SPOS(NL,4),1),64,8)ROFF$PRINT
FNC#(28,51)FROGS$=no "
2286 IF ANS="Y" THEN SPOS(NL,3)=9 ELSE SPOS(NL,3)=0
2288 RETURN
2289 REM ***** move down *****
2290 NL=NL+1:IF NL>LN THEN NL=LN
2291 IF SPOS(NL-1,1)=9 THEN 2220
2293 IF ANS="N" OR ANS="S" OR YE=0 THEN PRINT FNC#(SPOS(NL-1,1),63)MD$MD$=AR$(SPOS(NL,1),4),1),64,8)
2292 PRINT FNC#(SPOS(NL,1),63)RMD$MD$=AR$(SPOS(NL,4),1),64,8)ROFF$#
2293 SUNK$=VAL(MD$(AR$(SPOS(NL,4),1),9,3)):IF SUNK=0 THEN 2324 ELSE GOSUB 18888
2292 PRINT FNC#(-1,11)ULON$BKGD$#2)ULOFF$FRGDS#
2294 RETURN
2295 REM ***** move up *****
2298 NL=NL-1:IF NL<1 THEN NL=1
2299 IF SPOS(NL,1)=9 THEN 2380
2301 IF ANS="N" OR ANS="S" OR YE=0 THEN PRINT
FNC#(SPOS(NL,1),63)MD$MD$=AR$(SPOS(NL,1),4),1),64,8)
2302 PRINT FNC#(SPOS(NL,1),63)RMD$MD$=AR$(SPOS(NL,4),1),64,8)ROFF$#
2303 SUNK$=VAL(MD$(AR$(SPOS(NL,4),1),9,3)):IF SUNK=0 THEN 2364 ELSE GOSUB 18888
2303 PRINT FNC#(-1,11)BKGD$!ULON$#2)ULOFF$FRGDS#
2304 RETURN
2305 REM ***** save changes *****
2400 PRINT FNC#(-1,8)ULON$*Save the confirmed planned dates (Y/N) ?:
"SPACE(16)FRGDS$ROWE=1;COL=42;MAXL=1;MINL=1;GOSUB .89999:IF 1<>("Y" AND 1<>("N"
THEN 2410
2410 PRINT FROGS$GOTO 2426 ELSE 2470
2420 IF HED$="N" THEN 2440 ELSE 2427
2427 LPRINT STRING$(186,"--")
2428 LPRINT "USER : "|NAME$ | PLANNED DATE CHANGES | DATE: "|DATE$|LPRINT
2429 LPRINT "Original" | "Revised"
2430 LPRINT "---------" | "--------
2431 LPRINT "Order Planned Reference Date Planned Part
Customer Qty Required" | "Date" | "Date" | "Number"
2432 LPRINT "Reference Date Reference Date Number
Date"
2433 LPRINT STRING$(186,"--")|HED$="N"
2440 OZ=1:WHILE OZ<LN+1
2441 IF SPOS(OZ,2,3)=5 THEN 2450
2442 IF SPOS(OZ,2)=8 THEN 2450 ELSE SUNK$=SPOS(OZ,8)=GOSUB 18888:OZ=OZ+1:GOSUB 2470
2630 ELSE SUNK$=OZ+1:GOSUB 47500:GOSUB 2490
2443 IF OZ<8 THEN 2426=SPACE$(4) ELSE
2444 OZ=OZ+1:STR$(OZ),6,2)+"/*HMD$(STR$(OZ),4,2)+"/*HMD$(STR$(OZ),2,2)
2444 PRI$="*FRI$=PRI$="*OZ$="SPACE$(4)+"OZ$="*
2445 GOSUB 2565:PRI$=PRI$+PTEMP$**":"+D$(1)**":"+MID$(3)**":";GAL=99:DOD=8:GOSUB
1859:GAL=8
2446 PRI$=PRI$+RIGHT$("**"+STR$(DOD),5)
**"+MID$(STR$(D(23)),6,2)+"/"+MID$(STR$(D(23)),4,2)+"/"+MID$(STR$(D(23)),2,2):LPRI
2447 NT PRI$;
2448 IF SPOS(02,3)<0 THEN GOSUB 2496
2449 SPOS(02,3)=5
2450 O2=O2+1:WEND
2455 GOSUB 2580
2456 PRINT CURPOS$CHR$(33):CHR$(32):BKGD=ULON*$All changes have been saved - Hit any key to continue
2457 *SPACE$(15):FREQ=ULOFF#:GOSUB 28820
2478 PRINT FNCPS(-1,0):BKGD=ULON*$SPACE$(78):ULOFF#:FRG#=
