UNIT 16 DEPENDENT DEMAND INVENTORY SYSTEMS

Objectives

Upon completion of this unit you will be able to:

- understand the concept of dependent demand systems and independent demand systems;
- know Material Requirement Planning (MRP) and Manufacturing Resource Planning (MRP II);
- get into the elements of MRP;
- the difference among the MRP, EOQ and Part period method;
- the application of MRP in different environment;
- difference between MRP and JIT;
- experience the changing role of production and hive fury control managers.

Structure

16.1 INTRODUCTION

Independent demand inventories are subject to market condition and thus independent of operations. Demand for product or service is termed independent when it occurs independently of demand for any other product or service. With independent demand, demand for one item is unrelated with demand for another item. In a movie theater, for example, demand for film postage is independent of demand for popcorn. Examples of independent demand inventories are also finished goods and spare parts in a manufacturing company that are used to satisfy final customer demand. These inventories should be managed by the order point methods described in unit 15.

Dependent demand inventories, on the other hand, are not subject to market conditions. They are dependent on demand. When demand for one product is linked to demand for another product, the demand is termed dependent. Dependency may occur when one item demand is derived from *a* second item. If the demand for one item is known, then the demand for one or more related items can be deduced. If, for example, the demand for an end product is known, one can calculate how many of its sub-components are needed, because their demand is directly dependent on end-item demand. Example of dependent demand inventories are raw materials and work-in-process inventories used in manufacturing companies. These inventories should be managed by material requirement planning (MRP) or Just-in-time (JIT) system. The scope of this unit is Material requirement Planning (MRP), whereas JIT is discussed in unit 12.

Only independent demand needs forecasting; dependent demand can be derived from the independent demand to which it is linked.

16.2 WHAT IS MRP?

Material Requirement Planning (MRP) is a system of planning and scheduling the time-phased materials requirement for production operations. If the delivery schedule for the end products is known, then Me sue and timing of the requirements of the various lower-level work-in-process items and raw-materials can he planned exactly by simple arithmetical calculation. Such planning is known as Material Requirement Planning (MRP).

Although MRP is easy to understand, it can he used in two different ways: MRP-I and MRP-II.

MRP-I: It is an inventory control system, which releases manufacturing and purchase orders at the right time to support the maser schedule. This system launches orders to control work-in-process and raw materials inventories through proper timing of order placement. MRP-I doesn't include capacity planning. Henceforth the terminology MRP-I and MRP will be used interchangeably.

MRP-II: It is an information system used to plan and control inventories and capacities in manufacturing companies. The MRP-fl system coordinates sales, purchasing, manufacturing, finance, and engineering by adopting a focal production plan and by using one unified data tame to plan and update the activities in all the systems. The subsequent sections shall cover MRP followed by MRP-II.

16.3 MATERIAL REQUIREMENT PLANNING (MRP)

MRP provides the following objectives:

- **Inventory reduction:** MRP enables a manager to determine how many of a component are needed and when, in order to meet the master schedule. It avoids the costs of excessive inventory.
- **Reduction in production and delivery lead times:** MRP identifies materials and component quantities, timings, availability, and procurement and production actions required to meet delivery dead lines. MRP help avoid delays in production. It prioritises production activities by putting due dates on customers job orders.
- **Increased efficiencies:** MRP provides close coordination among various works centers as products progress through them. MRP focuses on having all components available at appropriately scheduled times. The information provided by MRP encourages production efficiencies.

Total process of Material Requirement Planning (MRP) is explained clearly in Figure 16.1 below:

