Chapter 18
Production Planning and Control

In any manufacturing enterprise production is the driving force to which most other functions react. This is particularly true with inventories; they exist because of the needs of production. In this chapter the relationship of production planning and control to work-in-process inventories is stressed.

Objectives of Production Planning Control

The ultimate objective of production planning and control, like that of all other manufacturing controls, is to contribute to the profits of the enterprise. As with inventory management and control, this is accomplished by keeping the customers satisfied through the meeting of delivery schedules. Specific objectives of production planning and control are to establish routes and schedules for work that will ensure the optimum utilization of materials, workers, and machines and to provide the means for ensuring the operation of the plant in accordance with these plans.

Production Planning and Control Functions

All of the four basic phases of control of manufacture are easily identified in production planning and control. The plan for the processing of materials through the plant is established by the functions of process planning, loading, and scheduling. The function of dispatching puts the plan into effect; that is, operations are started in accordance with the plant. Actual performance is then compared to the planned performance, and, when required, corrective action is taken. In some instances re-planning is necessary to ensure the effective utilization of the manufacturing facilities and personnel. Let us examine more closely each of these functions.

Process Planning (Routing)

The determination of where each operation on a component part, subassembly, or assembly is to be performed results in a route for the movement of a manufacturing lot through the factory. Prior determination of these routes is the job of the manufacturing engineering function.

Loading

Once the route has been established, the work required can be loaded against the selected machine or workstation. The total time required to perform the operation is computed by multiplying the unit operation times given on the standard process sheet by the number of parts to be processed. This total time is then added to the work already planned for the workstation. This is the function of loading, and it results in a tabulated list or chart showing the planned utilization of the machines or workstations in the plant.

Scheduling

Scheduling is the last of the planning functions. It determines when an operation is to be performed, or when work is to be completed; the difference lies in the detail of the scheduling procedure. In a centralized control situation - where all process planning, loading, and scheduling

for the plant are done in a central office- the details of the schedule may specify the starting and finishing time for an operation. On the other hand, the central schedule may simply give a completion time for the work in a given department.

Combining Functions

While it is easy to define "where" as process planning, "how much work" as loading, and "when as scheduling, in actual operations these three functions are often combined and performed concurrently. How far in advance routes, loads, and schedules should be established always presents an interesting problem. Obviously, it is desirable that a minimum of changes be made after schedules are established. This objective can be approached if the amount of work scheduled for the factory or department is equal to or slightly greater than the manufacturing cycle. For optimum control, it should never be less than the manufacturing cycle.

Dispatching

Authorizing the start of an operation on the shop floor is the function of dispatching. This function may be centralized or decentralized. Again using our machine-shop example, the departmental dispatcher would authorize the start of each of the three machine operations – three dispatch actions based on the foreman's routing and scheduling of the work through his department. This is decentralized dispatching.

Reporting or Follow – up

The manufacturing activity of a plant is said to be "in control" when the actual performance is within the objectives of the planned performance. When jobs are started and completed on schedule, there should be very little, if any, concern about the meeting of commitments. Optimum operation of the plant, however, is attained only if the original plan has been carefully prepared to utilize the manufacturing facilities fully and effectively.

Corrective Action

This is the keystone of any production planning and control activity. A plant in which all manufacturing activity runs on schedule in all probability is not being scheduled to its optimum productive capacity. With an optimum schedule, manufacturing delays are the rule, not the exception.

Re-planning

Re-planning is not corrective action. Re-planning revise routes, loads, and schedules; a new plan is developed. In manufacturing this is often required. Changes in market conditions, manufacturing methods, or many other factors affecting the plant will often indicate that a new manufacturing plan is needed.

Factors Affecting Production Planning and Control

The factors that affect the application of production planning and control to manufacturing are the same as the factors we have already discussed that affect inventory management and control. Let us briefly review these in relation to production planning and control.

Type of Product

Again, it is the complexity of the product that is important, not what the product is, except as this may in turn relate to the market being served. Production control procedures are much more complex and involve many more records in the manufacture of large steam turbine generator sets or locomotives to customer orders then in the production of large quantities of a standard product involving only a few component parts, such as electric blankets, steam irons, or similar small appliances.

Type of Manufacturing

This is probably the most influential factor in the control situation. For a large continuous manufacturing plant producing a standard product, we have already indicated that the routing was included in the planning of the plant layout.

Production Planning and Control Procedures

A detailed discussion of all the techniques and procedures of production planning and control is beyond the scope of this book; many complete text books exist on the subject. We have already indicated that planning and control practices will vary widely from plant to plant. Further the many ways in which of the functions might be carried out in practice were indicated earlier in this chapter.

Though no production control function can be entirely eliminated, the least control that results in effective operation of the factory is the best control. It must be remembered that production planning and control systems should be tools of management. The objective is not an elaborate and detailed system of controls and records, but rather, the optimum operation of the plant for maximum profits.

Production Planning and Control Systems

Because production planning and control places an emphasis on the control of work-in-process, the system will in effect tie together all previous records and forms developed in all planning for the manufacture of the product.

Market forecast

The market forecast is discussed in Chapter 26. Its value to production planning and control is that it will indicate future trends in demand for manufactured product. Work shift policies, plans for an increase or decrease in manufacturing activity, or possible plant expansions may often be

based upon the market forecasts and in turn affect the planning of the production planning and control group.

Sales Order

This is the second of the five classes of orders. It is a rewrite of the customer' order specifying what has been purchased – product and quantity and authorizing shipment of the goods to the customer. Multiple copies are prepared and all interested functions are furnished a copy. Sales orders may be written by marketing, inventory control, or production control.