2476 FOR O2=1 TO LN:IF I$="N" OR (I$="Y" AND SPOS(02,3)=0) THEN PRINT
2477 FNCPS(SPOS(02,1),63):MID$(AR$)(SPOS(02,4),1),64,8):GOTO 2479
2479 NEXT O2
2480 RETURN
2482 REM ***** OPENING TEMP FILE *****
2483 CLOSE #14:OPEN "R",#14,"TEMP.FIL",38
2484 FIELD #14,2 AS TREC$,16 AS PNO$,4 AS POTS$,8 AS SPS$;
2485 CLOSE #14:KILL "TEMP.FIL"
2486 OPEN "R",#14,"TEMP.FIL",38
2487 FIELD #14,2 AS TREC$,16 AS PNO$,4 AS POTS$,8 AS SPS$;
2488 RETURN
2499 REM ***** TEMP FILE WRITE BACK *****
2492 LSET PNO$=D$(2):LSET POTS$=MK$(D$(26+OP)):LSET TREC$=MK$(SREC$):LSET
SP$=SPACE$(8)
2494 C1%:C1%+1:PUT #14,CT%:,C1%:
2495 RETURN
2496 REM ***** RECALC BL(1) VALUES *****
2497 DMY=INT(26+OP):GOSUB 27000:DTMP$=Y$<18008)+<W$<1808>)=<01
2498 FOR I%=1 TO LOOP:IF SPOS(02,0)=AR$(COM$+19,1) THEN 2499 ELSE NEXT 19
2499 AR$(COM$+19,0)=DTMP$:FF%=COM$+19):F:RETURN
2500 GOSUB 2880
2502 IF I%=1 TO 78:BL(I$)=:ORD%(I$)=8:ORD%(I$)=:NEXT 19
2505 PRINT FNCPS(-1,0):ULON*$BKGD=SPACE$(40):CUP#=GOSUB 9900:PRINT
2506:FRG#=CUP$:RETURN
2505 REM ***** STRING A DATE ROUTINE *****
2507 PTEMP$=MID$(STR$(D$(26+OP)),6,2)+"/"+MID$(STR$(D$(26+OP)),4,2)+"/"+MID$(STR$(D$(26+
2508 OP)),2,2)
2509 RETURN
2598 REM ** DLOC QTY=CAP **
2772 DN WCC:GOTO 2798,2798,2908,2908,2818,2828,2838,2848
2798 CODE=WA$%()%.0004:GOTO 2858
2799 CODE=WA%()%.00:GOTO 2850
2800 CODE=WA$(2+$%).00:GOTO 2850
2818 IF D$(2)=8 THEN CODE=WA$:GOTO 2850 ELSE CODE=WA%()%.20:GOSUB 2868:VA=CODE:GOTO 2858
2829 CODE=WA$:GOTO 2850
2838 CODE=WA%()%.GOTO 2850
2848 REM "SPARE"
2855 RETURN
2868 REM ** DLOC DEC PLACES*;
2862 CODE=INSTR(STR$%CODE%):",*/":IF CODE=0 THEN RETURN
2863 IF WCC$=4 AND AFLAGS/=8 THEN 2864 ELSE IF VAL$(MID$(STR$(CODE),CUB$+1,1))=4
2866 THEN CODE=COD$+1
2864 IF W$=0 AND AFLAGS/=8 AND VAL$(MID$(STR$(CODE),CUB$+1,1))=1 THEN CODE=COD$+1
2865 CODE=FIX(COD$):RETURN
2988 REM ***** CHANGE PLANNED DATE *****
2918 MINL=1:MAXL=6:ROW=SPOS(NL$)+COL=$63:GOSUB
40780:SPOS(NL,2)=CDMAT:SPOS(NL,3)=8
2928
MID$(STR$(CDMAT),5,2)**="MID$(STR$(CDMAT),4,2)**
//MID$(STR$(CDMAT),2,2)
2936 SPOS(NL,2)=CDMAT
2998 RETURN
3100 REM ***** UPDATE THE ORDER BOOK *****
3105 IF (OP=8 AND OP=4) THEN 3110 ELSE RETURN
3110 PRINT FNCP$(<-1,8>);R$=CHR$(7);"Update Order File (Y)es/(R)est/(C)ontinue ?:
";SPACE$(36)
3118 COL=4:ROW=1:MAXL=1:MINL=1:GOSUB 68980:IF IS$="Y" AND IS$="R" AND IS$="C" THEN 3110
3125 IF IS$="C" THEN GOSUB 60980:GOTO 3110
3124 IF IS$="R" THEN GOSUB 9998;PRINT FNCP$(-1,8):"Re-setting*SPC(45):GOSUB
3125:GEND=:RETURN ELSE PRINT FNCP$(-1,8):"Sure (Y/N):*SPC(58)