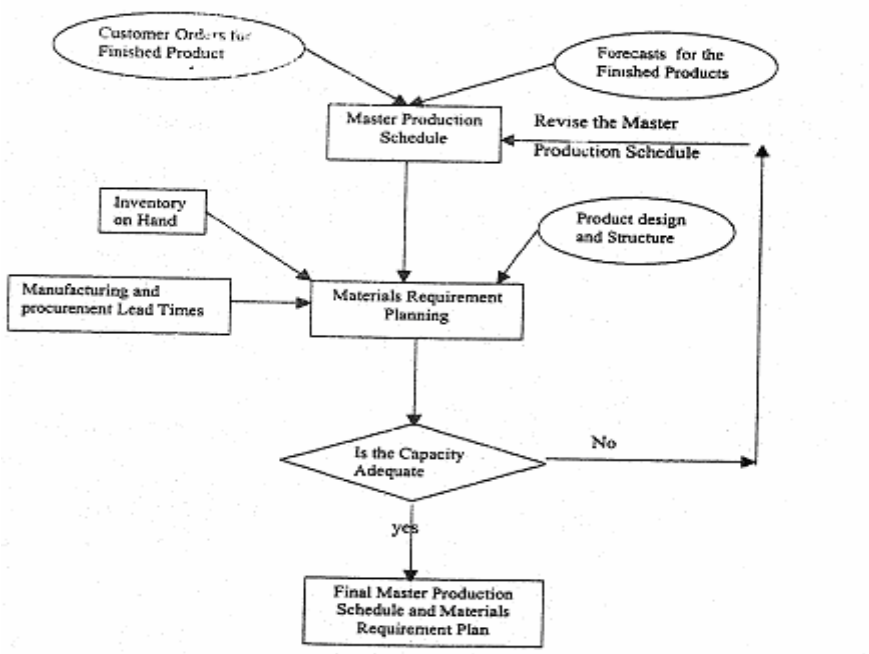

Fig. 16.1: Material Requirement Planning Process

Source: Theory and problems in production and Operations Management, S.N.Chary, TMH outline series.

16.4 MRP VERSUS ORDER-POINT SYSTEMS

Prior to the advent of MRP, there was no choice. The typical manufacturing companies managed all inventories with order-point systems. Some of the key distinctions between MRP and order-point systems are summarised in the table-below.

Comparison of-MRP and Order-point systems

	MRP	Order point
Demand	Dependent	Independent
Order philosophy	Requirements	Replacement
Forecast	Based on master schedule	Based on past demand
Control concept	Control all times	ABC
Objectives	Meet manufacturing needs	Meet customer needs
Lot sizing	discrete	EOQ
Demand pattern	lumpy but predictable	Random
Types of inventory	Work-in-process and raw material	finished goods and spares parts

Source: Operations Management by R.G.Schroeder, International student edition, 1st edition, 1955, McGraw Hill.

Activity A

It has been said that MRP is an information system, which does not rely on sophisticated mathematical models. Discuss the historical significance of this statement.

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16.5 SOME IMPORTANT ELEMENTS OF M

Master scheduling, Bill of Materials (BOM), inventory records, capacity planning and purchasing are few important elements in MRP system. Each one of these elements will be discussed in detail.

Master Scheduling: By controlling the master schedule, top management can control customer service, inventory levels, and manufacturing costs. The purpose is to specify the output of the operations function. Top managers can not perform the master scheduling task by themselves, because there are too many details. They can set master-scheduling policy, thereby controlling the materials planning function. Top management should also interface with manufacturing through the aggregate production plan. The aggregate production plan deals with families of products or product lines, not the specific products, models. For example in car manufacturing the aggregate production plan might contain various types of cars, but not the particular type of engine, hydraulic options, other features which can be selected by the customer. It seeks to make the resources, equipment,' people, and other facilities available for the future. As a result of an inflated master scheduling, the order priorities are no longer valid. The formal MRP system then quickly brakes down and the informal planning and control system dominates. Nothing is more insidious than an infloated master schedule which leads to invalid order due dates. Rarely is the master schedule a reflection of future demand forecasts. Rather the master schedule is a forecast of what will be produced. finished-goods inventory is a buffer between the master schedule and final customer demand, smoothing out loads and providing fast customer service.

Bill of Materials (BOM): It is a structure list of all the materials or parts needed to produce a particular finished product, assembly, subassembly, manufactured parts, or purchased parts. It is as good as a recipie used for cooking. Some companies have several BOMs for same product. Engineering has one BOM, manufacturing hat: a different version and cost accounting has still different. An MRP system requires a single BOM for the entire company. BOMs are constantly undergoing change as products are redesigned. If there errors in BOM, the proper materials will not be ordered and the product cannot be

assembled and shipped. As a result, the ordered parts which are available will wait in inventory while the missing parts are expedited. Management must insist that all BOMs are accurate 100 per cent. It is not too costly to have 100 per cent accuracy. Rather it is too costly to tolerate imperfect BOMs.

