UNIT 8 MATERIALS PLANNING AND BUDGETING STRUCTURE OF THE UNIT

Structure

Objectives

In this unit, we will discuss the activity of materials planning and budgeting for production and manufacturing of end products. Whereas, the terms manufacturing and production are synonymous to the layman, there is a subtle difference; and we will highlight this distinction since not only do the end products (of the two) differ in character, but also there are some differences in the operation of these two types of industries. Thereafter, we will discuss the management of production and manufacturing since this provides the backdrop of our subsequent discussion of materials planing and budgeting. Material requirements planning (MRP) is a very useful technique and it is used by all kinds of production and manufacturing industries for materials planning and budgeting. However, before taking up the detailed discussion of the MRP algorithm, we will define dependent and independent demand and bring out the distinction between dependent and independent demand inventory items. This is necessary since this distinction is the foundation (basis) of MRP. We will end our discussion of materials planning and budgeting by observing (and discussing) the differences in the way MRP is applied by continuous process industries engaged in the production of bulk materials and products. The student is advised to read one of the textbooks given at the end of this unit.

8.1 INTRODUCTION

Production and manufacturing are terms used to describe a set of processes used for converting raw materials into finished products. These raw materials, or inputs, undergo a number of stages of conversion, with each stage using a particular production, or manufacturing, process, and at each stage, the material(s) undergoes conversion and assumes a different form. The effective management of production and manufacturing must provide finished, or end, products of the required quality, and in appropriate quantities to satisfy the demand for the products, at the desired times and at a reasonable cost. Thus production and manufacturing planning and control functions are concerned primarily with the aspects of quantity or volume, delivery or timing, quality and cost. Before going any further, we must note the fine distinction between production and manufacturing. Technically, manufacturing and production are the same, but whereas the term manufacturing can be used for any kind of production, it is generally used in cases where discrete products are produced. Such products are usually engineered products like automobiles, aircraft's, refrigerators, machine tools, heavy, medium and light machines, televisions, radios and appliances, and manufacturing is the process of transformation of raw materials into these discrete engineered products. These products are distinctly different from bulk materials and products such as steel, fertilizer, chemicals, cement and pharmaceuticals. The important point here is that material in various forms, such as ores, raw stock, raw materials in the form of bars, plates, sheets, angles etc., purchased components and subassemblies, and in-house manufactured component and subassembly, is the essential input, and production of bulk materials and manufacturing of discrete products can only be carried out effectively if, and only if, the requirements of various materials are adequately planned, budgeted and controlled.

Material planning and budgeting is the starting point and the most important activity of materials management. If the planning of the requirements of various material inputs is either wrong or untimely, then the functions of manufacturing planning and control are most adversely affected. Materials planning deals with a number of critical questions, which include the following:

i) whether to make a component/subassembly or an intermediate product, in house, or buy from an external vendor/supplier?

ii) How much to order? Or how much to order every time an order is placed?

iii) When to order? Or how frequently to place orders for that material?

Moreover, the amount of order will depend on the stock, or inventory, in hand and on order. The elements of the task of materials planning and budgeting for production of bulk materials and products differ (and at times quite significantly) from that for the manufacture of discrete products. The procedures and algorithms used for planning, budgeting and control are also somewhat different.

In this unit, we will discuss the various aspects of materials planing and budgeting in manufacturing and production. However, before we can take up the details of materials planning and budgeting in manufacturing industries, and in continuous process industries engaged in the production of bulk materials and products, we must briefly discuss the management of production and manufacturing. We must also identify the links and interfaces of materials planning and budgeting with purchasing and stores, one hand, and materials control, on the other. The material requirements planning algorithm will be discussed in detail in this unit.

8.2 MANAGEMENT OF PRODUCTION AND MANUFACTURING

When we think of materials management, we basically have in mind the management of materials required for production and manufacturing of end products. Materials management is very closely tied with production and manufacturing and, as a mater of fact, the requirement of materials originates from production, or manufacturing. For this reason, we must first briefly discuss the relevant details of production and manufacturing management.