3130 COL=12:GOSUB 68980:IF IS$="Y" AND IS$="N" THEN 3140
3135 IF IS$="N" THEN GOTO 3110 ELSE PRINT FNCP$(-1,8):"Updating Order File . . .
";
3140 FOR I%=1 TO CT$:$
3149 GET I%,1%:I%=I%+1
3150 TRECP=OVI(TRECP%):P=PN$=POTE=OVS(POTE%)
3159 SN=$=TRECP:GOSUB 19988
3160 OS$(2)=P$:X$(2)+OP$=POTE:GOSUB 15988
3164 NEXT I%
3169 CS=:
3170 PRINT FNCP$(-1,8):"Update Complete - Hit any key to continue
":";GOSUB 2829:RETURN.:
3180 REM ***** DATCON4 - YYWW -- YMM00 *****
3189 GOSUB 3324
3190 DTEXT=+(Y$+19000)++(M$10)+019
3192 RETURN
3194 REM *** WHAT YEAR ? ***
3195 DYY9=RIGHT$(STR$(I$YY9),6)
3199 Y$=VAL(MID$(DYY9,3,2))++VAL(RIGHT$(DYY9,2)):Y+$=VAL(MID$(DYY9,3,2))
3203 Y$=Y$+1988
3204 IF Y$<INT(Y$+4) THEN YEAR=1995 ELSE YEAR=366
3206 IF YEAR=366 THEN L$(2)=29
3209 S$=L$(Y$+1800)-1
3213 L$=L$(Y$);L$(Y$);L$(Y$)
3216 CP$=S$+C$+U$+G$+B
3219 IF C$=YEAR THEN 3226
3224 CT$=G$=G
3228 WHILE G$*L$(CT$)+1*CP$
3232 CT$=CT$+1
3235 G$=G$+L$(CT$)
3236 WEND
3256 MTH$=CT$+1
3255 IF CP$=G$ AND S$=1 THEN GOSUB 3375:GOTO 3372
3258 DY$=CP$+$G$
3262 Y$=T$8
3264 GOTO 3372
3266 OY$=CP$-YEARS
3268 YT$=T$8+1
3276 MTH$=1
3272 L$(2)=28
3274 RETURN
3276 REM
3278 CP$=L$(12)+CP$
3388 GOTO 3382
3382 MTHB=12;DSY=CPB;YT8=Y8-1
3384 RETURN
3400 REM **** RESET COMPLETELY *****
3455 PRINT FNC P(-1,0)CHR$(7)*All changes will be lost. Ok. to continue (Y/N)?:
3418 RON=1:COL=59;MAX=1;MNL=1;GOSUB 6898:IF Y(1)*N AND 1*K)*Y*Y THEN 3418
3415 IF 1*K)*N THEN 3470
3429 PRINT FNC P(-1,0)Re-setting . . . . . . . . . . . . **SPACE$(28)
3422 LAD=8:AG=8;SS=8;PD=0;YH=10;CT%=0;HED$="*FIRS=90;CD="**
3425 FOR 1001 TO COUNT:GET H1,1
3426 RES=DUS(RES1%);RES2=DUS(RES2%);RES=DUS(RES3%)
3427 FNC P(160)=AR(160,0)=RES:AR(160,1)=RES2:AR(160,2)=RES3:3AND=RESZ;GOSUB
3428 6058:ORD(100)=0:GOTO 160
3424 FOR 1001 TO 78:ORD(15)=1:RES=DUS(15,15):GOSUB 78:RES=78:RES=60
3429 FOR 1001 TO 100:FOR 1001 TO 41:SPOS(16,15)=0:NEXT 15:IS=16
3444 GOSUB 2888:GOSUB 9808:IF GEN=1999 THEN RETURN ELSE RS=1:GOSUB 4088:GOSUB
3488:GOSUB 2942
3458 PRINT FNC P(-1,0)Res-set complete - Hit any key to continue . . .
3453 SPACE$(18):GOSUB 2888
3478 PRINT FNC P(-1,0)SPACE$(8):RETURN
3500 REM **** SORT (NORMAL string TYPE) *****