Inventory Records: In practice constant effort is required to keep inventory records accurate. Traditionally, inventory accuracy has been assured by annual physical inventory count, where the plant is shut down for a day or two and everything is counted from wall to wall. With cycle counting, a small percentage of the items are counted each day by storeroom personnel. Errors are corrected in the records and an attempt is made to find and correct the procedure which caused them.

Capacity Planning: The necessary elements of an order-launching materials requirement planning system have been described above. This system requires master scheduling, a DOM, inventory records and parts explosion. The parts explosion process assumes that the master schedule is feasible with respect to capacity. Using the master schedule as, input, parts are exploded to produce shop orders and purchase orders. If sufficient capacity is not available, then either capacity or the master schedule must be changed until the master schedule is feasible. The resulting order-launching system will determine correct due dates if sufficient capacity is available. If sufficient capacity is not available, inventories will rise, past-due orders will build up, and expediting will be used to pull orders through the factory. To correct this situation, a capacity planning subsystem is deeded.

Purchasing: The purchasing function is greatly enhanced by the use of an MRP system. First, past-due ' orders are largely eliminated because MRP generates valid due dates and keeps them up to dam. By developing and executing a valid materials plan, management can .eliminate much of the order expediting which is usually done by purchasing. With an MRP system, it is possible to provide vendors with reports of planned future orders. The practice of giving vendors planned orders more closely interlocks them with the company's own material plan.

16.6 MANUFACTURING RESOURCE PLANNING (MRP II)

MRP systems were developed on a segregated basis, rather than as part of a highly information system. More recently, companies are beginning to relate many of their information subsystems to the MRP system. Bills of materials data can be shared with an engineering information system data base; order release and order receipts data can lie shared by the order billing and accounts payable information systems; and inventory status data from MRP can be part of marketing or purchasing information systems. This type of information integration, in fact, is exactly the impetus for a new generation of manufacturing planning and control systems and is called as Manufacturing Resource Planning (MRP II)

Manufacturing Resource Manning (MRPII) is an integrated information system that shares data among and synchronizes the activities of production and other functional areas of the business. MRP II is an integrated information system. The MRP II system coordinates sales, purchasing, manufacturing, finance, and engineering by adopting a focal production plan and by using one unified database to plan and update the activities in all the systems.

One use of the MRP II system is to evaluate various business proposals. If, for "ample, the ou'put of product X increases by 20 per cent in weeks 15 to 20 and that of Y decreases by 15 Per cent in weeks 10 to 15, bow would operations and profitability can be affected? The system can simulate how purchases and, hence accounts payable are affected, when deliveries to customers and accounts receivable occur, what capacity revisions are needed, and so on. The company-wide implications of the proposed change can be evaluated, and various departments can be coordinated according to a common purpose.

The MRP II used to have integrated modules that handle everything from incoming raw materials to inventory control, bill of materials, forecasting, production scheduling, product costing, and general ledger transactions. With a network of some computer workstations, employees have accurate inventory and production information on which to base their decisions.

A schematic diagram of MRP II is given in Figure 16.2, which is self-explanatory. See the figure 16.2.

As shown in figure, the process involves development of production plan from business plan to specify monthly levels of production for each product line over next one to five years. Production plan affect all other functional departments. So it is developed by all the executives of different functional department. The production department is expected to produce at the committed levels, the sales department to sell at these levels, and the finance department to ensure adequate financial resources for these levels. Guided by the production plan, the master production schedule specifies the weekly quantities of specific products to be built. At this point a check is made to determine whether the capacity available is adequate to sustain the proposed master schedule. If not, either the capacity or the master schedule must be changed. Once settled, the master schedule is used in the MRP logic to create material requirements and priority schedules for production. Then, and analysis of detailed capacity requirements determines whether capacity is sufficient for producing the specific components at each work center during the scheduled time periods. If not, the master schedule is revised to reflect the limited available capacity. After a realistic, capacity feasible schedule is developed, the emphasis shifts to execution of the plan. From these schedules, work center loading, shop floor control, and vendor follow-up activities can be determined to ensure that the master schedule is met.