Production is the term used for the set of processes needed to transform raw materials into finished products. These raw materials can be different forms, such as, ores for production of steel, copper, aluminium etc., raw stock for production of chemicals and pharmaceutical formulations and crude oil for production of petrol, diesel, kerosene/ aviation fuel etc., pig iron and steel scrap for iron foundries, and bars, plates/sheets, pipes/tubes etc. for being converted into components for discrete products like automobiles, machine tools, refrigeration's etc. The production processes transform these raw materials through various stages of conversion to the desired end products(s), with each stage of conversion transforming the input material to another form. The cut length of steel bar, a raw material, becomes a spindle (a component), and then the component becomes an input to the next stage, undergoes an assembly process to become the part of a subassembly, and so on. The point to remember is that all these – the bar, spindle and subassembly – are materials, and the timely availability of these materials is crucial for the production of the end product.

At this point in our discussion, we must note the fine distinction between production and manufacturing. Technically manufacturing and production are the same, but whereas the term manufacturing can be used for any kind of production, it is generally used in cases where discrete products are produced. Such products are usually engineered products, like automobiles, aircraft's, machine tools, refrigerators and washing machines, heavy, medium and light machines, television, radios and appliances, and manufacturing is the function which deals with the transformation of raw material into these discrete engineered products*, which, in turn, must be distinguished from bulk materials and products, like steel, cement, bulk chemicals and fertilizers. In manufacturing, the products are generally assemblies consisting of a number of subassemblies, like engine, transmission, suspension and the chassis, and these subassemblies, in turn, are made from a number of components. These components are made from different raw materials (like steel, copper, gunmetal etc.), in different forms, like plates, bars/rods, castings and forgings, through different processes of manufacture, which consist of activities, or operations. These components then go through the subsequent process(es) of assembly to finally become the end product. The transformation of raw materials into a discrete engineered production is shown in Fig. 1.

The management of production and manufacturing thus deals with the management of industries engaged in the production of bulk materials and products and the manufacture of discrete products. We should first examine the different types of such industries, and this should be followed by a discussion of the function of planning and control of production and manufacturing systems in these industries.

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* In India, the manufacturing industry has been traditionally known as the engineering industry. The justification is that it is engaged in the manufacture of discrete engineered products.

8.2.1 Types of Industries

We have already made a distinction between production and manufacturing. Based on this distinction, we may classify all these industries under two broad heads, namely:

1) Continuous process industries engaged in the production of bulk materials and products, and

2) Manufacturing industries engaged in the manufacture of discrete products.

The manufacturing industry is very diverse, ranging from aircraft and shipbuilding industries, right through machine building (heavy, medium and light), machine tools, equipment manufacturing, manufacturing of consumer durables and appliances, upto automobiles, and manufacturers of electronic devices, computers, radios and television. This diversity of products gives rise to differences in the mode of management of the manufacturing system. There are companies which take up the manufacture of the product only after the receipt of an order from the customer. These are the make-to-order companies. In these companies there is no finished goods, or end product, inventory. Then there are the make-to-stock companies which manufacture products for inventory and then this finished goods inventory is sold to the consumers through the channels of distribution. The third kind of manufacturing company is the assemble-to-order company. These companies assemble a wide variety of end products from a smaller set of standardized options. The difference here (with the make-to-stock companies) is that the finished goods inventory is essentially of standardized subassemblies/assemblies and devices, and when an order is received from the customer, these standardized options are assembled, in accordance to the specific requirement, to make the desired end product. In the make-to-stock companies, the finished goods inventory acts as a buffer and separates the assembly process from the customer orders. The forecast of demand for different products, in its portfolio, is thus crucial in such companies. The reader should also realize that the demand of some of the products may be seasonal in nature. As opposed to this, the assemble-to-order firms need to carefully integrate actual customer orders with planning of manufacture of the standardized options and final assembly.

Another distinction between manufacturing companies has to do with the complexity and volume of component manufacture and assembly undertaken. Some companies do little in-house manufacturing, and purchase most of the components prior to assembly, whereas, others with extensive machining and other processes of conversion, have significantly more complex and larger component manufacturing activities.

8.2.2 Manufacturing Planning and Control*

The three primary objectives in most manufacturing organizations are as follows:

1) Maximizing customer service.

2) Minimizing inventory investment.

3) Achieving efficient plant operation.