3518 SW=COUNT+1:SW#0 THEN S="No matching orders on file":LPRINT S;GOTO 158
3526 PD$=0:SW=SW+2:IF SW#0 THEN RETURN
3528 PD$=PD$+1
3546 IF PD$=SW+1 THEN 3526
3558 IF AR$(PD$)=AR$(PD$+SW,0) THEN 3538
3568 SWAP AR$(PD$),AR$(PD$+SW,0)
3578 SWAP AR$(PD$+1),AR$(PD$+SW+1)
3588 PD$=PD$+1
3598 IF PD$=SW+1 THEN 3548
3588 IF AR$(PD$)=AR$(PD$+SW,0) THEN 3538
3618 SWAP AR$(PD$),AR$(PD$+SW,0)
3628 SWAP AR$(PD$+1),AR$(PD$+SW+1)
4000 REM ** WINDOW CAPACITIES **
4050 0=-1:0=55:OCC=OCC$(WCC$):RT=-1:0=55;0=22:YMC=18;GOSUB 648
4050 FOR 2=1 TO 7:O=DUS$(US$(2)):NP=2;NP=5;GOSUB 3758
4868 PRINT FNC P(R+2,0+C)HD$(2,0,13)="A"**
4878 NEXT 2
4875 FOR 2=8 TO 18:PRINT FNC P(R+2,0+C)SPC$(2):NEXT 2
4868 PRINT FNC P(R+18,0)"Capacity (1-7) ? :**
4868 MAX=1:MNL=1:RON=9:COL=74:GOSUB 68988:IF VAL(1)(0) OR VAL(1)(7) THEN 4088
4868 ELSE WCC=VAL(1)**
4861 IF VAL(1)(0) THEN GOSUB 2888:GOSUB 4088
4865 IF (HD$(WCC$),9,5)="Spare" OR (HD$(WCC$),9,5)="Spare" THEN 4088
4899 PRINT FNC P(R+18,0,C)"Re-value (Y/N) ? :"GOSUB 68988:IF Y(1)*Y*Y AND 1*K)*N*Y*Y THEN 4088
4188 IF 1*K)*Y** THEN 4118 ELSE FT=8;GOSUB 4120
4118 MAX=8:COL=78:PRINT FNC P(R+18,0)"New value = :**
4868 GOSUB 68988:IF VAL(1)(0) THEN 4118 ELSE WCC=VAL(1):CCC=VAL(1):FT=999;NP=2;NP=5;GOSUB
3758:PRINT FNC P(R+18,0,C)**
4126 PRINT FNC P(R+18,0,C)"Alterations (Y/N) ? :**MNL=1:MAX=1:COL=76;GOSUB
4898:IF Y(1)*Y*Y AND 1*K)*N*Y*Y THEN 4126
4138 IF 1*K)*Y** THEN 4088 ELSE RETURN
4498 REM **** START DATE FOR PROD. PLAN. ****
4518 A=VAL$(MID$(STR$(D(23)),4,2)):B=VAL$(MID$(STR$(D(23)),4,2)):C=VAL$(MID$(STR$(D(23)),
4,2))
4515 IF INT(C/4)=C/4 THEN LNX(2)=29
4526 REM * USE EITHER 9438 OR 9448 FOR LEAD TIME IN WKS. OR DAYS, RESPECT'Y *
18148  D(J1) = CVS(MID$(SPT*,5,4))
18156  G=6+4
18168  NEXT J1
18172  FOR J1=27 TO 36
18180  D(J1)=DVS(MID$(SPT*,5,4))
18198  G=6+4
18208  NEXT J1
18218  RETURN
18508  REM ** SHORT ORDER READ 1 **
18518  GET #7,SRW:IDX(22)=CVI(MID$(PCT#,39,2)):RETURN
18568  REM ** SHORT ORDER READ 11 **
18618  GET #1,SRW:GET #7,SRW:C%=9
18628  D4(J1)=D4(I1):IDX(22)=CVI(MID$(PCT#,39,2)):IDX(3)=CVI(MID$(PCT#,1,2))
18638  FOR J1=12 TO 21:IDX(J1)=IDX(MID$(PCT#,C1,2)):C%=C%+2