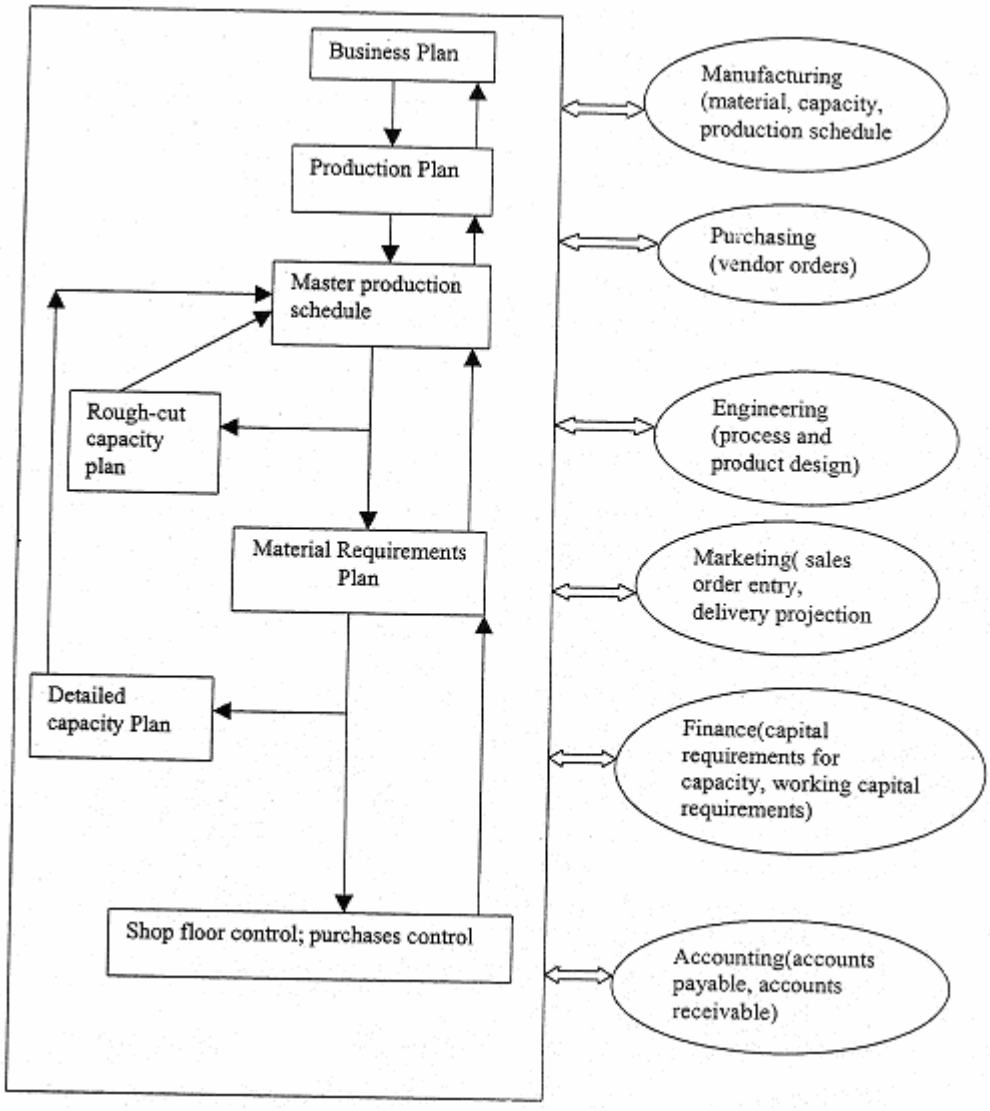

Fig. 16.2: MRP IT: An integrated system for planning and control

Source. Production and Operation Management E.E. Adam and R.J. Ebert

16.7 MRP COMPUTATIONS

a) Lot-for lot

In order to make these MRP computations, one needs to know

1) The product structure showing how the end-product is made up of certain assemblies, sub-assemblies, down to the components, a Bill of Materials being derived therefrom. The Bill of Material (BOM) is a structured list of all the materials or parts needed to produce a particular finished product, assembly, sub-assembly, manufactured part, or purchased parts. If there errors in BOM, the proper materials will not be ordered and the product cannot be assembled and shipped. As a result, the ordered parts which are available will wait in inventory while the missing parts are expedited. Management must insist that all BOMs are accurate 100 percent. It is not too costly to have 100 percent accuracy. Rather it is too costly to tolerate imperfect BOMB.
2) The lead times to produce/procure the different items at the various levels (from components to the end products).
3) The demand or the delivery schedule of the end products.
4) The current on hand stock of the various items as also the schedule receipts of the items being planned.

