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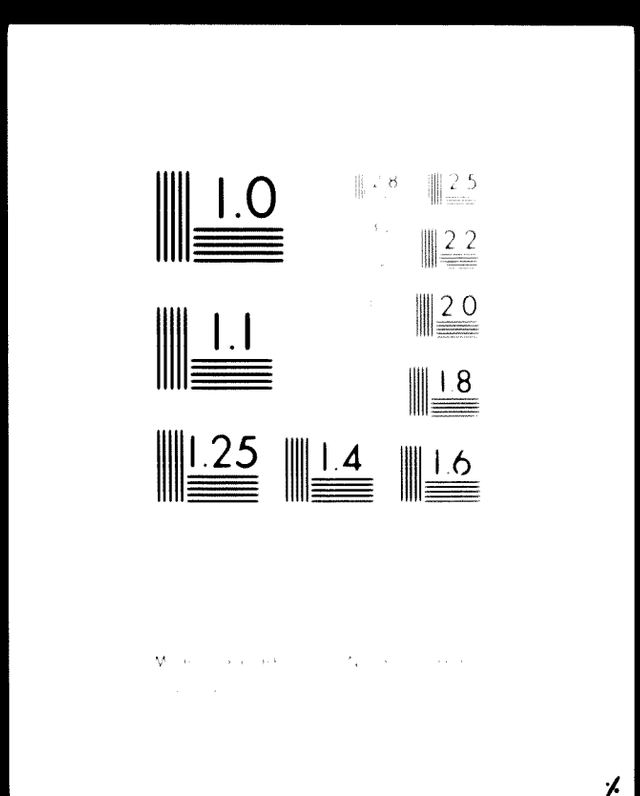

UNIDO - UAR

BOOKLET

ON

PRODUCTION PLANNING AND CONTROL

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November 1970

UNIDO MISSION
to UAR

Preface

Rapidly advancing technology and managerial competence are changing the nature and form of production planning and control. The economic facts of industrial workshops life – increasing raw material prices for imported and indigenous items, increasing wages due to variable reasons, taxation and general overall costs – makes it essential to institute also standardisation while maintaining product quality cost.

Computerization, numerical control, new materials that allow alternative and cheaper methods of manufacture are affecting the type and kind of production planning organisation and expertize required.

However, even in industrially advance countries, at the present time, it is not always possible nor feasable to introduce such simplified yet sophisticated methods, without a great deal of research, re-design of products and machines, and considerable capital expenditure.

This paper therefore concentrates on less advanced labour intensive production planning and control organisation and methods, what will probably remain suitable for UK for at least another decade.

The paper places emphasis on production planning and control for the engineering factories, but the principles and systems outlined can be readily modified and adapted to suit most manufacturing sectors.

The detailed organisation, and the amount of training of personnel required to create an effective production planning and control unit, will be understood as this paper is read. In the smaller factory, it is possible to combine planning function and individual tasks, but every step discussed in this paper will have to be included to create an efficient central production planning organisation.

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c o n t e n t s

INTRODUCTION

Mass production in the sense of manufacture of successive identical articles within what can properly be called a factory appears to have begun in England about 160 years ago. Henry Maudslay, designer and maker of some of the finest machine tools early in the 19th century, built a plant at Portsmouth between 1802 and 1807 for the manufacture of ships' pulley blocks. A series of machines conceived by Marc Brunel took the place of laborious production by skilled wood-workers, and these machines were so well designed and constructed that these are still in use. By 1808 this factory was turning out 180,000 pulley blocks a year.

Today, manufacturing has become an highly complex matter, yet mass production, in the true sense of the phrase, occurs in very few industrial enterprises. Production is accomplished more usually by organising work into batches. Batch production means the manufacture of between an hundred and several thousand identical parts, and taking a specific case, this is normally accomplished in the light engineering sector by breaking down the work to be done an any part into between 5-30 operations. Analysing these operations one would find that the actual metal cutting time required, or any other actual machine time required, to change the nature at form of raw material into the finished part is very brief in duration. Yet a survey made covering a large number of medium size factories has revealed that the part manufacturing cycle time is between 3-6 months (from raw material issue to entering the finished goods store) with an average of around 100 days, even when only a few operations are involved. And it has been estimated that only 1% of this time is usually required for the machine work of all operations required to turn raw material into finished part. Even in the smaller machine shops, it is difficult to avoid a full day's delay between one machining operation and the next operation.