18648  D(J1+15)=DVS(MID$(SPT*,G1,4)):G=6+4:NEXT J1
18659  D(23)=DVS(MID$(SPT*,1,4)):RETURN
18688  REM ** READ CAPACITIES **
18819  C%=9:K%=12:MATCH=BP(3)
18828  GOSUB 59000
18948  GET #13,SRW
18952  IF S1H=0 THEN 11945 ELSE GOSUB 49000:GOTO 11950
18954  GOSUB 39000
18958  IF S1H=999 THEN 11868 ELSE CCC=CVS(MS$*\CC$)
18968  CLOSE #12:CLOSE #13:CLOSE #14
18975  IF CCC=\"YES\" THEN GOSUB 2486 ELSE GOSUB 2482:REM ** OPEN TEMP.FIL **
18979  FLAG=1:RETURN
15000  REM **** WRITE TO ORDER ****
15010  TEMP$=\"**
15020  FOR J1 = 1 TO 3
15030  LSET F$(J1) = D$(J1)
15040  NEXT J1
15050  FOR J1 = 16 TO 20
15060  TEMP$ = TEMP$+D$(J1)
15070  NEXT J1
15080  LSET CORD4=TEMP$
15090  TEMP$=\"**
15100  FOR J1 = 3 TO 22
15110  TEMP$=TEMP$+M$(IDX(J1))
15120  NEXT J1
15130  LSET PCT4=TEMP$
15140  TEMP$=\"**
15150  FOR J1 = 23 TO 24
15160  TEMP$=TEMP$+MS$(IDX(J1))
15170  NEXT J1
15175  FOR J1 = 27 TO 36
15177  NEXT J1
15180  LSET SPT=TEMP$
15190  TEMP$=\"**
15200  FOR J1 = 1 TO 3
15210  PUT #1,SRW
15220  NEXT J1
15225  PUT #7,SRW
15230  RETURN
28800  REM **** ANY KEY ROUTINE ****
28810  PRINT FNCP$(21,0)"
28819  "CUT$+
28828  S$=INKEY$:IF S$="" THEN 28820
28830  IF ASC(S$)=198 THEN GOSUB 61230
28840  RETURN

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25888 REM ** SHORT METHOD READ I **
25889 GET #8,RNX;CN=1;TX=1;PC=1
25890 FOR JX=1 TO 2:0:(JX)=0:V1(MID$((N RX%,CN,2)));CN=CN+2
25891 D(K,JX)=D(0(D((P X%,P,B)));P=P%:B:NEXT JX
25892 FOR JX=1 TO 22:0:(JX)=0:V1(MID$((FPT(,TX,4));TX=TX+1:NEXT JX
25893 D(K,JX)=D(0(D((P X%,P,B)));P=P%:B:NEXT JX
25894 D(K,JX)=D(0(D((P X%,P,B)));P=P%:B:NEXT JX
25895 D(K,JX)=D(0(D((P X%,P,B)));P=P%:B:NEXT JX
25896 RETURN
26000 REM ** SHORT METHOD READ II **
26001 GET #8,RNY;GET #8,RNY;TY=1:CN=1
26002 FOR JY=1 TO 2:0:(JY)=0:V1(MID$((NR%,CN,2)));CN=CN+2
26003 D(K,JY)=D(0(D((P Y%,P,B)));P=P%:B:NEXT JY
26004 FOR JY=1 TO 22:0:(JY)=0:V1(MID$((FPT,TY,4));TY=TY+1:NEXT JY
26005 D(K,JY)=D(0(D((P Y%,P,B)));P=P%:B:NEXT JY
26006 D(K,JY)=D(0(D((P Y%,P,B)));P=P%:B:NEXT JY
26007 D(K,JY)=D(0(D((P Y%,P,B)));P=P%:B:NEXT JY
26008 RETURN
27888 REM **** dd/mm/yy --> d/m/a/yy ****
27889 DMY$=RIGHT$(STR$(OMY),6)
