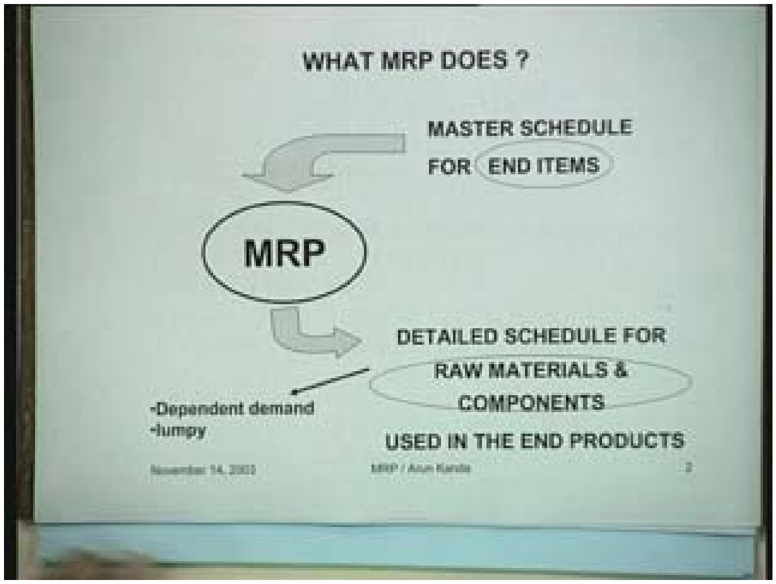
Project and Production Management

Prof. Arun Kanda
Department of Mechanical Engineering
Indian Institute of Technology, Delhi

Lecture - 40
Material Requirements Planning

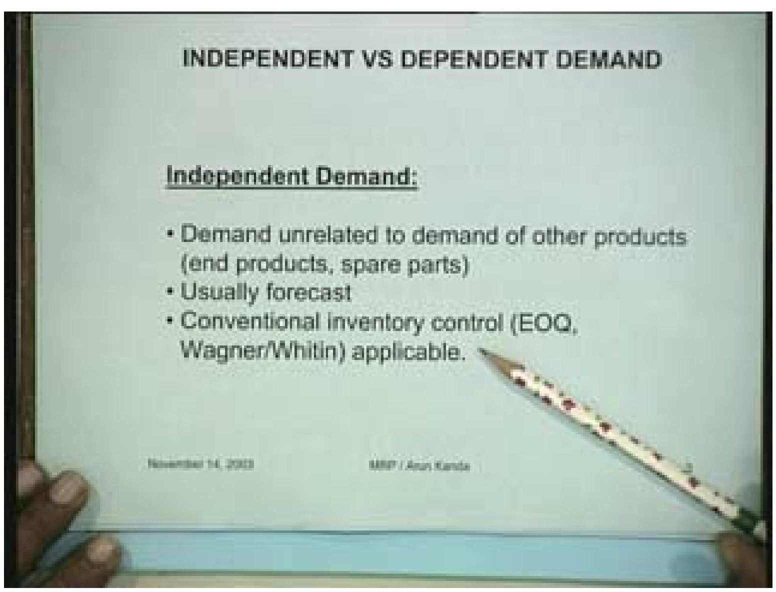
In the last two lectures we have been talking about basic inventory models and in today's lecture we are going to be talking about another kind of inventory, which is known as material requirements planning. MRP, as it is often abbreviated as. Now when we talk about MRP, we must know what exactly MRP does and I think the important thing to realize is that MRP is valid for those situations where you have, let us say an assembly of parts and components and we are talking about the master schedule of the end item. For instance what it might mean is that suppose the schedule of cars that you want to produce is known and then you got to plan out when to make the various sub assemblies, how to assemble the various raw materials and so on. So from the given master schedule for end items we are basically trying to determine the detailed schedule for the raw materials and the components used in the end products. So that is the primary purpose of MRP that is starting from a master production schedule of the end item and since there are a very large number of end items in very large number of raw materials and components involved in the end item, for instance a typical car might have something like 8-10,000 components. So we have to actually plan for the procurement and production of all those components and depending upon the master schedule we find out when to have, when to procure, when to make the raw materials and the components which are used in the end product. I think the point to be noted here is that a typical MRP system, the demands that you are dealing with for the raw materials and the components that we call are dependent demands or lumpy demands rather than independent demands. That is the crucial difference between MRP and conventional inventory control.

(Refer Slide Time: 03:25)



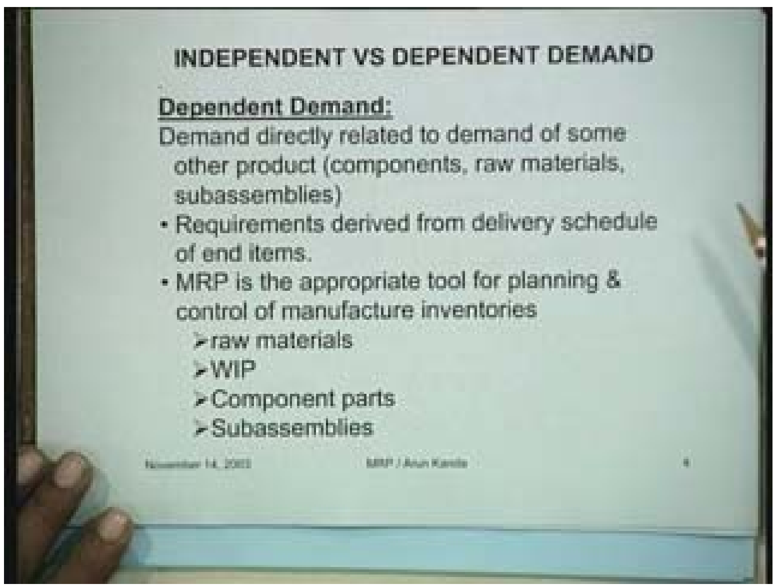
So when you try to make this distinction between independent and dependant demand systems, basically independent demand systems are those systems where the demand is unrelated to demand of other products such as end products or spare parts etc. These are demands which are totally unrelated to the demand of the other products. These independent demands can usually be determined by a forecast and conventional inventory control using EOQ or Wagner within models is generally applicable in these situations.

(Refer Slide Time: 04:11)



So when we talk about independent demand normally EOQ deals with independent demand items. That means you are assuming that the demand for that particular item actually is determined by environmental factors and is not influenced by anything else. So you may then tend to use this particular demand for purposes of finding out either the forecast or what should be the lot size involved in such systems, but mind you this will not be the situation when you are dealing with raw materials and the components involved in a dependent demand system. So when you are dealing with dependent demands, the demand is directly related to the demand of some other product such as components raw materials or subassemblies and the requirements are derived from the delivery schedule of the end items and MRP is the appropriate tool for planning and control of manufacture inventories such as raw materials work in progress component parts and subassemblies in that sense.