The need for effective production planning and control is therefore evident. A system of scheduling production and controlling the workflow pays for itself in the better use of manpower and equipment, better understanding of the job by the workers, avoidance of overmanning, reduction of overtime and rush work. It should allow the most economical combination of resources to be devised and the effective use of cost control.

Planning means preparation for the future and the best apportunity for creating a good planning system is offered when a new factory is built. But planning must be carried on continuously throughout the entire life of the industrial enterprise.

Production planning is an understanding of all the ways and means which make manufacture possible in accordance with plans made in advance; these plans aim to deliver the products in certain quantities, in certain qualities and at certain dates by the most economic utilization of the means of production. It means also even and continuous work with minimum of capital tied in stores and stocks inventories.

BASIC PRINCIPLES

There is no one good system of planning, but there are certain basic prinoiples which can be universally applied. A planning system already in use at one place should not be copied until it has first been subjected to critioal examination.

a) Different ways of planning.

The planning of factory operations can be carried out in three different ways:

i) By direct personal supervision: This is the oldest method and is used only for small-scale production.

Nowadays everyone appreciates that all enterprises, except small ones with a simple type of production, cannot be well managed by personal supervision alone, although good leadership is, of course, always needed.

ii) By mechanical "pace-setting"

Mechanical pace setting may be provided by power conveyors. It eliminates much of the paperwork otherwise needed. In other words, the planning was more or less already done when the conveyors were installed and the jobs evenly loaded by methods and time studies.

Activity is mainly concentrated on planning of materials. If material is delivered to the conveyor and the operations properly balanced, the planning of operations is almost eliminated.

iii) By paper work, that is by the use of systems and routines.

A paperwork system must be used in those cases where a mechanical pace setting system does not exist. This system varies according to the different kinds of production systems.

b) Types of production systems.

The three main types of production systems from a planning point of view are:

iv) Jobbing and miscellaneous - production of special orders of one or small number of units.

v) Batch production - in smaller or sometimes larger batches.

vi) Continuous production - either process work or flow (mass) production.

The first two types require more complex 'paperwork' systems than the continuous type. Different coloured cards/paperwork will be used for easy identification by all.

An organized planning and control system must be established on clearly defined functional lines and adapted not only to the type of production system but also to the plant in which it will be used.

No two plants are alike so it is dangerous to copy a system unless it has first been subjected to critical examination. The principles which can be universally applied must be followed but there is no good universal system of planning.

c) Basic principles.

The basic principle of any planning system is the functionalization of all planning activities. This means that the mental effort of production is reduced to a minimum by planning before work has started. This is done by centralizing the various functions and allocating them to specialists and this also releases the line people from most of the planning work.

Other general principles are concerned with planning in advance: WHAT is to be done; HOW it should be done; WHERE it should be done; WHEN and by WHOM.

The following general procedure has to be observed:

vii) No work is started without proper authorisation from a recognised source.

viii) Products, methods (operations) and processes are carefully analysed.

ix) The operations are routed in advance: this means determining which operations are to be performed and where.

x) The production of all items is scheduled in advance - where and when the operations are to be performed.

xi) All paperwork relating to jobs and operations is distributed, thus putting the plants into effect and starting the actual jobs.

xii) The progress of all plans and orders is controlled by the follow-up.

d) Practical rules.

Some practical rules to be borne in mind when applying the general principles are:

xiii) Plans can be made only for normal conditions - only normal rejections, etc. can be foreseen.

xiv) Plans should be made to ensure all parts are ready for assembly at the same time, when this is relevant.

xv) Plans should be made so that all machines and/or workers are evenly and continuously loaded if possible.

xvi) It is impossible to produce more than bottlenecks permit.

CO-ORDINATION OF NEEDS AND PRODUCTION

Reliable estimates of probable needs are the best bases for planning.

In order to ensure the proper utilization of equipment, plans should therefore be drawn up in the production departments by close cooperation with the marketing or sales department.

The planning department provides a link between sales and production. It has to co-ordinate the activities of the marketing and sales department and the production departments.

For example:

a) It has to strike a balance between the call of the sales people to 'make what is sold' and the call of the production departments to 'sell what is made'.

b) It has to try to level out seasonal variations in sales through production for stock, etc.

c) When demand exceeds productive capacity it is faced with alternatives - such as refusing orders, using sub-contractors, or expanding capacity. On the other hand, when productive capacity exceeds demand, it may plan to manufacture for stock or suggest an intensive marketing campaign to stimulate sales.