27890 Y1=VAL(MID$(DMY$,1,2));M1=VAL(MID$(DMY$,3,2));DD1=VAL(MID$(DMY$,5,2))
27893 Y2=Y1
27894 IF Y1>99 THEN GOTO 27868
27895 Y1=Y1+1900
27896 DF=DD1;MF=M1;YY=Y1:GOSUB 27108:U=NO
27897 D1=DX(U-7)*INT(U/7)+1
27898 U=NO:GOSUB 27128
27899 RETURN
27900 REM ** SOLVING FOR DAY NO. **
27910 NDN=DF-1
27911 FOR I1=1 TO MF-1;NDN=LX(I1);NEXT I1
27912 N1=INT(YF/100)
27913 IF YF<>INT(YF/4) GOTO 27190
27914 IF YF/100=11 GOTO 27190
27915 IF ND>59 GOTO 27190
27916 IF MF=3 GOTO 27190
27917 IF MF=4 GOTO 27190
27918 IF MF=5 GOTO 27190
27919 IF MF=6 GOTO 27190
27920 RETURN
27921 REM ** SOLVING FOR WEEK NO. **
27922 IF Y2<>SY1 THEN GOTO 27268
27923 FOR I2=1 TO ((Y2-1)-SY1)
27924 IF SY1+I2=INT(SY1+15)/4 THEN UN=UN+1
27925 NEXT I2
27926 IF Y2<>INT(Y2/4) AND M1<>2 THEN UN=UN+1
27927 UN=UN+1:(SM1=-(S01-1)+D01
27928 IF Y2<>SY1 THEN GOTO 27268
27929 FOR I1=SM1+1 TO M1-1;AA=UN+LX(I1);NEXT I1
27930 GOTO 27388
27931 ME=12-(SM1-I1)=SM1+1
27932 FOR I1=1 TO (Y2-(SY1+1))NE=NE+1:NEXT I1
27933 FOR I1=1 TO ME;WN=WN+LX(I1)
27934 IF I1=11 THEN
27935 IF I1<>12 THEN I1=1
27936 NEXT I1
27937 FOR I1=1 TO M1-1;WH=WH+LX(I1);NEXT I1
27938 REM **
27939 IF D1<>7 THEN WN=WN+7-D1
27940 WN=WN+1:REM ** ALLOWING FOR 1 OF JAN '83 **
27941 WN=INT(WN/.24293)+1
27942 IF WN<52 THEN WN=WN-52 ELSE GOTO 27458
27943 IF M1=12 AND WN=53 THEN Y2=Y2+1
27944 GOTO 27428
27945 RETURN
38888 REM ** CDF SCREEN **
PRINT FNCP$(R7-2,C7)"ULON#"SECTION"ULOFF#"*"CN#
FOR LOOP=1 TO 7:HM$=CN$(LOOP):NP=2:DP=5:GOSUB 37598
PRINT FNCP$(R7-1,C7-18)SPACE$(18)MID$(HD$(LOOP),6,25)HM$*
"*
NEXT LOOP
PRINT FNCP$(21,0)"Select Capacity 1-7, default is"*RIGHT$("**STR$(WCC$(2,2))") :"*CUPS
ROW=21:COL=36:MAXL=2:MINL=0:GOSUB 69980:CC$=M(1):IF CC$(8 OR CC$(7) THEN
PRINT FNCP$(21,3)"If CUPS=8 THEN CC$=WCC$;PRINT FNCP$(21,36)"STR$(WCC$)CUPS
PRINT FNCP$(21,9)"MID$(HD$(CC$),9,5)=""SPARE" OR MID$(HD$(CC$),9,5)=""Spare" THEN 38858
PRINT WCC$(CC$)
PRINT FNCP$(21,8)SPACE$(75)CUPS
PRINT FNCP$(21,17)"Any Alterations <Y/N>:"*CUPS$=MAXL=1:COL=48:GOSUB 48980:IF I$="Y" AND I$="N" THEN 38855
PRINT "Y" THEN 38848
RETURN
REM ** FORMATTING ROUTINE **
SDP=NP=1
M=M+1#:*MID$(STR$(1-G(0)),4,4),NP:=RETURN:
REM ***OPENING FILES***
OPEN OPENING FILES 1,2,3 & 4