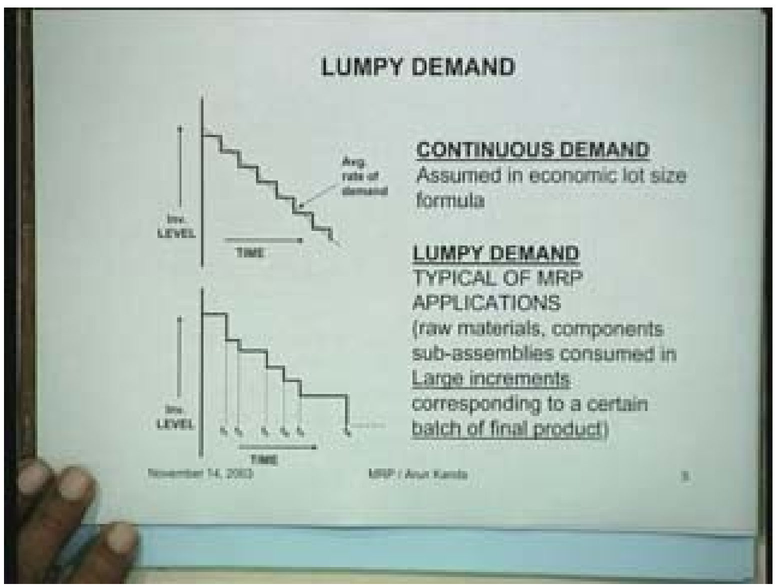
(Refer Slide Time: 05:29)



To give you an example, take the example of the car. The car manufacturer has a large number of components and raw materials needed. What you can say is that the demand for the car follows an impendent demand but when you are talking about the demand for tires, each car has produced five tires including the stepney and therefore if you have to produce 20 cars in a particular month, the demand for car tires during that month will be in which you are assembling the car tires is 100. So this is what we mean by demand. The demand for car tires is actually dependent upon the production of cars in that sense of the term. So MRP systems are actually applicable in those situations where we are dealing with dependent demands and not independent demands. That is the point we have, given the independent demands of cars that we need and we are trying to find out how many tires, how many steering wheels and how many other components we would be requiring during the entire period of production. Another very important feature of the dependent demand is the fact that the demand is lumpy unlike continuous demand.

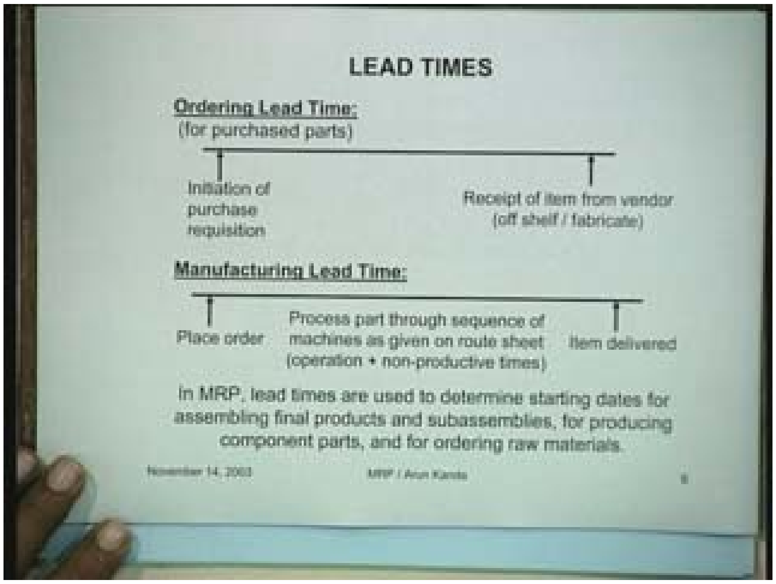
For instance if you take the economic order quantity or the economic lot size formula, what happens there is we assume that the demand is falling at a constant rate. The actual demand might not be falling at a constant rate but the withdrawals might be few, so that actually the variation of the inventory level could be a stair case function of this kind which you are actually approximating by an average rate of demand. So this is the kind of thing which we assume when the demand is continuous. However when you have lumpy demand, lumpy demand would mean that suddenly there would be a withdrawal. For instance in this particular period you are withdrawing suddenly and it may be 100 tires. So the demand inventory, the inventory for tire suddenly falls from this point to this point and then there is no further withdrawal and then there is a withdrawal of a few items and then this is constant for some time and so on. So basically features of typical lumpy demands are which are typical of MRP applications that all these raw materials component subassemblies which are consumed in large increments correspond to a certain batch of the final product. So this is a withdrawal which takes place during this period. There is a demand for so many units of this particular product. So this demand shows this kind of large increment and which is showing for instance a sudden withdrawal and then non change and then a small withdrawal and then no change and so on. This kind of situation is what we call a lumpy demand.

(Refer Slide Time: 08:54)



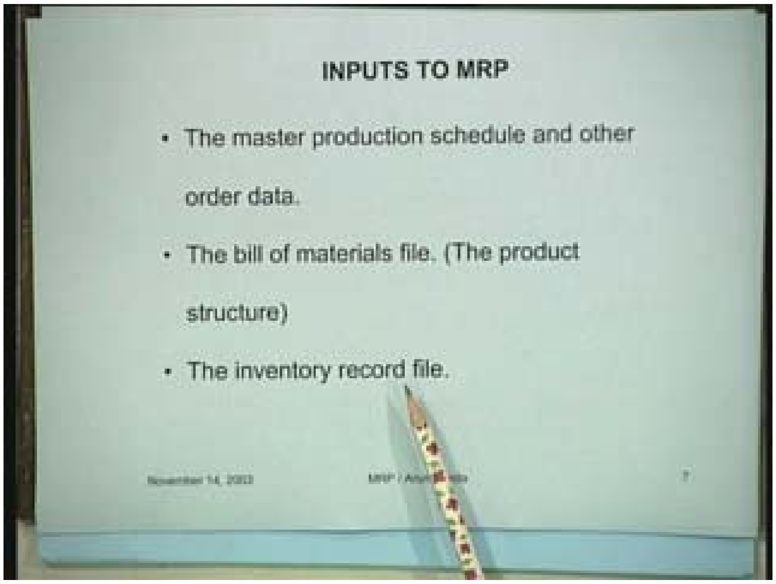
So in a nutshell we can say that typical demands in a MRP situation for the components and the raw materials are lumpy demands. I think the other aspect that you need to consider in a MRP setting is the typical definition of lead times and normally we are concerned with two kinds of lead times. We are talking about an ordering lead time for purchased items or parts and we are talking about a manufacturing lead time for those items which are actually manufactured within the company. For instance in this case all you have to do is, you have to do the initiation of the purchase requisition at this point of time and ultimately you get the receipt of the item from the vendor either off shelf or he fabricates it at this particular point of time. So this interval between the initiation of the purchased requisition and the receipt of the item from the vendor is actually called the ordering mean time. Similarly when you are talking about a manufacturing situation you place an order at this point of time, internally for manufacturing something and then you process the part through sequence of machines as given on route sheet operation plus non productive times and the item is actually given to you here. So this difference then is actually the manufacturing detail. In MRP we require lead times because they are used to determine the starting dates for assembling final products and sub assemblies for producing component parts and for ordering raw materials because anything that you procure or produce has a time requirement or a lead time.

(Refer Slide Time: 10:56)



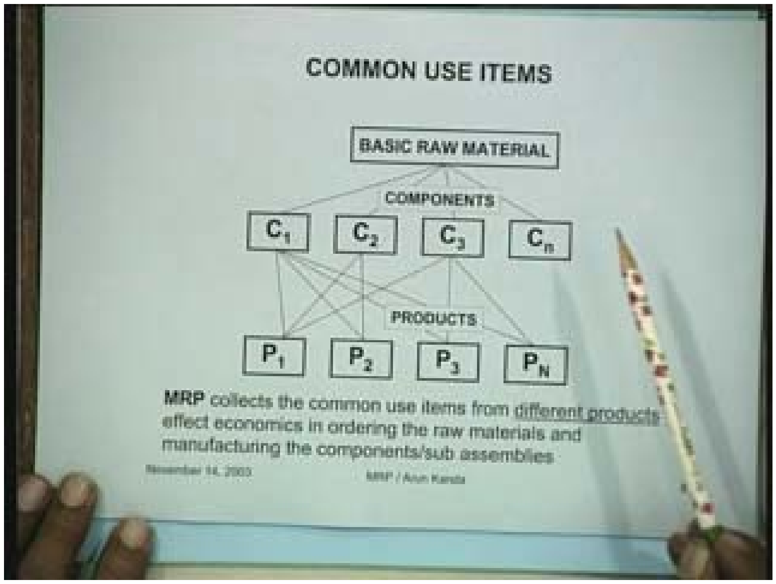
So it could either be an ordering lead time for those items which are procured or it could be a manufacturing lead time for those items which are manufactured and this is a typical input to the MRP system. So if you look at a MRP system, the major inputs to a MRP system are these three. Number one, the master production schedule and other order data for the end item, because to run a MRP you must specify how many cars or how many units of the final product you would like to have in different periods. So this is that master production schedule. For this, based on this information and also based on what we call the bill of materials file the bill of materials file actually specifies the product structure. How many components? How many subassemblies are required to make the final product and how are they related to each other? This is actually the information which is available in the bom file, the bill of materials file and the third major input to the MRP system is the inventory record file. That means you must know the stock of different items/components raw materials that you already have, so that when you are making purchases, you account for the materials that you already have.