MRP is thus a calculation of the requirements of the dependent demand items, i.e. items whose demand in dependent upon the demand for their respective higher level items. The end products in a company would be the independent demand items if the demand for these is not easily computable based on the demand for other items some where else.

The MRP system generates planned order releases. Each order is associated with a set up cost i.e. cost of placing and receiving an order. This raises the question of how much to order. One must consider the tradeoff of ordering costs and holding costs. Various lot-sizing policies are possible. *Lot-for-lot* ordering is one important lot sizing policy. Lot-for-lot is a lot sizing policy in which order quantity equals net requirements for the period. The definition will be more cleared through examples discussed subsequently. The main advantage of an MRP system is that it avoids unnecessary stocks of items and produces/procures them only when required and in the quantities required. Classical inventory systems use `averaging' techniques suffer from a predictable drawback: in some periods there is more of the stock when less is needed and in others there is less when more is needed. This type of averaging technique is of an unrealistic approach. For most dependent demand items their demand is `bunched' or `lumpy'. MRP treats the discrete distribution as discrete and not continuous. In the classical production-inventory systems, averaging is a part of the system. In such cases the economies in materials are sought through Economic Order Quantities (EOQ) or Optimal Period of Review which try to balance the order cost with carrying costs for the materials. MRP obviates this need and treats the problem of costs due to the materials directly, by producing/procuring the materials in the quantity and the time these are required.

The timing of the order quantities are not `averaged' and made uniform. The material is .ordered in the lot sizes, but only at the -time they are required for production. There is no extrinsic trigger for placing an order quantity or a review period.

Computing the MRP for releasing a production/procurement order, involves following steps.

1) To determine the time the higher level item are required and in what quantity?
2) To determine the time when and in what quantity the next lower level item is required? This gives the gross requirement of the material.
3) To obtain the real or net requirement, the `on hand' and `schedule to receive' quantities of the item are deducted from the gross requirement. If there is sufficient quantity on hand then there is no need to order for a further quantity.
4) The MRP so calculated are checked for viability vis-à-vis the production capacity. If there is mismatc5 then the master schedule is modified and the MRP is calculated again.

Example 1: (Adapted fr4om Productions and Operations Management by S.N.Chary) Given the following information, how many units are on hand at the end of week 9? Which are the weeks in which the orders may be placed?

Lot-for Lot; Order quantity = 200		Week								
Lead Time = 2 weeks		1	2	3	4	5	6	7	8	9
Requirements		90	10	140	55	5	15	115	95	100
Scheduled receipts										
On hand at the End of period	110									
Planned order release										

Solution

On hand stock is 110 units. First step is to calculate the on hand stock for all the weeks. When we reach week 3, the figure turns out to be negative. Therefore, week 3 is the period when there should be the receipt of the order quantity. Since the lead time is two weeks, the order for this quantity should be placed in the 1st week (3-2=1). The rest of the computations are also done in the same manner. The summary of calculation is shown in the table below.

MRP calculations:

Lot-for Lot ; Order quantity = 200		Week								
Lead Time = 2 weeks		1	2	3	4	5	6	7	8	9
Requirements		90	10	140	55	5	15	115	95	100
Scheduled receipts				200			200		200	
On hand at the End of period	110	20	10	-130/70	15	10	-5/195	80	-15/185	85
Planned order release		200			200		200			

Since the on hand balance could tuna negative in the weeks of 3, 6 and 8, there should be scheduled receipts during those weeks. Giving two weeks' lead time (as shown in backward arrow), the order release should be planned in the weeks of 1, 4 and 6. The on hand balance at the end of the week 9 works to be 85 units.

Example 2: (Adapted from Productions and Operations Management by S.N.Chary)

Ramco industry uses MRP for its production materials planning. The table below provides the information about a particular component X. The demand for this component is somewhat uncertain and in order to take care of a sudden spurt in the demand, a safety stock of 50 items is recommended.

Lot-for-lot; Order Quantity=250 Lead Time=3 weeks		Week								
		1	2	3	4	5	6	7	8	9
Requirements		40	100	70	150	20	20 `	50	100	70
Scheduled Receipts			250							
On Hand at the End of the period	150									
Planned Order Release										

During which week/weeks should the receipts be planned? When should the orders be placed`? What is the expected on hand position at the end of week 9?