The inherent problem in meeting these objectives comes from the fact that these three objectives are basically in conflict with one another. Maximum customer service can be provided if finished goods and in-process inventories are raised to very high levels and the plant is kept flexible by altering production levels and varying production schedules to meet the changing demands of customers/market. The second and third objectives are thus in conflict with the first. Efficient, that is low cost, plant operation can be achieved if production levels are seldom changed, machines are run for long periods once they are set up for a particular product and no overtime is incurred.

* In this section, the terms manufacturing and production are used interchangeably, since the planning and control system is the same.

However, this results in large inventories and poor customer service. Inventories – raw materials, work-in-process**, and finished goods – can be minimized if customers are made to wait, and/or if the plant is forced to react rapidly to changes in customer requirements and interruptions in production resulting from changes in priorities. The fact is that few companies, if any at all, can afford to work towards one of these objectives to the exclusion of the others, since all three are equally important for earning an adequate profit on investments made and for the sustained success of the organization. Manufacturing planning and control is concerned basically with providing the information needed for day-to-day decisions required to reconcile these objectives in plant operations. Thus an effective manufacturing planning and control system is essential for the successful operation of a manufacturing organization.

Before we take up the discussion of the manufacturing planning and control system, a basic misconception must first be removed. This is that production and inventory control are two separate functions, because in most organizations, production and materials management are separate departments. However, the basic truth is that raw material and purchased/bought-out components are procured in a manufacturing plant and their inventories maintained to support production, and thus materials and inventories are themselves the result of production. Only in a trading organization, where materials are bought and then resold without any processing at all, can material/inventory planning and control have a meaning apart from manufacturing planning and control (however, in such organization, the production function does not exist and therefore, there is no need for manufacturing planning and control). Thus material/inventory planning and control is an essential part of the manufacturing planning and control system.

Figure 2:

A block – diagrammatic representation of the manufacturing planning and control system is shown in Fig. 2. The figure shows the principal activities (shown in blocks) and the way they are connected to each other (shown with the help of arrows). Since planning and control are evidently an ongoing iterative series of activities (control based on plans and feedback from control, in turn, affecting the plans), material control and capacity control are connected to material planning and detailed capacity planning respectively with the help of two-headed arrows. The process of planning begins with forecasting. Long-range forecasts are used to develop resource requirements for production, such as technology, equipment, machinery, capital, and skills required. These resources do not

** Component inventory forms a part of work-in-process (WIP) inventory.

change in the intermediate range*, that is, over the period for which production has to be planned. Thus the resource requirement plan, derived from the long-range forecast*, is then used as an input to production planning (Note: resource requirements planning is a part of strategic planning* and this has been so noted in the figure). Production planning is also known as aggregate production planning, or aggregate planning** in short, and its objective is to establish general production levels (or volumes) for the different products and product groups in the intermediate range (over the next 12 to 18 months). It is used to check the availability of different types of production capacities (as for example, turning hours, welding and fabrication man-hours and machine-hours, assembly man-hours etc.) for the end products demanded/ forecast in the intermediate range. The master production schedule (MPS) is derived from production planning. MPS breaks up the production plan into time periods and gives a detailed statement of quantities of each product, or product group, which is planned to be produced in each time period of the planning horizon (that is, in each week, or each month, of the next financial year). Short-range forecasts are the principal ingredients to finished goods planning of products made to stock, and also provide information directly to the master schedule for products made to order. Let us, as an illustration, consider the circuit breaker manufacturing division of an electrical equipment manufacturing company (also assume that this division makes only air-blast circuit breakers). The MPS for this division is given in Table 1.

The MPS is the driver of the manufacturing planning and control system. Once the MPS is deemed to be realistic (or achievable), it is taken as the basic planning document, and plans for material and capacity requirements are generated in detail. Feedback during execution (the control function) detects significant deviations from plans and then the material and capacity plans are updated and simultaneously necessary corrective actions

are also initiated. A careful study for Fig. 2 reveals the following interesting aspects of the manufacturing planning and control system:

1) Most interactions between elements of the system are represented by two-headed arrows indicating that direct linkage between the two elements so connected is essential for proper operation of the system.

2) Forecasting is an exception; forecast of demand for products are made unilaterally, and they should not be influenced by constraints since demands for products must be met by the system. MPS is derived from the production planning exercise which gets its input from forecasting.