(Refer Slide Time: 12:26)



That is the basic idea. So these are the three major inputs that we have for the MRP system in this particular framework. Now what may happen is we may have what are known as common use items and these are the ones which tend to complicate the process of computation of the requirements of different types of products. For instance we might be producing say n different products P_1 P_2 P_3 and P_n. These different products might be requiring different types of components. For instance what is shown here is that P_1 requires component C_1. It requires C_2 and it also requires c_3 whereas P_2 requires only C_1 and C_2 and so on. It is like trying to say that if I am making Maruti 800, zen and other models of the car some of the components could be common to various brands, others could be different, That is what is shown here.

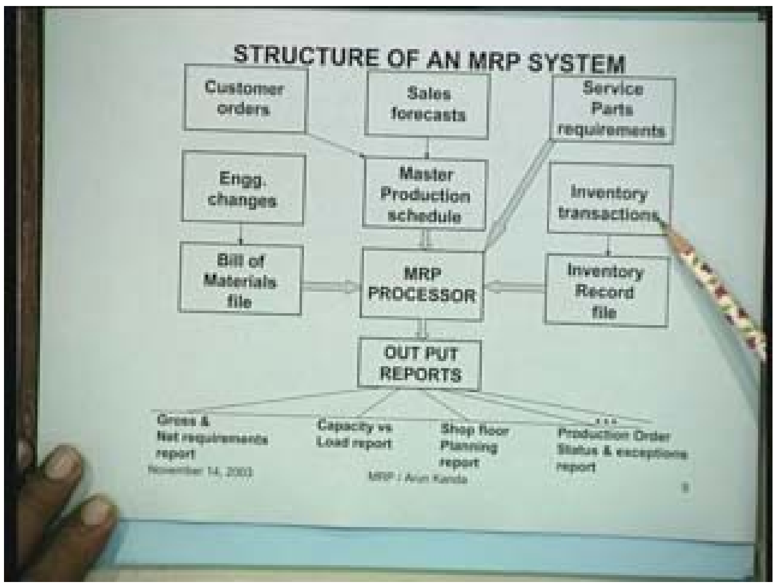
(Refer Slide Time: 13:57)



A particular raw material for instance, if they are all made of stainless steel, this particular component, basic raw material could be common may be to all these various components. Now this kind of information is basic information when you are dealing with MRP because MRP collects the common use items from different products to effect economies in ordering the raw materials and manufacturing the components and the subassemblies. What do we say here? For instance, if you are trying to place an order for the component C_3, the component C_3 is required in the product P_1. It is also required in the product P_3 and it is also required in the product $p_{n.}$ So depending upon your requirements for these three products you will have contributions to the product $P_3$from all these particular requirements so that when you are either placing an order for purchase or manufacture of this component all this will be in fact shown in this particular scheme of things.

First let us try to get an overall idea of what a MRP system would look like because the number of components could run into thousands is generally a computerized system and therefore a typical MRP system will have this kind of a structure. What it requires is information on the master production schedule. The master production schedule is generated from two sources. One is the customer orders which have already been placed and then on the sales forecasts that you have made. So sales forecast and the customer orders when aggregated together will give you the master production schedule which will tell me the requirement of this particular product in the month of January, in the month of February, in the month of March and so on. So this is a master production schedule which is derived from basically these two bits of information. Then what we have is we have a basic bill of materials file. The bill of materials file is kept update with any engineering changes. If you change the design of the product for instance that particular change in the design is captured here and therefore it would be available in the bill of materials file. For instance if you are deciding to either omit a particular component, then this would be shown in the engineering changes and the bill of materials file will reflect this particular change. So this bill of materials file is the second major input to the MRP processor and of course the third thing that we have is the basic inventory transactions. Inventory transactions would mean that this is like an accounting system. It is like your bank account. You take out so much money, you put in so much money and therefore this is available to you at the end of this account. So similarly inventory transactions shows that as far as a particular raw material is concerned you have so much in hand and then you issue 50 tires and then you probably buy 20 more tires. So what is the status of the inventory of that item for each of the thousand of items that you have? Inventory transactions will tell you the basic status of the inventory of different types of items.

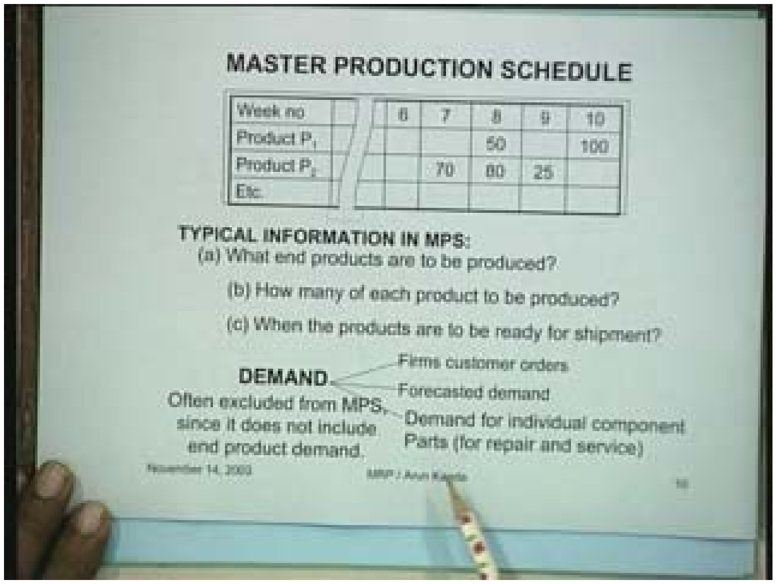
(Refer Slide Time: 18:02)



This information is normally available in what is called an inventory record file. These are transactions. A transaction is very much like the transaction that takes place in each of your entry in your passbook and the account is transaction. You withdraw money, you deposit money. These are transactions but on the basis of that you develop an inventory record file which is like your passbook, something like that and then of course you have service parts requirements. Now these service parts requirements are the requirements of parts which are in addition to the normal requirements that you have for the product. For instance if you sell 50 cars, then may from experience, you know that you will have to sell some additional silencers and so on which would be sort of replacements which are different. So for each item you will have some such requirement. So these are those and ultimately these can be combined with the master production schedule because they define the requirements in that sense of the term. So these are the three major inputs to the MRP system and what does the MRP processor do? It gives you typically reports output reports and the most commonly used reports are these four. This is the most commonly used report. It is called the gross and net requirements report, that means it tells you what the gross requirements of different jobs are and what are the net requirements of different jobs? Capacity versus load report which means it tells you that the capacity that you have and how much are you loading it in individual periods. Shop floor planning report is more detailed and it tells you exactly how various equipments and the machines in the shop floor are going to be loaded over the next one week, two weeks, three weeks and finally the production order status and exceptions report which will tell you that as the processing keeps going, you are within the are you conforming to your requirements or are making any departures from the schedule. So this kind of information is also available here. So this is broadly the structure of an MRP system in that sense, now we will take up an example to see how exactly a MRP system would operate with a limited number of items so that you understand the logic of how the computations actually are performed. What we are trying to say is what does a master production schedule look like which is one of the basic inputs to the MRP system. A master production schedule will be a document like this which will probably say that in week number 6, 7, 8, 9 and 10 product P_1 you need 50 of them in the eighth week and you need hundred of them in the tenth week. Similarly in this product you require 70, 80 and 25 in the seventh, eighth and ninth week. So like this for each product this is the end product. This is like the final product.