Solution: Even with MRP, for some items safety stocks may be necessary. The safety stock requirement here is 50 units. So, any time the on hand balance drops below 50, the receipts should be scheduled in that period. Based on the lead time, the order for the receipt of this batch of items can be planned. The computations are furnished as follows:

MRP Computations with Safety Stock

Order Quantity=250 Lead Time=3 weeks Safety stock=50	Week								
	1	2	3	4	5	6	7	8	9
Requirements	40	100	70	150	20	20	50	100	70
Scheduled Receipts		250	-	250					250
On Hand at the End of the Period 150	110	260	190	40/290	270	250	200	100	30/180
Planned Order Release	250					250			

The above table shows that the on hand balance falls below the safety stock requirements in the weeks 4 and 9. The order release is therefore planned for weeks I and 6, since die lead time is 3 weeks. On receipt of the material, the on hand position at the end of the week 9 would be 280 units as calculated above.

Activity B

What is the trade-off, if any, involved in using MRP instead of the traditional inventory control systems? Discuss.

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Activity C

What are the similarities and difference between MRP and JIT (Just-in-time)?Can the good points of MRP and JIT be combined in a production system? If so, how? Explain.

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The outputs from MRP are

1) Released orders which go to purchasing and in-house production shops
2) Planned orders which are used for capacity planning
3) Rescheduling information used by master schedulers

b) Part-period Balancing

While the ideal MRP system of producing the required quantity only at the required time is good, it implicitly ignoring the set-up costs every time an item is to be produced. One may say that the ideal MRP system assumes the set-up costs to be zero or near zero. Part period Balancing deals with combing the good points of economic order quantity system and the MRP system. Part period balancing consists of combining a few consecutive periods requirements in order to form a batch for production (or procurement). In such a ease, the component produced or procured this week may be held for die requirements of not only this week but also for those of the second, third or further weeks. For optimality, the inventory carrying cost incurred by holding this work-in-process or raw material inventory should balance the set-up costs incurred. This determines the batch size at that juncture. Since the net requirements of the different periods may not always add up to the economic batch size, the batch in part period balancing will usually vary in size and in frequency across the MRP time horizon. This concept can be well explained by an illustration.

Example: 3 (Adapted from Productions and Operations Management by S.N.Chary)
The net requirements of n item per week are as shown below:

Week	3	4	5	6	7	8	9	10	11	12
Net Requirement	200	-	100	50	500	-	400	200	150	250

The set-up costs for this item are Rs 1000. The inventory carrying costs are taken at 30 per cent. The value of the item is Rs 520 per unit. If (a) the lead time to produce the item is two weeks, (b) there is no stock of this item on hand now, and (c) we are in week 1, compute the size and timing of the order release/s for this item. Use part-period balancing in your computation.

Solution: Suppose we make available a batch of 200 items in weeks 3 exactly as per the requirements schedule, then we are not carrying any inventor y. However, if we combine the requirements of weeks 3,4 and 5, then we are carrying 100 units of inventory for two weeks, i.e. during weeks 3 and 4 until it is consumed in week 5. This involves a carrying cost of : 100 x 2 weeks x (Rs 520 x 0.30) / (52 weeks/yr.) = Rs 600.

This does not yet balance the set-up costs of Rs 1000. Therefore, we now combine the requirement,; of weeks 3,4,5 and also 6. Thus, if a batch of (200+0+100+50 =) 350 items is made available in week 3, then

cost of carrying = cost of carrying 150 units for two weeks(week 3 and 4) + cost of carrying 50 units for one week(week 5)

= (150 units x 2 weeks x Rs 3 per unit per week) + (50 units x 1 week x Rs 3 per unit per week) = Rs 1050.

This figure comes closest to the set-up cost of Rs 1000. So we make available 350 units of the item in week 3 itself.

Now the next computation will start from week 7. If we make 500 units available in week 7, there will all be consumed and there will be no carrying costs. Let us combine the requirements of weeks 7,8, and 9. This adds up to (500+0+400=) 900 units. In this case, an inventory of 400 units will be carried in weeks 7 and 8(i.e. for two weeks). The inventory carrying cost will be 400 x 2 weeks x Rs 3 per unit per week = Rs 2400.