3) Effective control of capacity is essential for the execution of the plan expressed in the MPS. This implies that the MPS must be revised if the capacity requirements of the formal plan cannot be met (feedback from capacity control). Once material and capacity plans are made (since materials, men and machines are the basic requirements of production), control is required to ensure that the plans are met during execution. This involves feedback during execution to report the actual status in relation to the plan and determination of significant deviations,

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* Forecasting is concerned with projecting, or predicting, the future demand of the company's products. Forecasts are often classified according to the time horizon over which they attempt to estimate/predict. Long-range forecasts look ahead 3-5 years, or more, and are used to guide decisions about plant construction and equipment and facilities acquisition. Intermediate range estimates one or two years in advance and are used for construction of the master production schedule (MPS) and to plan for long lead time components and materials. Short-term forecasts are concerned with demand over 3-6 months in the future.

** Moreover, aggregate planning becomes necessary since although in the intermediate range, the physical facilities are assumed to be fixed, fluctuations in product demand can be met by varying the production rate, the size of the work force, or the inventory level, or by subcontracting part of the work or a combination of these strategies.

which, in turn, must point out where corrective action is required to get back to the original plan. This intimate relationship between planning and control must be recognized.

Table 1: Master Production Schedule for the Circuit Breaker

									Financial Year: 1976-77			
Month	A	M	J	J	A	S	O	N	D	J	F	M
Total Number of Circuit breakers	40	25	50	30	30	50	30	40	50	40	50	30
MASTER PRODUCTION SCHEDULE												
Month	A	M	J	J	A	S	O	N	D	J	F	M
Railway Breakers	15	—	30	—	—	30	—	—	10	10	10	10
Metal-clad 11KV Breakers	20	—	20	15	15	15	20	20	20	20	20	—
Air-blast Breakers 220 KV	—	25	—	15	15	—	10	10	10	10	10	20
Air-blast Breakers	5	—	—	—	—	5	—	10	10	—	10	—

8.3 MATERIALS MANAGEMENT IN MANUFACTURING AND PROCESS INDUSTRIES

The manufacturing or production function, in the overall sense, can be viewed as a combination of the following two points:

1) Materials management to provide the planning for material requirements, purchasing of these materials, their storage and flow through the processes of conversion to finished product inventories.

2) Production management for the actual conversion activities, such as machining, fabrication, assembly and packaging.

A flow of materials occurs in any production, or logistics, process that procures raw materials, produces components, creates products for sale from in-house manufactured and purchased components and subassemblies, and moves them to consumers. This flow is shown in Fig. 3, where inputs received from vendors and suppliers are converted by conversion activities, and processes, to finished good inventories, which, in turn, are then shipped to customers and markets using different channels of distribution. From the figure it is also evident that manufacturing, or production, management is tied to the flow of materials and the set of process activities that transform these materials to the end products.

Figure 3:

The materials management concept stems from the need to integrate the planning for purchasing of the needed materials, their conversion and flow, and the inventories of finished products. Also recollect that these materials include not only raw materials in different forms, but also, in the manufacturing industry, purchased, or bought–out, components and subassemblies. Raw materials and the purchased components must be purchased and stored, if necessary, and this can only be done if the type (what?), quantity, or amount (how much?), and timing (when should it be available?) of the requirement of these materials is determined first. Thus purchasing and storage and inventory control have to be preceded by planning and budgeting of material requirements. This activity is the first activity of materials management; and the three activities of materials management are (i) materials planning, (ii) purchasing, and (iii) storing, inventory control and material handling. The materials manager takes the responsibility for designing, installing and operating an inventory and materials control system. The basic purpose of the system is to develop manufacturing plans and a flow of materials that will conform to the stated plans and policies, using inventories properly to minimize operating costs. The complexity of this system depends on the product diversity/product mix, the conversion processes and cycles, and the manufacturing environment (make-to-order, make-to-stock or assemble-to-order) and method of distribution. The simplest combination is a few products made in a single plant by a continuous process, as in a chemical or a fertilizer plant, and distributed directly from the factory, and the most complicated combination is a variety of complex assembled products produced from components purchased and manufactured through multi-operation processes, involving several plants and distributed both from the factories and from warehouses or branches.