This is like the car, how many Maruti 800s and how many Zens etc do I need in different periods? So this information is called the master production schedule and this is the basic driver of the MRP system. You can see what is the information that you get in the master production schedule? You get what end products are to be produced; it tells you product $P_1$and p_2 are to be produced, then how many of each product is to be produced. This tells you when the products are to be ready for shipment. So it basically specifies all these three things when you are talking about a master production schedule. When you talk about the demand, often demand will have, let us say these three components. It will have the firm's customer orders which are a part of the demand. Forecasted demand will be based on your forecasting system. So you have this as the demand. The third thing that you typically have is demand for individual component parts for repair and service.

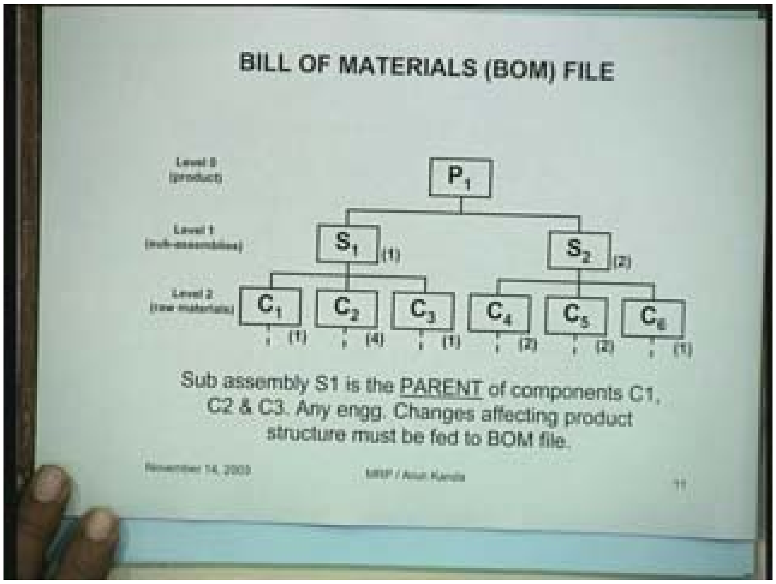
(Refer Slide Time: 22:47)



Normally this component of demand is excluded from the master production schedule. So the master production schedule generally talks about only these two. This could also be included and there is no problem but typically when you are talking about a master production schedule you have only these things. So there is this particular thing demand for individual components and parts are often excluded from the master production schedule since it does not include end product demand. That is the reason because this is like a demand for only wipers or demand for only additional silencers or demand for only windscreens broken, windscreens which you are replacing. Now this is generally excluded because it does not emanate from the end product. It is an additional thing. Now we have seen what the master production schedule looks like. Let us see what is bom file a. What is a bill of materials file?

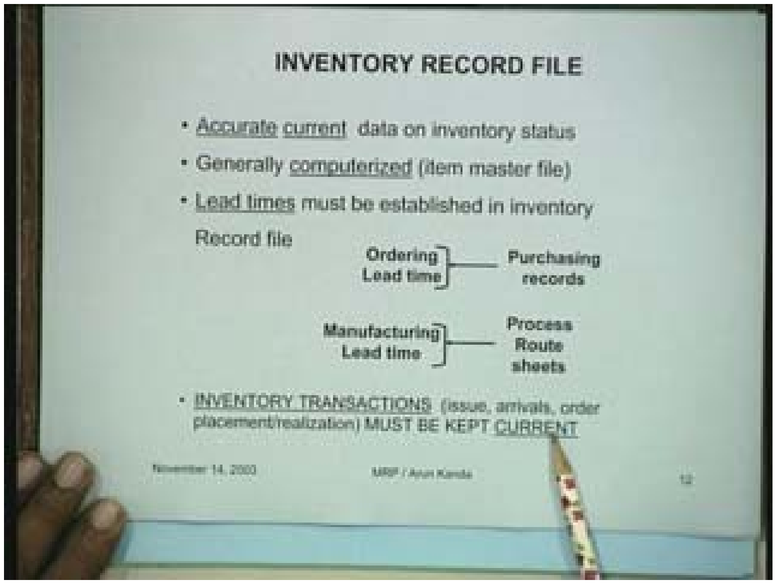
A bill of materials file will typically be a hierarchical structure of this nature. At the level zero you have the product which is the final product P_1. This product is composed of two subassemblies S_1 and S_2 and there are numbers here which indicate that for each product I have one subassembly s one and two subassemblies S_2which are needed to make the final product which means you can imagine that if this was a cycle the bicycle then you would have two wheels subassemblies to produce the bicycle and may be one frame which is required for making the bicycle. So 1 and 2 here refer to the number of parts of that type going to make one unit of that particular product. Then of course we have at the level of the raw materials, we again have subassembly S_1 is composed of C_1, C_2 and C_3 and the numbers here show that one unit of component one, four units of component two and one unit of component three. They are all required to make one unit of subassembly one. See that is the notation. Similarly, here when we say two units of component four, two units of component five and six units of component one, these are required to make one subassembly S_2. So since we need two, we will have to double this particular value here, that is the notation, then of course the subassembly s one which is shown here is said to be the parent of components C_1, C_2, and C_3. So this is the parent and these are the three components and any engineering changes affecting the product structure must be fed to the bom file. That means if you are changing the design what does it mean? You are either eliminating this component or making a different component. So these changes in the design will have to be reflected in the bom file that you have with you.

(Refer Slide Time: 26:19)



So we have looked at the master production schedule which is of the end items. We have seen the bom file which is nothing but the product structure. How is the product composed? In fact if you would recall your lessons from graphic science when you do an assembly drawing, you develop a bill of materials with that drawing. What is that bill of material? That is exactly this. It tells you how many components of each kind will go into the final assembly. So that is the information and how will they go into this? Then the third major thing which we need to understand is the inventory record file because these define the three major inputs to a MRP system. An inventory record file is important in the sense that it should give you an accurate current data on inventory status. It should not have lags. If you want to find out how much money you have in the bank today, if your copy is not updated for the last six months you will not be able to find this out. So what you need is an accurate current data on inventory status. Each inventory transaction is reflected and then you can find out how much would be this quantum of inventory of different products you have. This is generally computerized in the form of an item master file and in this when we are talking about the inventory status, lead times must be established in the inventory record file. We talk about both the ordering lead times and the manufacturing lead time. So this comes from the purchasing records and this comes from the process route sheets of the manufacturing that you are doing within the factory. So you should have this information on lead times corresponding to each item in the inventory because when you are placing orders you must know how much time it is going to take. Then of course the inventory transactions which mean the issue of material, the arrival of material, the order placement, and the realization must be kept current.