POLICIES

Production planning calls for the development of policies as a guide for day to day decisions. Some common policy matters which arise are:

a) Whether to make various parts in the plant or buy from outside sources.

b) Whether to use continuous or intermittent processes.

c) Whether to make for stock in order, for instance, to shorten delivery dates.

d) Whether to segregate repair work from regular production.

e) Whether orders from different customers can be combined to form the optimum size of a manufacturing order. (The optimum size of all manufacturing orders should be calculated in any case.)

THE CENTRALIZED PLANNING FUNCTION

a) Basic requirements.

Basic requirements of a planning department are that:

i) It must be capable at all times of supplying information regarding available capacity in relation to incoming orders and planned production.

ii) It must be able to give accurate dates of delivery.

iii) It must discover delays, in time for action to be taken.

iv) It should be able to assist the production departments to take quick and accurate decisions.

v) It must increase productivity and co-operation within the undertaking.

b) Organisation.

Planning usually comes under the chief production manager. The responsibility and authority for personnel must be clearly defined, by the use of organisation charts and job descriptions, etc. Process charts should be carefully prepared. Human factor is also a basis of any workshop undertaking.

A careful system and routine must be drawn up. The system should not be made either too rigid or too complex. Centralization should not go too far and supervision should be given a certain amount of freedom, for instance in the selection of individual machines for particular jobs.

The planning department has a central position and therefore has to co-operate with almost every other department in the enterprise. Planning and control operations are usually organized in three main sections - overall planning; work preparation; and detailed planning sections, respectively. Sometimes, and especially in smaller companies, it is impossible to distinguish the job of one section from that of another. The functions of the different sections are briefly described below.

THE OVERALL PLANNING SECTION

a) Functions

The functions of this sections are:

i) To give a rough picture of the total capacity of the plant and its possibilities for different types of production at different times.

ii) To give probable dates of delivery on request.

iii) To make up broad plans for production.

iv) To reserve capacity.

In a continuous and similar type of production, the capacity is more or less fixed and the department should know for how long in advance the output is required.

In batch production one user may suddenly require an order to be increased, a second may require information on delivery dates. The alteration to the first order may necessitate a change in the delivery date of the second and it is obvious in this case that close co-operation between user and planning departments is necessary.

In jobbing production, the diffioulties are greater. The first time that a product is made, data on operation and times may not have been kept. It may only have been estimated when the tender was given. In this case, it is almost impossible to make the best use of available capacity and day to day planning is very much increased.

b) Types of orders

Planning usually starts as soon as an authorized order is received from the departments. There are four main types of orders.

1) Rush orders are orders which will not be available for despatch at the required time if they follow the regular routine. Special handling, overtime, etc. is therefore required. It seems that these types of order can never be entirely eliminated. They include also regular orders which are behind schedule and have to be rushed to meet railway accident requirements.

2) Repair orders are orders against goods already indented. If they have to be placed in regular manufacturing shops, they may be placed in the rush order category. They can also be placed in a special repair division.

3) Regular orders are orders that have delivery dates which fit into the planned programme and routine.

4) Stock orders. These orders are usually based on a manufacturing programme or stock record. A factory manufacturing for stock has usually more flexibility in its scheduling than a factory which manufactures against customers' orders.

c) Procedures

i) Master schedule

For each of the larger orders at least, a master schedule is made up which shows briefly how production must be timed in order to meet promised delivery dates. The schedule is the ideal and it is one which all should strive to follow and to demonstrate the methods to be used. Process sheets should be made use of, if based on past three years production available.

ii) Overall load chart

An overall load chart shows the total load of all orders against available capacity. One is usually made up for each larger group of machines or workers and is built up successively as orders pass through the process planning section.

It should always be borne in mind that such a load chart can only give an overall picture of the lead, and it may be used to give probably delivery dates to a customer when an enquiry is received. It can be drawn in many ways, and it may include figures regarding times of work performed, obtained from the accounting department.

Figures produced by the process planning section may be approximate and some of these may even be pure estimation, but the chart will be sufficiently correct if the overall error is within 10%.

If may be sufficient to investigate certain machine groups only for enquiries relating to small orders that will not require the use of all machines.

It is important that the figures used on the overall load charts are properly recorded on separate sheets.