As per the American Production and Inventory Control Society (APICS), the term materials management stands for "the grouping of management functions supporting the complete cycle of material flow, from the purchase and internal control of production materials to the planning and control of work in process to the warehousing, shipping and distribution of the finished product" (reference: Thomas F. Wallace and John R. Dougherty (editors), APICS Dictionary, 6th Edition, American Production and Inventory Control Society, Falls Church, Va., U.S.A., 1987). However, there is no universal agreement about the activities that come under materials management. Sometimes, materials management includes only the activities related to input materials, namely, materials planning, purchasing and inventory control, as noted earlier, and the terms logistics and physical distribution management are used to refer to shipping, transportation and warehousing of finished goods/end products. Logistics management may also be used for the management of all the activities given in the APICS definition (the full scope of material flow activities).

8.4 MATERIALS PLANNING AND BUDGETING

The objective of materials management is to have the right material required for manufacturing, or production, in the right amount, at the right place, and at the right time, and, as we have already noted, this implies that the what, how much, and when of material requirements must be determined first. This is the basic objective of the materials planning and budgeting function. The questions that must be answered are the following:

1) Which material inputs must we get?

   Note: The inputs required are dependent on the outputs/end products planned to be manufactured.

2) How much of each of these inputs do we need, and based on how much is available in stores and/or has already been ordered (inventory on hand and or order), how much of each of these should be ordered? The gross requirements of each of the required material inputs is calculated first and the net requirements are derived by subtracting from it the on hand and on order inventory.

3) When should the orders for each of these material be placed?

Note: This decision is dependent on (i) where in the manufacturing process for the end product is the particular material required, namely, the crankshaft forging for the machining of the crankshaft prior to its assembly with the piston, cylinder etc. for the engine subassembly of the automobile, and (ii) the lead times for procurement and manufacturing, namely procurement lead times for raw materials (including forgings and castings) and purchased, or bought-out, components and subassemblies, and manufacturing lead times for the in-house manufactured components and assembly operations, both subassemblies and final assembly.

Materials requirement planning (MRP) is a computational technique that converts the master schedule for the end products (MPS) into a detailed schedule for the raw materials and components used in the end products. The detailed schedule identifies each raw material and component item required for a particular end product. It also determines when each of these items must be ordered by the factory and delivered by the vendor/supplier to the factory so as to meet the planned completion date for the end product as per the MPS. The underlying concepts for the techniques collected and unified by Orlicky under MRP in the early 1960's had been known for many years, but they could not be fully exploited without the data processing power of the modern computers. Its early application, in the 1960's, was a bill of material explosion technique (desegregation of the end product) for determining the time-phased requirement of the components and subassemblies (for the quantity of end product given in the MPS) and a method of releasing manufacturing and purchase order to the shop and vendors/suppliers. Orlicky called the technique 'time-phased material requirements planning'. Before we take up the discussion the MRP technique, or algorithm, we must note the distinction between independent and dependent demand inventory item. This is necessary since this distinction is basic to the MRP technique.

8.4.1 Dependent Versus Independent Demand

Items stocked by a manufacturing company (inventory items) can be broadly classified under following four heads:

1) Raw materials and purchased, or bought-out, components.

2) Work-in-process

3) End products, or finished goods.

4) Maintenance items, or spare parts, and tooling inventory, namely, cutting tools, jigs, fixtures, dies and moulds.

The first three kinds of inventory items are directly related to the end products manufactured by the company. The fourth class of inventory item, however, is not directly related to the end products and is maintained to support the activity of in-house manufacture of components.

Demand for a given inventory item is termed *independent* when such demand is unrelated to the demand for other items, or when it is not a function of the demand of some other inventory items. The demand for spare parts and cutting tools is independent of the demand for raw materials, purchased components, or finished goods. Conversely, demand is defined as *dependent* when it is directly related to, or derives from, the demand for another inventory item or end product. This dependency may be 'vertical', such as when a component is needed to build a subassembly or end product, or 'horizontal', as in the case of an attachment or the owners manual which has to be shipped with the end product.