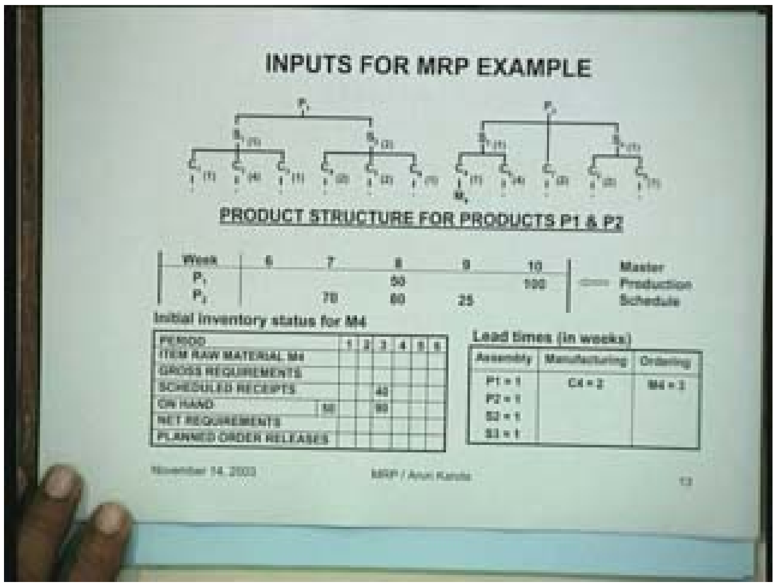
(Refer Slide Time: 28:37)



So these are the basic requirements of the inventory record file. So now that we have a fair idea of the three major inputs which are required for a MRP system, we would like to work an example to see how this information can be utilized for solving this particular case. So we will take this example which haS_2end products P_1 and P_2 and this is the bom structure for one and two. That means each product $P_1$is composed of subassembly one and subassembly S_2. So two of this and one of this make the product and similarly the sub assembly one requires the component C_1, C_2 and C_3 and similarly the subassembly S_2 requires the component C_4, C_5 and C_6 and in these quantities which are shown here, we can go down one level. We have the product level, the subassembly level, the component level and then you might go for the material level which is the purchased material. For instance we are showing it only for this particular part, for C_4 we have M_4. So actually wherever C_4 occurs, it occurs here also. So in this particular application as well as here you are going to use this raw material M_4

So this is the basically the product structure for products one and two, the bom file. This is the master production schedule. The master production schedule states that product one and product two, we require 50 in the eighth week and 100 in the tenth week and for P_2 it is 70, 80 and 25 in week 7, 8, and 9 respectively. So this is nothing but the master production schedule which is the second input required for this product. The third major input that we have to give is the initial inventory status. Suppose we are talking about various kinds of items, we are giving the initial inventory status for only M_4 which is the item at the bottom of this particular bom. So you would have information like the schedule receipts are we are expecting forty units of this item at the end in the third week. On the other hand we have fifty items. So once we have fifty items and forty, we are going to be received in the third week. Our stock level on hand will be ninety in the third week because, fifty plus forty. This kind of information is available to you and so this is like what is the inventory that we are likely to have item M_4 in the beginning and then we would require information on lead times because we require inventory status and lead time status and both of them together. For instance what happens is $P_1$is the final product? This has to be assembled from $S_1$and S_2. So P_1assembly takes one week, P_2 assembly takes one week. S_2 assembly of C_4, C_5 and C_6 takes one week and similarly S_3 that is the third assembly takes one week. Then as far as item number $C_4$is concerned which is required here at two places, has to be manufactured and it requireS_2weeks to manufacture this item. The ordering of M_4which is the item at the end requireS_3 weeks because an outside vendor takeS_3 weeks to supply this item. So this actually encapsulates the information pertaining to the product structure, the master production schedule and the inventory status for all the items.

(Refer Slide Time: 33:01)



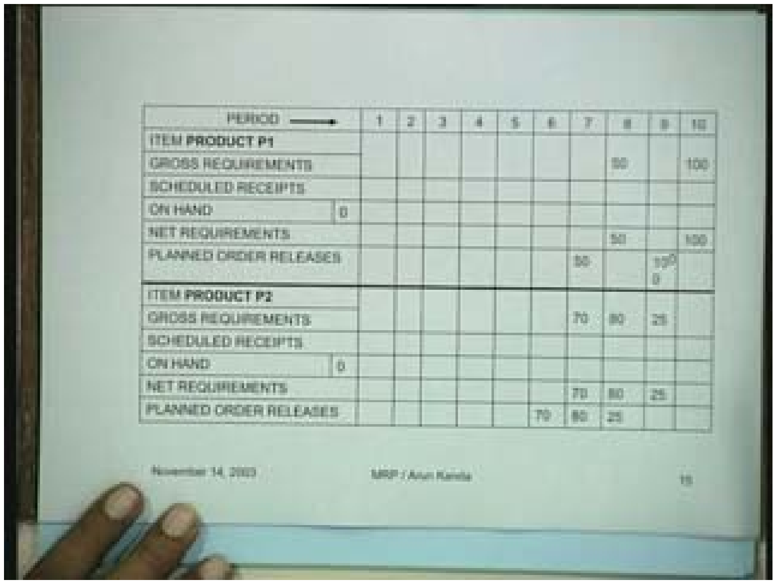
So this is the input. We have now developed the input for our example. Let us see how exactly we would develop the detailed requirements for the various parts. In fact the underlying logic of the MRP system is very sort of summarily described in this particular flow chart. What it shows is that you input the MPS, the master production schedule, the bom file, the inventory status and the lead times. So we have got all that information. Then you do what is called parts explosion. We will explain this when we come to the example and after the explosion you have to offset the requirements by lead times. So there is explosion. There is offsetting. Then there is netting. Netting means my gross requirements are hundred but I already have 20. So I need how many, 100 – 20 = 80. This is called netting. What is my net requirement? It is as simple as that and then finally you may do lot sizing of the net requirements for procurement or production.

(Refer Slide Time: 34:19)

These are the basic steps which are involved when you have to do the MRP logic, if you apply it in this particular situation. So you would begin this information from the end products. Product one and product two, we make a table like this in which we show the gross requirements. The schedule receipts, the on hand inventory, the net requirements and the planned order releases for each item. So as far as $P_1$is concerned, P_1has a master production schedule where the requirement is 50 in the eighth week and 100 in the tenth week. That is about all and nothing is available on hand. So our net requirements are 50 and 100. What we will have to do is for product one you will have to because the time required for a assembly the lead time is one week. Therefore you have to plan for order releases, one week prior to this.

That means in this period 50 and 100 here, which means that we have here, this is 50 and 100here. So what does this mean? This means we have said that our order release for these items, if we require them in the eighth and tenth period respectively must be initiated in the seventh and the ninth period and these are the quantities which we have directly. That is all. Similarly for product two, our requirements are 70, 80 and 25 in the seventh, eighth and the ninth week. Nothing is available on hand, so it directly translates into the net requirement and again the lead time required for assembly of part P_2 is one week. So you offset and hence this is called offsetting. That means this 70, 80 and 25 is offset by one week. The lead time been two weeks then you would have had to offset it by two weeks. So this process is called offsetting. You have this list here and then you say in order to meet this requirement you must plan your order releases well in time. So you place an order at this time, this time, and this time, only then you will get it here.

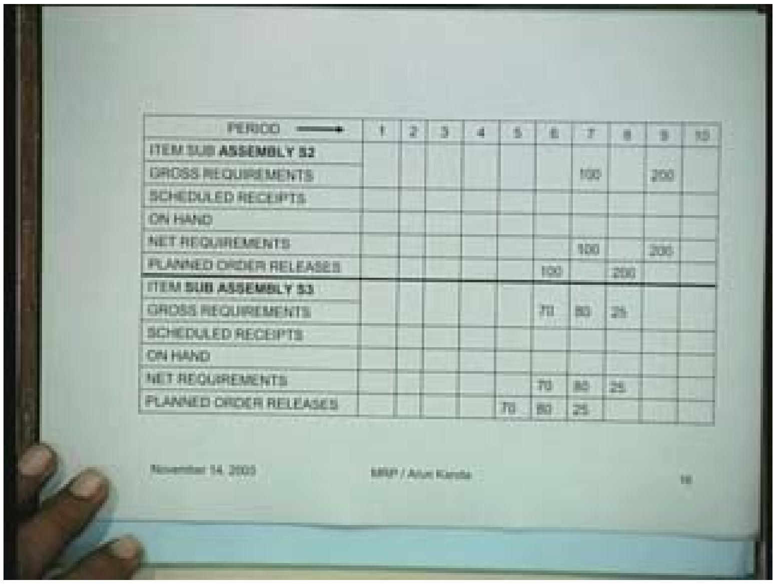
(Refer Slide Time: 37:03)



So it is like working backwards. So we have done this for requirements of product $P_1$and P_2. Now we can look for the assembly, subassembly S_2 and subassembly S_3. See what you can see is if you look at the bom, the subassembly S_2 and the subassembly S_3 is here. We will demonstrate these computations for the lowest level of only M_4 which means we will have to calculate S_2, S_3 and the various components here to be able to arrive at the value for M_4. So that is why we are illustrating how you will compute the requirements for subassemblies S_2 and S_3. How will you find out the requirements for subassemblies S_2 and S_3? Let me explain to you. This is S_2. We have already determined our requirements for part one and two units of subassembly are needed in each unit of part one. So what we will do is we will find out the requirements of part one which we have already found out and just multiply it by two. This is called parts explosion.