Stock Order

This third class of order is not always used. In the preceding paragraph we indicated how it may be used after sales order accumulate to an economical manufacturing lot. It is, of course, the principal order when manufacturing to stock. It will authorize production in anticipation of future sales.

Shop Order

This fourth class of order deals with the manufacture of component parts. Customer orders, sales orders, and stock orders are for the finished product. In the preceding chapters we discussed how, by product explosion, the requirements are established for component parts to build assembled products.

Standard Process sheet

This form is prepared by process engineering and it is the source of basic data as to the type of machine to be used, the time required for processing and the sequence of operations in the manufacture of the product. Routing and scheduling of shop orders, as well as loading of work-stations in advance of scheduling, depend on up-to-date standard process sheets being available to the production planning and control group.

Engineering Specifications

Blueprints and bills of materials are used by production planning and control when they become a component part of the packaged instructions issued to the shop through the control office. One good planning procedure is to accumulate all necessary data for a shop order in a single package- the standard process sheet, the blueprint, the bill of material (if an assembly operation is involved), the route sheet, and possibly the schedule for the production of the order.

Route Sheet

This is the form on which the route of a shop order is indicated. In practice, this form is generally combined with one of the other forms in the system. For example, the shop order, the standard process sheet, and the route sheet are often one piece of paper- usually called the shop order or the manufacturing order.

Load Charts

These charts are prepared to show the productive capacity that has been "sold" – and at the same time the available productive capacity. These charts may be prepared for each workstation or machine in the plant, or they may be for groups of machines or departments.

Job Tickets

This is the fifth and last type of order in a manufacturing situation. Job tickets authorize the performance of individual operations in the manufacturing process.

Project Planning Methods

The production planning and control methods discussed thus far in this chapter deal primarily with the production of consumer or industrial products which could be considered to fall within the area of "repetitive manufacturing". The products to be produced are often manufactured in quantities of more than one, and their total processing time can be measured in hours, or at most, days.

The best –known methods that have been developed are CPM (for Critical Path Method) and PERT (for Program Evaluation and Review Technique). The original PERT technique is now considered, more accurately, PERT TIME, whereas a later development is known as PERT COST.

From the optimistic, most likely, and pessimistic times, the expected elapsed time (t_e) can be obtained by statistical techniques. The relationship of the three estimates to the expected elapsed time is given by the formula

$$t_e = \frac{a + 4m + b}{6}$$

Where a = optimistic time
b = pessimistic time
m = most likely time

It can be seen from the formula that the most likely time estimate is given four times as much weight as the optimistic and pessimistic estimates when computing the expected time.

Systems Analysis

As with other manufacturing control systems and procedures, production planning, and control lends itself to modern mechanization techniques such as machine accounting and use of computers. Careful study of the control system through procedure analysis will indicate the savings that may be effected by the utilization of modern equipment. These savings may be in

the clerical help required in the administration of the system or in the advantages of quick compilation of data, which in turn results in up-to-date control data.

Production Planning and Control Organization

It should be obvious that there is no single pattern for the organization of the production planning and control activity. In many small plants the routing, loading, and scheduling functions may well be included in the duties of the operating line; the shop manager, superintended, and foremen. But it is difficult to combine day-to-day work with adequate planning, and as a result it is often more feasible to break away the production planning and control functions and assign them to qualified specialists. These groups should be organized as staff sections normally reporting to the top manufacturing executive.

Centralized Production Planning and Control

Centralization or decentralization of duties of the production control staff depends upon the design of the production planning and control system. In a completely centralized setup, determination of shipping promises; analysis of sales, stock, and shop orders; preparation of routes, load charts, and schedule charts; and dispatching of work to the shop complete with job tickets and all other necessary paper would be accomplished by a central production planning and control unit. In addition, as work is completed, a careful analysis of the actual performance would be made, and if corrective action were required, it would be initiated by this group.

Decentralized Production Planning and Control

We have discussed at great length that no matter how general the planning may be in a central office, the plan must eventually be developed into a detailed plan on the shop floor. Some companies are now endeavoring to make each foreman a manager of his own departmental operation. In these cases the foreman is furnished with a complete staff for the production planning and control of the activities in the department.

Planning Phase

We have already indicated in some details the duties involved in the production planning phase. Working from the basic data mentioned earlier, the personnel in this part of the activity routes and load and schedule charts.

Control Phase

The completed job ticket, or its equivalent, is the key to this phase of the production planning and control system. It is the means of reporting back from the shop floor that indicates that a job is completed; or if daily job tickets are turned in, the daily progress of a job can be determined.

Relation to Other Functions

Good relationships with all the other functions in the enterprise are essential to effective production planning and control. Full cooperation with the marketing group is necessary, particularly in view of the importance of market conditions and the goodwill of customers. Both product engineering and process engineering must keep production planning and control informed as to their plans to avoid the manufacture of goods either to incorrect specifications or by an improper method.

Measurement of Effectiveness

In determining the effectiveness of a production planning and control system, there are quite a few problems. The key criterion might well be whether or not shipping promises are being kept – the percentage of the order shipped on time. This, however, would not be a true criterion if excessive overtime of expediting costs were involved in getting any of these orders shipped.

The cost of the control system in relation to the value of goods shipped is another possibility. Again, however, this may not be sound: if markets slump, a bad ratio will develop. Many good production planning and control systems have been discontinued because of "high costs" under these conditions- and have never revived after business picket up.

In a study of benefits and costs of computerized production planning and control systems, Schroeder et al. list the following performance criteria by which production planning and control systems might be judged:

1. Inventory turnover
2. Delivery lead time
3. Percent of time meeting delivery promises
4. Percent of orders requiring "splits" because of unavailable material.
5. Number of expeditors
6. Average unit cost.