The first three classes of inventory items are needed for the end products and we may call them as items of production inventory to distinguish them from maintenance and tooling inventory items. Moreover, the bulk of the total production inventory is in raw material, components and subassemblies, and all of these are largely subject to dependent demand. Their demand is derived from the demand of the end products for which they are needed. Dependent demand should not (and need not) be forecast, as it can be precisely determined from the demand for those items which are its sole cause. On the other hand, the demands for the independent demand inventory items have to be forecast. Coming to the items of production inventory, the demand for the end products, therefore, may have to be forecast. For example, Maruti will need to forecast how many Wagon R model cars it will be able to sell in the financial year 2001-2002.

8.4.2 Material Requirements Planning (MRP)

The flow chart, or structure, of the MRP technique is shown in Fig.4. The most important input to the technique, or algorithm, is the MPS, which specifies the quantities of the end products to be produced in each time period of the planning horizon. As we have already noted, the MPS translates the aggregate production plan, which, in turn, is developed based on forecasts and firm orders, and expresses the overall plan in terms of the specific products and/or models to be produced (please see Table 1) in each time bucket/period of the planning horizon. After the end-product production schedules have been developed and enumerated in the MPS, they must be broken down into detailed requirements of purchased and manufactured components and subassemblies, and also the raw materials for the manufactured components. This is done by the MRP processor; the MPS triggers the MRP processor, which then converts the requirements of the end products given in the MPS into initially the gross requirements and subsequently the net requirements of purchased and in-house manufactured components which go into subassemblies and the final assemblies of the end products and also the raw materials required for the manufactured components. The calculation of gross requirements is done with the help of the bill of materials (BOM) file. The dependent nature of material requirements is given in the bill of materials, also known as product structure, or assembly parts list. The bill describes how an end product is made, or built up, from its constituent components and subassemblies. This the 'explosion' or desegregation of the end products into requirements of purchased, or bought-out, components and subassemblies and raw materials required for the in-house manufactured components is done by the BOM file. The net requirements must then be derived from the gross requirements and this is done with the help of the inventory status file. The inventory status file provides for each purchased component and the raw materials required for the manufactured components for all the end products an up-to-date (updated) information on on-hand inventories, scheduled receipts (inventories on-order and scheduled to be received), and planned order releases. The net requirements are obtained by subtracting the on-hand and on-order quantities from the projected gross requirements.

Figure 4:

Moreover, the inventory status file also provides essential material planning information, such as, lead times, stock levels, and scrap allowances for raw materials. Thus the time phasing of the purchase order releases and shop order releases can also be determined since information on lead times, both procurement and manufacturing lead times, is also available in the inventory status file. The time phasing, or back scheduling, by the amount of the relevant lead time (procurement lead time for the purchased component, or procurement lead time for the required raw material (e.g. crankshaft forging) and manufacturing lead time for the in-house manufactured component (machining of the crankshaft), or the assembly time (manufacturing lead time) for the subassembly and final assembly operations) from the time the specific material is required to be delivered for the manufacturing of the end product gives us the date by which the purchase, or shop, order must be released. With the determination of planned order releases, the material planning exercise is complete, since the what, how much, and when have been determined for all the materials of all the end products required to be manufactured and as given in the MPS. In Fig. 4, engineering changes and inventory transactions have been shown as inputs to the BOM and inventory status files respectively. In the manufacturing industry, changes to engineering drawings and material specifications are quite common and such changes come under engineering changes. Information on engineering changes and inventory transactions (receipts and issues) are used for updation of the two files.

8.4.3 Materials Planning and Budgeting in Continuous Process Industries

From the preceding discussion of the MRP technique, it would seem to the reader that the MRP technique is best suited to the manufacturing industries engaged in the manufacture of discrete products like cars, appliances, machine tools and television sets. This is so because in the manufacturing industries, the end product is subject to the independent demand of the marketplace, but given that demand, requirements for the raw materials and components depend on the manufacturing schedule (as given in the MPS), and this dependent demand condition is best served by MRP. However, the discerning reader will realize that the same holds true for the continuous process industries as well, wherein the demands for the end products, say steel plates and sheets, angles and channels, sulphuric acid, or urea, are subject to the independent demand of the marketplace, but once the demands are forecast, the requirement of the inputs are dependent on the production schedule of the end products. Thus the logic of MRP is universally applicable. However, since the continuous process industry environment differs, in some aspects, quite significantly from that of the manufacturing industry, there are some differences in the way MRP is applied for materials planning and budgeting in continuous process industries engaged in the production of bulk materials and products.

There are some basic differences in the operation of continuous process industries. Let us take up the calculation of gross requirements first. In most process industries, the bill of materials are not structured properly product-wise. Thus these have to be made out for all end products indicating the requirements of the input items (in kgs/gms) per tonne/kg of the end product. Also after they are made out, they should be collated in the form of a BOM file. Moreover, perpetual efforts are needed to keep the BOM file updated, since in process industries, there is some difficulty in evaluating the relative quantities of the constituents (inputs) per unit of the parent item (end product). This is because the losses and wastages differ from product to product, and within a product, vary from day-to-day depending upon the operating conditions, that is, the actual values of the process parameters. The other, and probably a more important, difference relates to the effect of manning on the output. In some units, the output is a function of the manning level, and therefore, the requirements of the individual inputs (constituents) also depends on the manning. In such industries, the requirements of the inputs have to be calculated from the ratios showing the rates of their usage relative to the manning levels in the various processing facilities. Moreover, these ratios need to be checked regularly against the actual consumption and adjusted to reflect the latest level of performance*.

Coming next to the determination of the net requirements from the gross requirements by subtracting the on-hand and on-order inventories, in process industries, whereas some inputs may be stored in stockyards, others may be kept in railway wagons and hopper trucks, and still others in bags kept on pallets in storage areas in the shops. To maintain the actual on-hand inventory is quite a job, and in the example cited by Plossl (see footnote for reference), the planner inventoried the raw materials every day in the morning. Also, the records with regard to on-hand inventories, issues, receipts, balances and on-order transactions were also maintained by him using a simple kardex system. Such a system may now be computerized, and the use of the computer will greatly reduce the clerical effort. Similarly, the details on open purchase orders, giving the material specification number/grade, vendor number (and name), purchase order number, railway/ truck way bill number, have to be maintained, and the material en-route has to be checked on a daily basis with the railways and truckers (trucking companies employed).

8.5 CONCLUDING REMARKS

Industry and industrialization creates wealth and provides the wherewithal for the economic upliftment of the population and the manufacturing sector (of the industry) serves as a prime engine for the economic development of the nation. Materials are a vital input to manufacturing and production, and the efficient flow of materials from the suppliers through the necessary production processes and on to customers and markets is essential for good customer service and generation of profits for a manufacturing company, and materials planning and budgeting is the first and most

* Plossl, in his book on Production and Inventory Control, cites the example of a real life application, wherein the end products were made from 12 items of clay, frits and glazes etc. Reference: Plossl, George W., Production and Inventory Control: Principles and Techniques, Prentice-Hall of Indian Private Limited, New Delhi, Second Edition, 1986, pp 166 and 167.

basic activity of materials management. Material requirements planning, or MRP, is also sometimes referred to as MRP I or little MRP (mrp). It takes the planned output (of end product) from the master production schedule (MPS) and, with the help of the product structure information (of the end products) given in the bill of materials (BOM) file and the information of inventory status of all necessary materials and lead times given in the inventory status file, determines the detailed schedule of timing and quantities of each item. The idea is to get the right materials to the right place (in the manufacturing process) at the right time.

MRP is not a system, by itself. It is simply a technique, or an algorithm, and forms a part of the manufacturing planning and control system. MRP does the following valuable jobs:

1) Determines the quantities of each item required for the manufacture of all the end products planned to be produced, and this includes purchased components and sub-assemblies, in-house manufactured components and subassemblies and raw materials.

2) Suggests the proper time to release orders, namely purchase orders for raw materials and bought-out components and shop orders for production activities like machining, fabrication and assembly.

3) Indicates the dates by which each of the above items are needed (to be delivered for further processing), and thus provides the necessary information for material control.

4) Provides information to assist the planning of capacity requirements*, and machine and work centre loading.

However, MRP is just a material planning technique and is incomplete in the sense that it (i) does not carry out the essential task of material control*, and (ii) does not do capacity requirements planning and capacity control*. Also since it does not carry out control activities and provide necessary feed back for manufacturing control, it does not close the loop*.

8.6 SUMMARY

The effective management of production and manufacturing must provide end products of the required quality and in appropriate quantities to satisfy the demand at the desired times and at reasonable cost. Thus production and manufacturing planning and control function is concerned with quantity, delivery, quality, and cost.

Technically manufacturing and production are the same, but whereas the term manufacturing can be used for any kind of production, it is generally used in cases where discrete products are produced. Such products are distinctly different from bulk materials and products, such as steel, fertilizer, cement and chemicals.

There are basically two different kinds of industries, namely continuous process industries engaged in the production of bulk materials and products and manufacturing industries engaged in the manufacture of discrete products.

Manufacturing industry is very diverse. Also manufacturing companies can be further subdivided under three heads, namely:

1) make-to-order

2) make-to-stock, and

3) assemble-to-order

* This will be discussed in much greater detail in the next unit under manufacturing resources planning, or MRPII.

Many manufacturing companies are a combination of (1) and (2), that is they use make-to-order for some of their products and make-to-stock for other products.

- Materials/inventory planning and control is an essential part of manufacturing planning and control system.
- Manufacturing planning and control system has been explained with the help of Figure 2.
- An example of master production schedule (MPS) has been given as Table 1.
- Flow of materials in a manufacturing/production set-up has been shown in Figure 3.
- The three activities of materials management are (i) materials planning and budgeting, (ii) purchasing, and (iii) storing, inventory control and material handling.
- The questions that must be answered by the materials planning and budgeting function are:

  i) which (material) inputs to get?

  ii) How much of each of these is needed, and how much should be ordered?

  iii) When should the orders for each of these items be placed?
- Bulk of the total production inventory is in raw materials, components and subassemblies, and all of these are subject to dependent demand. Dependent demand need not be forecast, as it can be determined from the demand of the end products, which are its sole cause.
- The material requirements planning (MPR) algorithm has been explained with the help of Figure 4.
- The logic of MRP is universally applicable. It applies to continuous process industries as well. However, there are some differences in the way MRP is applied for materials planning and budgeting in continuous process industries.
- MRP is not a system, by itself. It is a technique – albeit very useful, and forms a part of the manufacturing planning and control (MPC) system.
- Also MRP is, in a sense, incomplete since it does not (i) perform material control activity, (ii) carry out capacity requirements planning and do capacity control, and (iii) provide necessary feedback and close the loop.

8.7 BIBLIOGRAPHY & SUGESTED TEXTBOOKS FOR FURTHER READING

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8.8 ANSWERS TO CHECK YOUR PROGRESS

1) What is involved in material planning and budgeting? Briefly explain the importance of material planning the critical questions, or the important decisions called for

2) Explain with the help of a schematic (flow diagram) the required activities of manufacturing planning and control (MPC) system.

3) The fundamental principles of the MPC system are:

   a) the overall direction setting must be done before the detailed materials and capacity planning activities can be accomplished, and the latter, in turn, must be done before the execution of plans, and

   b) management decision can be improved with better information systems. Are these two principles justified? If yes, then why? Explain your answer with examples.

4) Differentiate between independent and dependent. Dependent demand inventory items do not need to be forecast. Why not? Explain with the help of examples.

5) Explain the material requirement planning (MRP) algorithim with the help of a flow chart.

   Discuss the importance of the master production schedule (MPS) and the roles of the bill of materials (BOM) and the inventory status files. How is the net requirement derived after the gross requirement of the components and raw materials are determined?

6) Discuss the use of material requirement planning (MRP) in continuous process industries. The use of computer can greatly ease the problems of implementation of MRP in such industries Discuss.

7) Discuss the various types of inventory carried by a manufacturing organization in what types of invetories can the FOQ and order level policies be used, and in what types of will the use of MRP be more effective?

Problems/Exercises

1) The Stowell Company is a well-known manufacturer of office equipment and furniture. The product structurs of one of its products the 3-drawer filling cabinet-is shon in the figure. The quantities of the sub-assemblies and components required for one filing cabinet are given in brackets in the figure. The relevant portion of the MPS is given in the table. Prepare a material requirement plan to meet the schedule.

Figure

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Table: Portion of MPS of Stowell Company

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