What we are doing is actually called parts explosion. So what happens is that you have subassembly S_2 and as far as the subassembly S_2 is concerned the product P_1which is the one that you have just computed in the seventh and the ninth period, 50 and 100 is the requirement. So what you will do is double this requirement for the subassembly S_2. So this will become 100 and 200. So that is exactly what has been done here. So the requirement for the subassembly S_2 is 100 and 200. Nothing is available on stock, so this is 100 and 200and this it has a lead time of one, so we offset it. So the moment we determine the requirements of a particular subassembly by multiplying the requirements of the previous parent product that process is known as explosion. You are actually exploding the requirements of the previous product and then finding out these values. Similarly the subassembly S_3 has these requirements. Now for subassembly S_3you require only one unit of the subassembly S_3 for each product. So these are the requirements of the parts P_2which come as it is. Then you can determine the net requirements and then you can offset it by one week, so the planned order releases for the subassembly S_3 will be 70, 80 and 25 in the period five six and seven respectively.

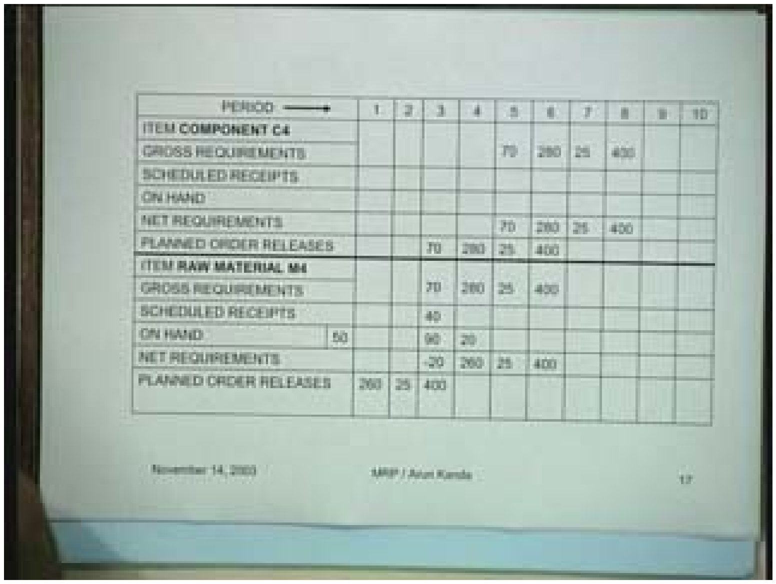
(Refer Slide Time: 40:19)



PERIOD →	1	2	3	4	5	6	7	8	9	10
ITEM SUB **ASSEMBLY S2**										
GROSS REQUIREMENTS							100		200	
SCHEDULED RECEIPTS										
ON HAND										
NET REQUIREMENTS							100		200	
PLANNED ORDER RELEASES						100		200		
ITEM **SUB ASSEMBLY S3**										
GROSS REQUIREMENTS						70	80	25		
SCHEDULED RECEIPTS										
ON HAND										
NET REQUIREMENTS						70	80	25		
PLANNED ORDER RELEASES					70	80	25			

So what we have seen is that from the original requirements of products $P_1$and P_2 we have been actually able to determine the requirements at a lower level which is the subassembly level and the two subassemblies S_2 and S_3 we have actually been able to determine from here. Now then our basic idea is that once we have determined the requirements for S_2 and S_3, we would actually like to find out the requirements for C_4 which is this component, which is common to two different products and at the same time we would then want to determine the material M_4 which will be occurring here as well as here. So when you are talking about the component C_4 the component C_4 actually indicates the concept of explosion in a much more dramatic form.

(Refer Slide Time: 41:29)



PERIOD →	1	2	3	4	5	6	7	8	9	10
ITEM **COMPONENT C4**										
GROSS REQUIREMENTS					70	280	25	400		
SCHEDULED RECEIPTS										
ON HAND										
NET REQUIREMENTS					70	280	25	400		
PLANNED ORDER RELEASES			70	280	25	400				
ITEM **RAW MATERIAL M4**										
GROSS REQUIREMENTS			70	280	25	400				
SCHEDULED RECEIPTS			40							
ON HAND 50			90	20						
NET REQUIREMENTS			-20	260	25	400				
PLANNED ORDER RELEASES	260	25	400							

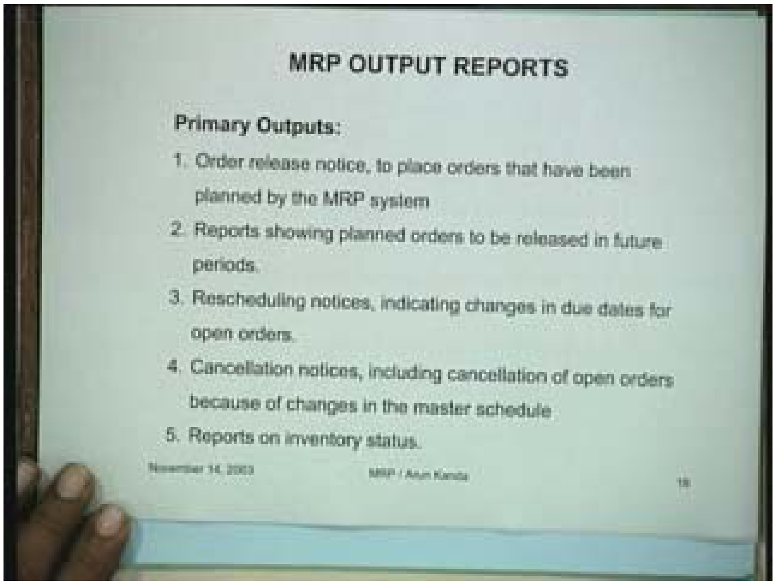
When we are trying to determine the requirements for C_4what do you see? 2 units of C_4 are needed in each assembly S_2. So we take the requirements for assembly S_2 and multiply this with two across the periods and we will get the requirement for C_4 from here but this C_4 that you are talking about here, just one unit of C_4 is needed in one assembly. So what we will do is we will have to multiply by two the requirements of S_2 and to get this particular value and then simply add this requirement of S_3 just once. This is what will have to be done. So that is precisely what is being done here. What you find is that when you take the subassembly S_3 for instance, take the subassembly S_2 and S_3. Let us put it this way. Basis is the subassembly S_2.