The set-up cost of Rs 1000 is closer to the carrying cost of zero (0) than to Rs 2400. Hence, the next batch of items will be made available only in week 7 and of the size of 500 units. The computation for the third batch is as follows:

Case I: batch of 400 units, cost of carrying = nil

Case II: Batch of 400+200 = 600 units, cost of carrying = Rs 600

Case III: Batch of 400+200+150= 750 units.

Cost of carrying = Rs 1950.

It is obvious that case II is closer to the closer to the set-up cost of Rs 1000. Hence we make available 600 unit,; in week 9.

The computation of 4^{th} batch is:

Case I: Batch of 150 units, cost of carrying 150 units nil

Case II: Batch of 1,50 +250 =400 units

Carrying cost = Rs 750

Thus the choice is Case II. Hence, we make 400 units available in the 11^{th} week.

The production decisions are:

Weekno. When the item made available	Quantity of the item made available
3	350
7	500
9	600
11	400

Accordingly, since the lead time is two weeks, the item should be ordered (i.e. order released) in weeks 1,5,7, and 9 respectively.

Activity D

Compare the cost tradeoffs involved in choosing among the following lot sizing rules: lot-for-lot, EOQ, and the part period methods.

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Activity E

Find or create data illustrating inventory-related cost advantages of part-period versus lot-for-lot sizing policies.

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16.8 MRP IMPLEMENTATION

MRP implementation takes a great deal of effort. Research indicates that there are five elements required for successful implementation.

1) Implementation planning
2) Adequate computer support
3) Accurate support
4) Management support
5) User knowledge

Too many companies jump in and start implementing MRP without adequate preparation and face the problems later on. Implementation planning can help smooth out implementation efforts. Implementation planning should include education of senior management, selection of a project manager, appointment of an implementation team representing all parts of the company, preparation of objectives, and detailed action plan. Selection of hardware and software, improvement of data accuracy and other implementation activities begin.

An adequate computer system is probably one of the easiest elements of MRP to implement. Many companies today use standard software available rather than to develop of their own. An MRP system requires accurate data, which are very difficult to obtain. A company that does not have an MRP system will need to create accurate Bill of Materials (BOMs) as a first step. Once the BOMs are accurate, a system will be needed to keep them maintained. Inventory records must also be accurate to support the MRP system. All other j MRP system data - such as shop routings, shop-floor status, and costs - must scanned initially for errors and then maintained in an acceptable state accuracy. MRP data accuracy is most important for maintaining the system integrity.

Many studies have shown that the top-management support is the key to successful implementation of MRP. Top management must actively involve and give support more then a lip service. The ultimate change required by managers at all levels is to use the system and not to override it by using the informal system.

The final requirement is user knowledge at all levels of company. An MRP system requires an entirely new approach to manufacturing. In the beginning of the installation, only a few managers need to be trained. But as the system begin to be used, all supervisors, middle managers, and top managers need to understand MRP, including managers inside and outside of manufacturing.

16.9 SOME MISCONCEPTION ABOUT MRP

(Source: Newsletter from Oliver Wight. 1977.Operations Management by R.G.Shroeder, 2nd edition)

1) *MRP is a computer system.*

   It's really a people system made possible by the computer. The computer does nothing bur generates output. It's what people do with that information that makes things happen in a factory.

2) *MRP primarily affects production and inventory control people.*

   We call it a Manufacturing Resource Planning today because it is a company plan, a way to tie up marketing, manufacturing, and engineering so that schedule of all of these activities can be coordinated to get-tie best result.

3) *Each, company requires u unique 'system' de signed for there to solve their unique problems.*

   In practice the problems of scheduling a factory, scheduling the vendors, and coordinating the activities of marketing, engineering, manufacturing, and finance are .not unique from company to company. There is a standard logic for MRP.

4) *The MRP installation problems are going to be in the computer area.*

   The real problems come in getting basic data like inventory records and bills of material accurate enough to support MRP If MRP system is going to work for people, these data are to be right. Real problem is to involve large number of people in the organisation. The trick is in teaching people to install and use these tools effectively.

16.10 COMPARISON WITH JIT

There are many differences between MRP and JIT. Some of them are listed below. The differences are explained in number of factors such as: inventory level, lot sizes, setups, queues, vendors, quality, equipment maintenance, lead times, and workers. Students can refer page number 4115 of Operation Management by Schroeder, 1985, McGraw Hill Publication.