FOR J1 = 1 TO 2
FILENAME = OD$*RIGHT$(STR$(J1))"*.FIL",5)
OPEN "R",,J1.FILENAME,16
FIELD #J1,16 AS F#(J1)
NEXT J1
FOR J1=4 TO 6:FILENAME=OD$*RIGHT$(STR$(J1))"*.FIL",5)
OPEN "R",,J1.FILENAME,16:FIELD #J1,16 AS F#(J1)
NEXT J1
OPEN "R",,7,000"*ORDER.FIL",112
OPEN #24 AS CORD$,40 AS FCT$,40 AS SPT$
OPEN "R",,#9,000"*RECORD.FIL",2
OPEN #9,2 AS REC$
OPEN "R",,#6,000"*METHOD.FIL",236
OPEN #6,16 AS F#(6),184 AS ROPE$,16 AS OPT$,80 AS FPT$,4 AS INR$,4 AS
DA$(7),4 AS DA$(8)
OPEN "R",,#3,000"*3.FIL",16
OPEN #3,16 AS F#(3)
OPEN "R",,#12,"CAP1.FIL",3
OPEN #12,0 AS W$%
OPEN "R",,#13,"CAP2.FIL",70
OPEN "R",,#14,"CAP3.FIL",2
OPEN #14,2 AS CREC$
GET #14,1
CREC$ = CJ$(CREC$)
OPEN "R",,#10,000"*METH2.FIL",168
OPEN #11,000"*RESET.FIL",168
OPEN #11,4 AS RES1$,2 AS RES2$,4 AS RES3$
RETURN
47500 'TO CHANGE ORDER NUMBER ON CASTING ONLY
47510 FOR K=16 TO 1 STEP -1
47520 IF ASC(MID$(D$(2),K,1)) <> 32 THEN 47545
47536 NEXT K
47549 MID$(D$(K),1,1)=<P>
47680 RETURN
58880 REM *** MATCH SUBROUTINE ***
58881 CX$ = CX$ + 1
58882 IF CX$ = CRESH+1 THEN FLAG = 8:RETURN
58883 SET #KP,CX$,
58884 ONS = WS$.
58885 IF LEFT$(CN$,KEYLEN) = LEFT$(CN$,KEYLEN) THEN GOTO 58888
58886 GOTO 58818
58887 FLAG = 1
58888 RETURN
58889 REM ***** GRAPH MAPPING *****
58890 LPRINT CHR$(27),*/8*
58891 LPRINT CHR$(27),/8*/
58892 IF LAC$<>0 THEN #O28 ELSE LPRINT CHR$(27),/>8*/
58893 DEF SEG=#H400
58894 LPRINT CHR$(152),STRINGS$(00,CHR$(149)),CHR$(153)
58895 FOR I=0 TO 23
58896 WS$="*":LPT1="$0"
58897 FOR J=0 TO 158,STEP 2
58898 WK=PEEK$(12+J(J+J)):IF WU=64 THEN WU=WU+156 ELSE WU=WU-64
58899 WU=WS$+CHR$(WU)
58890 NEXT J2
58891 NEXT J
58892 IF WU<>0 THEN WU=ASC(MID$(WS$,J2,1))
58893 IF W>32 THEN W=W+GOTO 60110
58894 IF W=168 THEN W=241:GOTO 60110
58895 IF W=132 THEN W=W+GOTO 60110
58896 IF W<>14 THEN W=W+145 ELSE IF W=188 THEN W=146 ELSE IF W=196 THEN W=149
58897 IF W=179 THEN W=W+158 ELSE IF W=218 THEN W=W+152 ELSE IF W=191 THEN W=153
58898 IF W=192 THEN W=W+154 ELSE W=W+17 THEN W=W+155
58899 Z=127:J=1:FOR J=1 TO 15,STEP 2
58900 IF (W=2J+1 OR W=2+J+J) OR W=2+J OR W=2+J+1 THEN W=W+6
58901 J=J+1:NEXT J
58902 LPT1="$0":LPT1=CHR$(WU)
58903 NEXT J2
58904 LPRINT CHR$(150),CHR$(150)
58905 IF (I=2 OR (I=2 AND LAC$=1)) THEN LPRINT
58906 CHR$(150),STRINGS$(86,CHR$(149)),CHR$(155)
58907 LPT1="$0":NEXT I
58908 LPRINT CHR$(154),STRINGS$(88,CHR$(149)),CHR$(155)
58909 LPRINT CHR$(27),"*":CHR$(27),"*/8*/"
58910 RETURN
58911 MAXL=8:REM *** DATE CHANGE ROUTINE ***
58912 GOSUB 69920:IF VAL(I$)=0 THEN COMDAT=0:DAT$="":GOTO 68820
58913 A=INSTR(I$,"/"):IF A<>0 THEN A=INSTR(I$,"."),
58914 IF A<>0 THEN 68700 ELSE P#=LEFT$(I$,A-1)
58915 B=INSTR(A,+1,I$):IF B<>0 THEN B=INSTR(A+1,I$,"."),
58916 IF B<>0 THEN 68700 ELSE 68820=MOD$(I$,A+1,B-(A+1))
58917 C=MOD$(I$,B+1,2)
58918 A=VAL(P$)+B=VAL(B$):C=VAL(C$)
58919 IF B$=0 OR B$=12 OR A$=31 OR C$=99 OR C$=31 THEN 68700
58920 COMDAT=(C+18888)+(B*188)+A
58921 DAT$=P$,"/,B+6","/<C$:
58922 PRINT FNCP$(ROW,COL),DAT$:CUP$:RETURN
58923 I$=DE$t$:PRINT FNCP$(ROW,COL),I$:GOTO 68720
58924 REM INPUT STRING ROUTINE
58925 I$=""
58926 PRINT FNCP$(ROW,COL),I$=SPACES(MAXL-LEN(I$)):ROFF=CUP$
61018 GOSUB 61118
61028 IF X=0 THEN GOTO 61068
61038 IF X=13 AND LEN(1*#)=ML THEN GOTO 61088 ELSE IF X=13 GOTO 61088
61048 IF LEN(1*)+ML THEN J=J+@6
61058 GOTO 61088
61068 IF LEN(1*)=9 THEN J=LEFT$(1*,LEN(1*)-1)
61078 GOTO 61088
61088 PRINT FNCP$(ROM(COL)14,CUP$)
61098 RETURN
61108 REM GET VALID CHARACTER
61118 A$=INKEY$:IF A$="="THEN GOTO 61128
61128 X=ASC(A$)
61138 IF X>31 AND X<91 AND X>34 AND X<37 THEN RETURN
61148 IF X=27 THEN CLOSE:CHAIN "ONLINE"
61158 IF X=190 THEN GOSUB 61208
61168 IF X=186 THEN GOSUB 62000:LPRINT
61178 IF X=189 THEN GOSUB 62000:FOR L=1 TO 18:LPRINT:NEXT L
61188 RETURN
61198 REM
61208 DEF SEG = &HFO00
61218 FOR I2 = 0 TO 23
61228 W$="*
61238 FOR J2 = 0 TO 158 STEP 2
61248 W$=W$+CHR$(ABS(PEEK(12*160+J2)-64))
61258 NEXT J2
61268 LPRINT W$
61278 NEXT I2
61288 WIDTH 255
61298 RETURN
62000 RETURN:REM "**** GENERAL ERROR ROUTINE ****"
62018 PRINT FNCP$(21,0)""  
62028 SYSTEM ERROR "ERR" ENCOUNTERED AT LINE "ERR" - HIT ANY KEY "CHR$(7)CUP$
62038 A$=INKEY$:IF A$="=" THEN 62028
62048 X=ASC(A$):IF X=27 THEN 61158
62058 PRINT FNCP$(21,0):SPACE$(79):CUP$
62068 RESUME
63999 END
63999 REM "C2 (APRICOTS@9) E - CRE 27/11/85)"
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