The requirements for subassembly S_2 are 100 and 200 directly and when you are trying to work out for C_4 you will have to multiply this by two. So when you multiply this by two you would get 200 and 400 here and then to these values you should add the requirements for the subassembly S_3 which is a simple requirement of 70, 80 and 25. So 70, 80 and 25 added to the original values of 200 and 400 will lead to 700, 280, 25 and 400. So I hope this process is clear. This is a typical process of explosion. We are finding out the requirements of C_4 from the requirements of one particular subassembly and another subassembly where this particular item is used. So you would get requirements like this and then the net requirements are the same and this has a lead time. The component C_4 has a lead time of two weeks. So we offset by two weeks. 70, 280, 25, 400, once we have determined the requirements of the component C_4 we can actually utilize this information to compute the requirements for the raw material M_4. I am coming down to the lowest level now. So what we are simply saying is that as far as C_4 is concerned this is fine and this is now how $C_4$and M_4 are placed. Each unit of M_4 is required in a unit of C_4 and here of course what is really required is that you have each unit of M_4 will be required in a unit of C_4. So what we can do is the total requirement for item number M_4 will be whatever has been computed already for component C4. So it is 72, 80, 25, and 40 and then the schedule receipts for this component are 40. We had seen that we were expecting a consignment of M_4 in the third week. This information was known. So you have this here and on hand for this item is fifty. So that means you will get ninety here and when you get ninety here what it means is that you can take care of this demand of 70 in this particular period and 20 will be carried over to the next period and when you carry this over your net requirements now will be – 20. – 20 indicate that you do not require anything because your net requirements are 70 and you have actually 90 available. So this is – 20 and then 280, you have 20 available. So 260 and this is called netting. We shall now consider net requirements and then the planned order release. This is an excess by 20. So you take it by 3 weeks because the ordering time for M_4 is 3 weeks. So we offset this. So we have 260, 25, 400 and of course this period. It would have to take into consideration because this is in excess. So this gives us the planned order releases for item number M_4.

Something similar can be done for each component. Each subassembly and each part and the information therefore that you are getting is for each component or each raw material. We are finding out how much of each of these components are required in different periods, different weeks. Similarly here, so I think that essentially gives you a summary of how the computations are to proceed in terms of the various products that we have at our disposal. Now let us try to look at the various kinds of output reports which are typically being produced by any MRP system. The primary outputs for any MRP system are actually summarized here and the first required, first bit of information that you get from this system is you get order release notice to place orders that have been planned by the MRP system. That is the first thing it tells you.

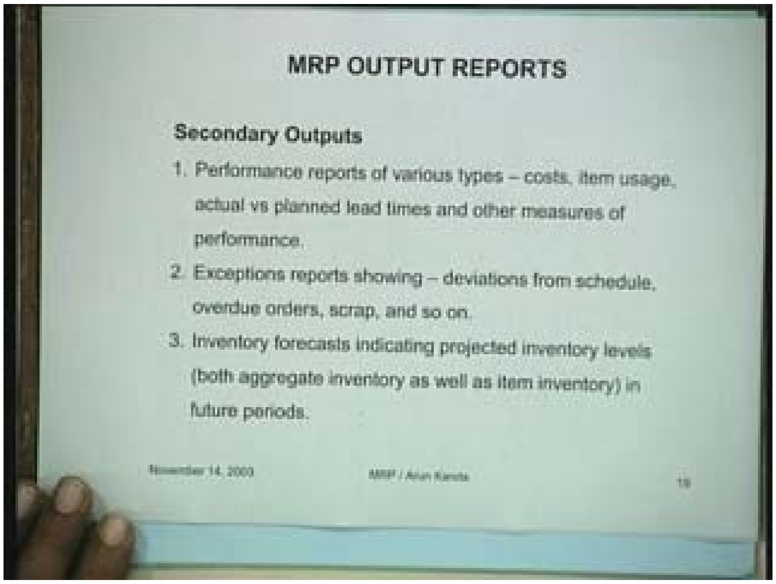
In fact it tells you how many items are required in each period. So the moment the lead times for those items have been encountered, you can automatically initiate a purchase order for each of these items and purchase an item for each of those items and especially in a situation where you have tens of thousands of items. That means automatically the computed would place an item, place an order for each of these items, whenever this is required as per the MRP schedule which is determined because this is the information that you get. You recall and that is what we mean. We ultimately get planned order releases which means for this component you need to place orders for 260 in the first week, 25 in the second week and 400 in the third week and so on. So you have this information for each item. This is something that will guide you for a material procurement and material requirement. Why is it called material requirements planning? You are determining the requirement of materials in different periods like we showed you. That is the idea is and the reports shows planned orders to be released in future periods. This can also be done because it is not only the order that you have to place but also planned orders that have to be released in the future periods. If for instance you are currently in period one, it tells you that in future periods two and three, you have to place orders for 25 and 400 of item M_4. You can have rescheduling notices indicating changes in due dates for open orders. What does this mean? What can be done is for instance, suppose there is a change in the due date of a certain orders. You wanted 20 cars in January, now you do not want 20 cars in January; you probably want 30 cars in January. So there is a change in the MPS, then again you can run the MRP system again and do this rescheduling notices which will tell you what is the additional number of items that you would require of different types in for various kinds of open orders. This information is available. Next we come to cancellation notices. If the demands are cancelled, including cancellation of open orders because of changes in the master production schedule, this can be determined and then reports on inventory status can be made available to you, directly from an MRP system.

(Refer Slide Time: 50:17)



These reports are called primary reports. Primary reports meaning that they are generally the kind of reports which are generated by any MRP system and then of course you can generate any number of secondary outputs. Secondary outputs are generally those outputs which you generate on the basis of specific requirement. So these are custom made to the requirement. If you have a certain report for instance what will happen is that performance reports of various types like costs item usage actual versus planned lead items and other measures of performance. This particular report can be generated because the data would be available in the MRP system. Exception reports showing deviations from schedule overdue, orders, scrap and so on could also be obtained from a MRP system. Inventory forecasts indicate projected inventory levels, both aggregate inventory as well as item inventory in future periods. These could be made available to you.

(Refer Slide Time: 51:35)

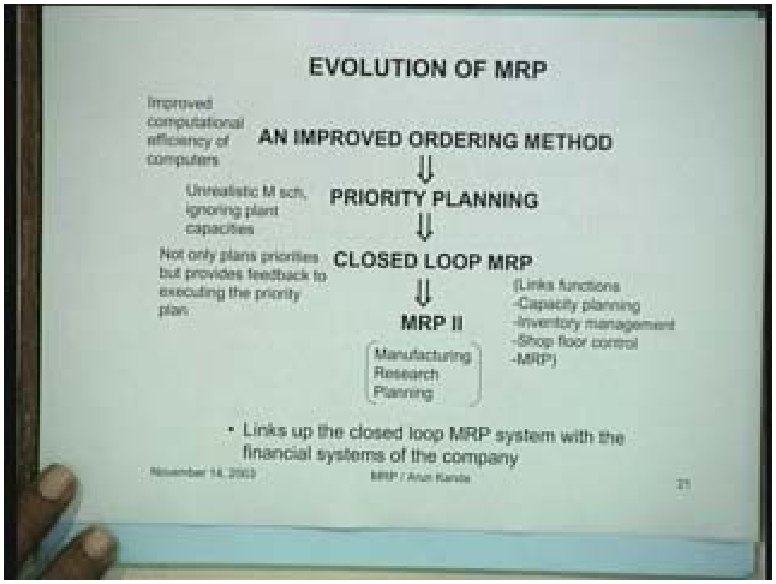


So depending upon the need you can generate a large number of secondary outputs from these ports from the system that you have. What are the typical benefits of a MRP system? You now have an idea of what a MRP system does starting from the master production schedule the bom and the inventory status and then through an example we have tried to look at how you generate the requirement of the parts in different periods. So the next thing would be, what would be the benefits of a MRP system? Some of the major benefits of a MRP system are that these are typically reduction of inventory from thirty to fifty percent in work in progress. This is what has been reported in the literature. I think this is obvious because when you are actually calculating how much you need and you are ordering on that basis. That means you are not ordering unnecessary amounts which you would otherwise have ordered. That is why there is a reduction in inventory. There is an improved customer service. Later orders are being reduced by ninety percent and quicker response to changes in demand and master schedule, greater productivity, reduced set up and product changeover costs, better machine utilization and increased sales and reductions in sales price.