MRP uses it planning philosophy. The emphasis is on constructing a valid material plan and then executing according to that plan. In contrast, JIT emphasizes eliminating waste. This is done by reducing inventories, exposing problems, and pulling materials through the plant. MRP takes the plant as given; JIT does not.

While MRP utilises computers and sophisticated information processing, JIT uses a simple visual control system. MRP produces shop orders, purchase orders, exception notices and a great deal of paper work to control the plant. JIT has Kanban cards, which serve shop orders or purchase orders. JIT has minimum paper work and does not require computerisation

JIT requires a stable master schedule which is uniform from. day to day and hour to hour. MRP uses a highly variable master schedule.

JIT seeks to achieve low setup times and small lot sizes. MRP takes setup times as given. With MRP systems, lot sizes are either set by edict or the tradeoff between setup and carrying cost. Lou- runs and large lot sizes are considered desirable in traditional MRP approaches. With .TIT vendors are considered part of the team. Long-term relationship is encouraged; and frequent deliveries are expected. With MRP vendors are treated as adversaries.

With JIT systems, workers are responsible for producing quality parts just-in-time to support the next process. Workers participate in problem solving and are charged with improving productivity and quality. With MRP workers are a part of the system. They are controlled and specialised to a single job. The worker's role is to follow the plan.

Despite the differences, MRP and JIT systems have their particular areas of usefulness. In repetitive production, JIT probably gives the best results. MRP systems give the best results for type job shop or small batch environment, where production is non-repetitive

in nature. In a semi-repetitive environment, perhaps a combination of JIT and MRP system will be the most effective. In this case, MRP is used to plan materials in advance and JIT is used to control the shop floor.

16.11 SUMMARY

Material Requirement Planning (MRP) is an information system that enables managers to improve the efficiency of operations, shorten delivery lead times to customers, and reduce inventory levels in many organisations today. MRP is applicable where end items are produced from many demand -dependent components, assemblies, and materials with a known and stable sequence of product buildup. With, information from bills of material, inventory status tiles, and master production schedule, the MRP processing logic provides time-phased plans for procuring and utilising materials. MRP is especially useful in complex operations where new customer orders are arriving for a variety of products Quid where shop orders for various component are in different stages of completion.

16.12 SELF-ASSESSMENT EXERCISES

1. Is MRP a materials planning system, a production planning system, both or neither? Explain.
2. Read about MRP-Il and discuss the similarities and differences between the traditional MRP-I and MRP-II.
3. In what ways do independent-demand inventories differ from dependent-demand inventories?
4. A vendor has quoted a lead time of 10 weeks for delivery of a part. Your purchasing manager says the part can be delivered in 3 weeks if necessary. Of course, the vendor disagrees. Who is correct'? Explain.
5. Outline the purpose of MRP and explain how an MRP system can achieve these purposes.
6. Explain the role of master production schedule and how it relates to the other elements of an MRP system.
7. It is claimed that MRP produces several cost-savings. What is the source of these cost -savings?
8. Within the context of overall planning and scheduling systems for operations, explain the role of MRP. I
9. Explain how the demand pattern for a component can be discontinuous or lumpy, even though die demand pattern for its parent item is smooth.
10. Can the good points of MRP and of JIT be combined in a production system? If so, how explain.
11. What is (i) `pull' system and (ii) `push' system?
12. Explain the concepts of safety stock, safety times acid safety capacity. Are these relevant to MRP? If so, how? Would these be relevant to JIT? If so, how?
13. Discuss the relevance of MRP in the Indian context. What are the challenges to be experienced in the implementation of MRP in the Indian situation?
14. `Manufacturing in the overall organisational strategy' is being much talked about these days. Will MRP be helpful in the light of overall strategic considerations? Explain.

16.13 FURTHER READINGS

Adam, E.E., and Ebert, Ronald, *Production and Operations Management,* Fifth edition, 1997, Prentice-Hall of India, New Delhi.

Schroeder, R.G. *Operations Management.* Second edition, McGraw-Hill, New York.

Chary, S.N. *Theory and Problems in Production and. Operations Management.* TMH Outline Series, New Delhi.

Narasimhan, L., McLeavey, D.W., and Billinton, P.J. *Production Planning and. Inventory Control,* Prentice Hall of India, New Delhi.