The overall planning section frequently faces the problem of estimating the total time from start to finish of certain items or products. For this work it should be borne in mind that time is dependent on:

- The batch size
- Number of shifts
- Number of parallel machines or groups of workers
- Number of similar tools
- Time of delay between operations
- Sequence of operations

When a long operation follows a short one, usually no delay occurs, but when the situation is reversed it is advisable not to start the second operation before the complete batch has gone through the first operation.

iii) Order chart

Irrespective of how detailed the planning is, an order chart should then be made, showing when the different orders should be started and their dates of delivery.

Most of the charts mentioned above can be made in small graph form.

iv) Past annual statistical manufacturing data and time motion study will assist considerably, if already done in Railway.

c) How far to plan in detail.

Having dealt with overall planning, the question now arises as to how detailed planning should be. There are two extreme cases:

1) In the first case the analysis should indicate what is to be produced: when and how it shall be manufactured; and it should list the work for the production shops, including the collection of drawings, material, tools, work orders and operation sheets with sequence of operations, job tickets etc. It should ensure broadly that available corresponds to the actual load at all times. The production shops are then responsible for the performance of the jobs at the right time. The planning is on a broad basis and there is no attempt to direct the production shops in detail.

2) In the second case planning covers everything mentioned above but also directs the production in detail from day to day or week to week. Orders are only sent to the production shops immediately before the job should start.

Between these two extremes many types of planning are possible depending on economical and psychological factors. Generally speaking, a central planning department has a better picture of the work than individual supervisors and it can, therefore, direct the work in a better way. It should, however, allow supervisors to direct the work within their own departments as much as possible.

THE PROCESS PLANNING SECTION

a) Main functions and organisation.

The main function of this section is that of analysing three major factors:

- The product intself
- The operations or process charts
- The processes

Its position within the organisation differs from one company to another. In the larger factory it is usual for this section to be combined with the work study department under one head, who reports to the chief of the planning department. But in plants with a more complex type of production, its work may be performed by a separate department under the production manager.

b) Critical analysis.

Its first task is to criticise the design or specifications and to ensure production at minimum cost. It may suggest changes in design or specifications to reduce manufacturing times, the use of cheaper tools, etc.

c) Examination of materials.

It is the task of the designer to decide the qualities of the raw materials to be used. But the process planner is often more capable of deciding the most economical shape or form of the raw material using established standards as far as possible. Keeping in mind the specifications and gestation period for import or local bulk purchase/availability stores.

d) Operations and sequence.

The next step is to decide which items should be bought and not produced taking into account manufacturing cost, quality and available machines.

The main task of the section is to determine the operations necessary for the making of each item, the best methods and machines to use, inspection positions and the estimation of standard times of these do not exist.

Its work is embodied in a draft operation sheet which contains all the information needed by the shops. In this way the information given on a sales order or drawing is translated into 'operation shop language'. The sheet should contain the following data:

- Name of part or item in parts list
- Number of part in parts list
- Number of drawing
- Raw material and specifications
- All operations in sequential order
- Departments where the operations should be performed
- Which operations should be inspected, if not all operations
- Machine numbers or groups of machines
- Estimated or fixed standard times or piece rates including set up times (time motion study done or not?).

If very detailed instructions of operations are necessary, special instruction cards should be used.

e) Estimating times.

It is usual for the person who has decided the operations to make the estimates of the standard times. This estimate is facilitated if a proper record is kept of old operation sheets, work study data, etc. on similar jobs. Naturally, close co-operation should be established with the supervisors and industrial engineering section.

The work of the section should be carried out by men with good practical production shop experience and common sense and technical education.

f) Ordering special tools.

One duty of the process planning section is to ensure that all special tools are ready in the tool stores when required.

g) Stage inspection after "first off" approval is needed.

h) "Salvage section" should be with inspection progress section for speedy replacement work orders to meet target.

THE DETAILED PLANNING SECTION

a) Functions.

Once the process planning section has decided how the work should be done, it is the task of the detailed planning section to decide where and when the work will be carried out, and finally, to put the plans into effect.

The main functions of this section are:

- To ensure the supply of material
- To order the standard tools required and ensure that they are available when needed
- To schedule the making of the parts without overloading of machinery
- To prepare the paperwork as soon as draft operation sheets are received.

b) Basic tools.

As basis for its work it should have the following:

i) Drawings, specifications and parts list.

A check should be made to see that all parts going into manufacture are listed so that there will be no shortages in the final assembly stage. Bill of materials should be re-checked.

ii) Material plan.