(Refer Slide Time: 53:02)

When there is an increase in sales you can offer the advantages to the consumer and bring down the prices. So this has been the effect and these are some of the major benefits of a MRP system which is involved here. Now the MRP system that we have discussed is the basic system talks only about determining the material requirements that is why it is called material requirements planning. There is an evolution of MRP that has taken place. What is the evolution? The first thing that happens with a typical MRP system is that it becomes an improved ordering method. You tend to order things only when you need them. So you are progressing towards in some sense just in time. This is becoming an improved ordering method and then you can talk about unrealistic machine schedule, ignoring plant capacities and therefore you can do priority planning on that basis in the second stage of evolution. Then when you graduate further you can talk about what is called the closed loop MRP which not only plans priorities but provides feedback to executing the priority plan. For instance the major defect with the MRP system is once you calculate the material requirements you do not know whether you have the capacity to actually deal with those requirements because there was no capacity check. So here we are making those checks and ultimately in trying to integrate everything we know we come to what is known as MRP two. MRP two is actually called manufacturing resource planning. When you are talking about manufacturing resource planning, basically you are linking the various functions of the organization. Next we come to Capacity planning inventory management shop floor control and MRP, links up the closed loop MRP with the financial systems of the company. In MRP material requirements planning, we have not done any financial linkages.

(Refer Slide Time: 55:15)



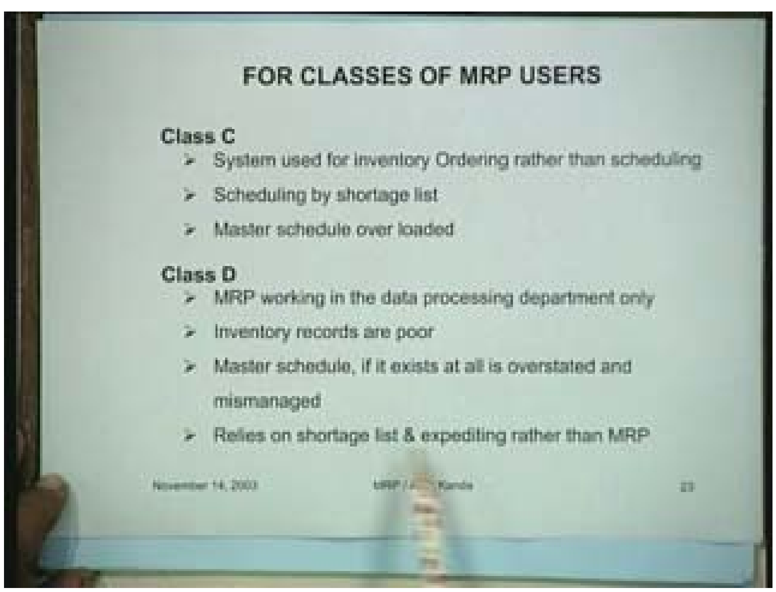
This links up the finances. So then it tells you exactly how material is flowing, at which point maximum value added is taking place and things of that kind. That would be manufacturing resource planning. So we would talk about these kinds of things.

There are typically four classes of MRP users. These are like users who become mature in the use of MRP. So the four classes are A, B, C and D. Actually you start with class D, then graduate to C, then come to b and then come to A. It is like saying if you were to practice on a PC, you would start as a D class user, then become a C class user, then become the B class user and ultimately you would become an a class user. So typically A class user which is the best would mean that you would tend to use closed loop MRP. You would have integrated systems; you would help to plan sales engineering production. So you are talking about integration of various functions and there are no shortage lists to override the production schedule. That means your production scheduling is so good that you are not deviating from the production that you have planned in class A. In class B the system has MRP capacity planning, but no vendor scheduling. Vendor scheduling is not a part of this. It is used as a production control system, needs help from shortage list inventory higher than need be.

(Refer Slide Time: 57:00)

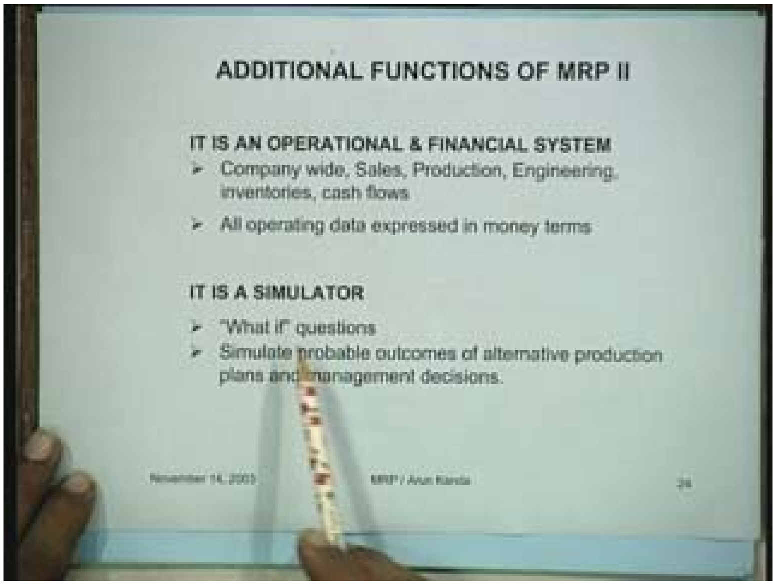
So we have not talked about integrating vendor scheduling here. That means when should which vendor place an order? Then class C would be system used for inventory ordering rather than scheduling. Scheduling by shortage list and master schedule would be over loaded and similarly the class D user would be one who is just using the MRP system as a data processing department only. Inventory records are poor and you are relying on shortage lists and expediting rather than MRP.

(Refer Slide Time: 57:37)



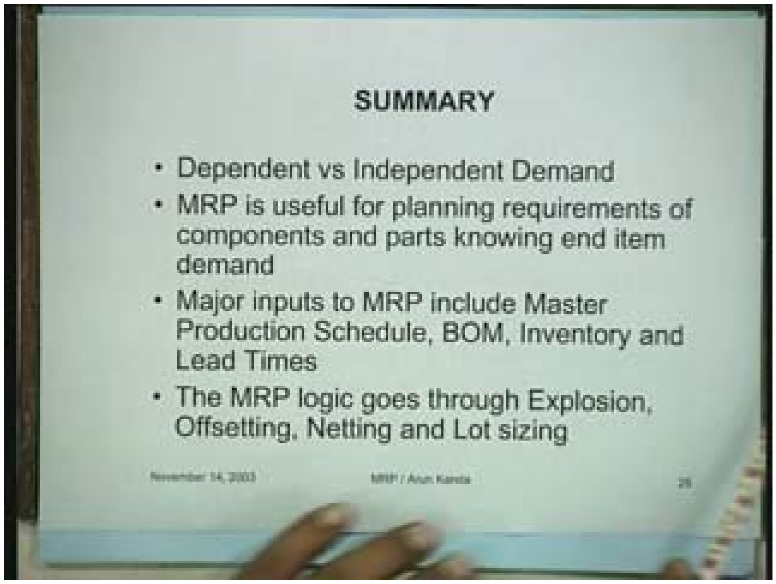
This would be the typical users for this, however when you talk about MRP 2, that is manufacturing resource planning, it is an operational and financial system which does company wide operations and it is also a simulator which means that it talks about answering a variety of what if questions.

(Refer Slide Time: 58:02)



Finally let us try to summarize what we have done today. We have seen the difference between dependent and independent demands. We have seen that MRP is useful for planning requirements of components and parts knowing end item demands and the major inputs to MRP are the master production schedule, the bom, the inventory and the lead times, that is what we saw and the MRP logic goes through operations like explosion offsetting netting and lot sizing in a bid to determine the requirements of the various parts and components which are there in that particular thing.

(Refer Slide Time: 58:40)



Finally some of the major benefits of MRP include improved planning, lesser inventories and shorter lead times. However MRP does not integrate cost functions. That is a defect and MRP two which is manufacturing resource planning links the financial functions across the organization.

(Refer Slide Time: 59:08)

We have now seen that essentially MRP systems are valid for dependent demand situations and through an example we try to show how the basic computations can be made. Thank you very much.