For larger units, the parts list may be completed by a special bill of material which is a summary of all material going into the product. This contains the whole quantity of each kind of material, also quantities already ordered or reserved, parts to be purchased and from where, quantities required from own stores, etc. and finally specification of tests or inspections to be made during processing or on completion.

iii) Estimates.

It is important that the planning department should know on which estimates of labour and material the tender (when this is relevant) is based.

iv) Records of capacity and manufacturing times.

These are the same records as those used by the process planning section. The age of machines play very important role for executing targetted workload.

v) Draft operation sheet, or process sheet.

This is the most important sheet produced by the process planning section.

vi) Master schedule.

The schedule kept by the overall planning section.

vii) Overall load chart.

This is the schedule kept by the overall planning section and it must be consulted to decide approximately at what dates the planning must load the machines to maintain the planned schedule and targetted production.

c) Procedures.

viii) Materials.

If standard material is kept in stock, this should be re-ordered on a minimum stock system. The task of the detailed planning section is then to reserve material in a perpetual inventory file. If material does not exist in stock, a purchase requisition should be sent to the purchasing department.

In some cases, important material may have been already ordered by the design office. As mentioned above, it is important for the design office to inform the planning section when this has been done.

Under all circumstances, it is the task of the planning section to follow up the delivery dates and check that they really can be kept. It must make sure that it obtains reliable information from the buying office, and naturally it is responsible for giving desired delivery dates to the buying office. How the deliveries are followed up will be dealt with on stock control. It is common practice for material planning to be undertaken by a special section, viz. Progress section/stock control section.

ix) Tools.

Standard tools such as inspection gauges, bars, milling tools etc. may be re-ordered by sending a purchase requisition directly from the tool stores. But all special tools required by the process planning section should be ordered by that section and the deliveries regularly followed up. It must be stressed that the supply of all necessary tools at the right time is one of the most important functions of the planning department. Tools repair shop should not become machine shop as in Rly. workshop.

x) Determination of manufacturing periods.

By the manufacturing period is meant the time (in hours, weeks, etc) during which the production of a certain product or part is going on in a machine or shop, group of workshops, or individual machine. Past statistical annual data with "progress charts" will also assist.

For example, there may be available a number of machine groups with certain capacities and a number of jobs of different kinds which are to be produced in these groups. The process planning section on the operation sheets has prepared standard times for the respective machine groups and it has usually also calculated the total number of machine hours required to complete the jobs in question. The master schedule also indicates the approximate dates at which each important stage should be completed.

If there are no sub-assemblies in the completed job, the manufacturing 'picture' of each part is simple. The total manufacturing time can easily be estimated by adding to the manufacturing time, set-up and delay and fatigue times. But if sub-assemblies etc. have to be made, it is necessary to make up a detailed 'manufacturing picture' for all parts comprising the final assembly.

The next step is to study the machine load chart for each group of machines, which is usually a Gantt chart. On this the new manufacturing times must be fitted-in between times already planned. If possible, starting and finishing dates should be fixed. Difficulties often arise in the form of 'bottle necks' which should be avoided by one or more of the following means:

- Performing the operations in other less loaded machine groups.
- Changing the sequence of operations so that they fit better into the machine load chart.
- By overtime or adding a shift, partly or entirely in the fully loaded groups.
- Placing the operations at later dates.
- Placing already planned operations at later dates.
- Using sub-contractors for urgent meeting of Quarterly Annual needs by off-loading.
- Buying new equipment and in this way expanding the capacity of machine tools.

It is usually the responsibility of the manufacturing departments to take these actions but naturally it is the task of the planning department to call attention to the difficulties and to indicate ways of solving the problems to meet production target and deliveries.

xi) Summary of detailed planning procedure.

The sequence of the activities of the detailed planning section can briefly be summed up as follows:

The material for each part must be ready by a certain date. With the aid of the operation sheets and the machine load charts, the machines are loaded as far as available capacity exists. If necessary manufacturing picutres are made up in order to fit these in with the previously planned dates, which are obtained from the respective machine charts. If bottle-necks occur, different action must be taken. When all dates are fixed, the overall load charts should be adjusted accordingly.

d) Preparing and issuing of paperwork.

This is done as soon as drafts of operation sheets are received or prepared.

The paperwork consists of forms prepared and filled in by the planning department; these are instructions to the shops to carry out the necessary operations. There are many types of orders used by different factories but the following information must always be given: