Production and Operation Management
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Lecture 24 - Material Requirements Planning (MRP)

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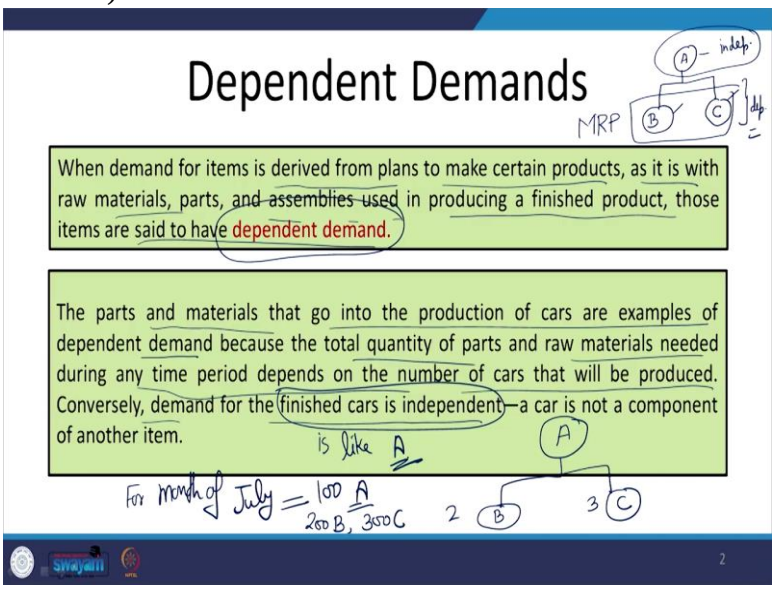

Welcome friends! So far we were discussing about inventory management models. We discussed in detail about various issues which are required in independent inventory management. Now what is this independent and dependent inventory management, that will differentiate between the policies of inventory management. That will differentiate between tools and techniques which we are going to use for inventory management.

In last 7-8 lectures, we were discussing the inventory management using P method, Q method; single time order system and all those methods were applicable for maintaining the inventory of those items which have independent demand. Now there are a lot of situations where demand is not independent. Demand is dependent on some major product and that is requiring a different type of inventory management system.

Now in this particular session, we will discuss the management of those dependent inventory systems and the title of the session is Material Requirement Planning so which is popularly known as MRP. Now the issue of MRP comes in the case of dependent demands.

Now in the case of dependent demand, you have product A and this product A uses 2 components B and C. So the demand of B and C, demand of these two, B and C is dependent on the demand of A. So the demand of A is independent and demand of B and C, these are

dependent. So in our previous discussions of 7-8 sessions, we discussed how to do inventory management of A type of items or independent items. Now in the Material Requirement Planning, MRP deals with the inventory management of these dependent inventory items.

So when demand for items is derived from plans to make certain products as it is with raw materials, parts or assemblies used in producing a finished product, those items are said to have dependent item. So demand of B and C is depending that how many A we want to have. And further the issue is that, for an example for making 1 A, you require 2 Bs and 3 Cs.

For making 1 A, you require 2 units of B and 3 units of C. So if for month of July I want to have 100 units of A, that means I want 200 B and 300 C. So the calculation that 200 Bs are required and 300 Cs are required is an example of dependent demand. So there are variety of situations we all know where any component is made of so many smaller components, so many other subassemblies are required for making a bigger assembly. So all those components, subassemblies which are used in making a final product have dependent demand. So the parts and materials that go into the production of cars are examples of dependent demand that is very common thing, that if I am thinking that how many cars will be required in a particular month, so that example is for the independent demand.

But if I am making a car and car is using 4 tires, so that is an example of dependent demand, because the total quantity of parts and raw materials needed during any time period depends on the number of cars that will be produced. Conversely, the demand for the finished car is independent. So that, this you can understand is like A. So the car is like A and various other components which are required in making a car, these are your B, C, D, E, F, G etc, etc. So that is the case which we are going to discuss in our Material Requirement Planning.

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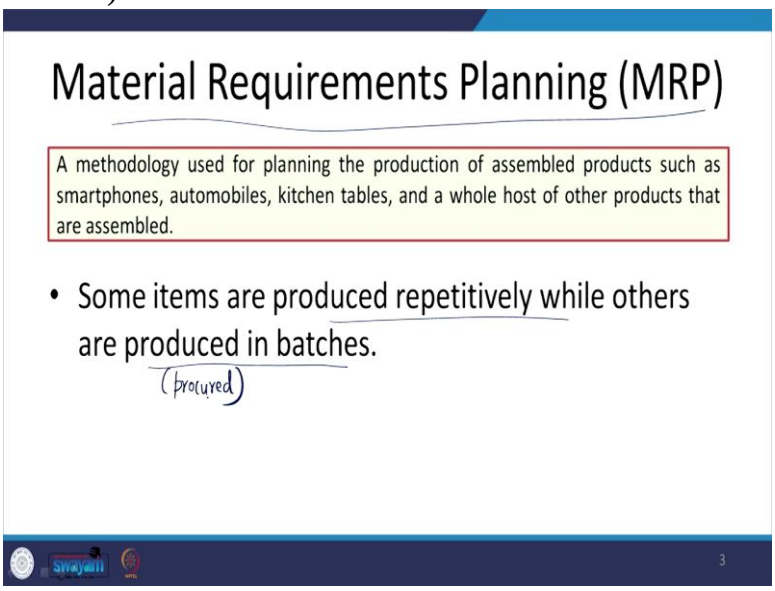

So MRP which is Material Requirement Planning is going to help us in determining the quantities or how should we manage the inventory of those items which have dependent demand characteristic. Now some items are produced repetitively while others are produced in batches. So those items for which dependent demand is there, they also have different types of characteristics. In some items, you have a regular production kind of system. So here again the inventory management will be relatively simpler.

But there are items which are to be produced or to be procured, not only produced but you can also understand that these are procured. So some of the items are procured in batches, so these items, how to procure them in batches, what should be the size of batch, what should be the frequency of that purchase, that is very much dependent upon the requirement of your final product. So that is important thing to understand. Now when we are discussing this Material Requirement Planning, it is going to give you a complete idea that what all is involved in this Material Requirement Planning.

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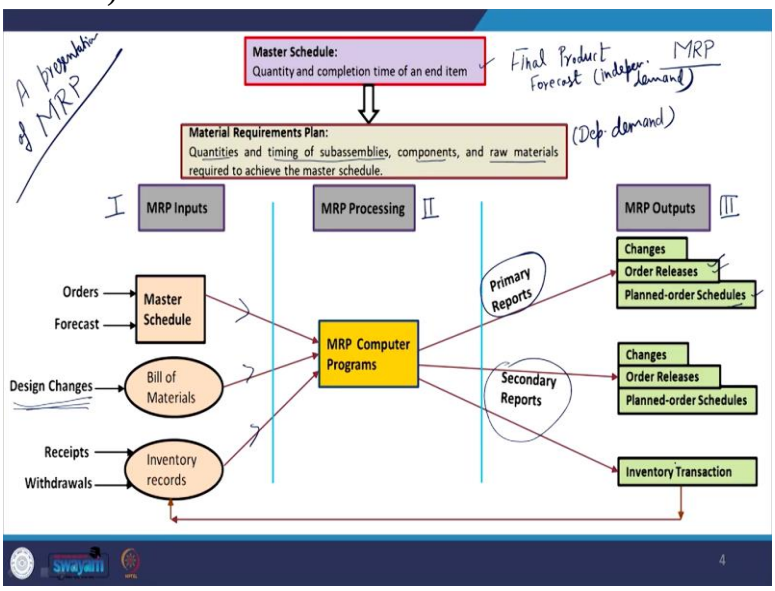

So this is a presentation of MRP. Now for MRP, you can divide the entire process into three phases. One is the input, the other is, so this is Phase 1 that is the input to the MRP, second is the processing of MRP and third is the output of MRP. So these are the three phases of material requirement planning.

Now if you just want to have a definition of MRP, so these are the quantities and timing of subassemblies, components and raw materials required to achieve the master schedule. And what is master schedule? Because these are the terms which we will be using again and again, so one term which we need to understand is MRP.

So this is the answer of two things, quantity and timing. When you want to have different types of subassemblies, components, raw material etcetera, so that you can fulfill the expectations of your master schedule, and master schedule is the quantity and completion time of the finished product. So the difference between master schedule and MRP is that master schedule is about final product or you can say master schedule is governed by the forecast. Or it is giving you independent demand pattern. And material requirement planning, it is governed by master schedule, so this is actually dependent demand pattern and you require MRP for each component separately.

If there are let us say, 10,000 components in some big assembly 10,000 components are there, you require 10,000 different MRP. For each component, each subassembly there is a separate material requirement plan.

So we will see those examples in this session but just I am giving you an idea that how this is to be used. Now the input for preparing an MRP, that is, first is your master schedule, that at what frequency how many quantities of finished goods are required, so that is one important input to material requirement planning.

The second is Bill of Material. Bill of Material is how many quantities of different type of subassemblies, components etcetera are required. So that is second important thing that component, like in the previous example, we discussed that A requires 2 B and 3 C. So if 100 A's are required, we require 200 B and 300 Cs. So that type of information is bill of material.

And the third type of information is about inventory records. That out of those 200 Bs and 300 C, it is possible that 50 B and 75 Cs are already available in my stock and maybe it is possible that I have already placed order for 50 B and 100 Cs. So there are something which is already available in stock, for something I am expecting that it will arrive in a day or two, and then I need to see how many additional units I need to order. So all that is planned receipts and planned withdrawals and planned releases are the part of your inventory records.

Then all this information, all this information is fed to the MRP computer programs. Nowadays very good MRP computer programs are available. So the entire information of your master schedule, the bill of material and the inventory records are fed into these computer programs. And from this programming, the algorithm will process it and it will produce different types of reports. And these different types of reports are the output of your MRP processing.

What are these reports? One type of report which are primary report, that is how many changes are going to have in the coming period, how many order releases you have to do? How many planned order schedules are there, that means with respect to your inventory how many new release you have to do and how many schedule you have to receipts.

Then secondary reports are also possible. Whenever there is a change in design, whenever there is a change in design, on the basis of that you have secondary reports also and secondary reports also contain the same type of thing that how many changes are there, how many order releases are there and how many planned order schedules are there. And because you are releasing the orders, you are receiving the orders also, so there will be some changes which are going to take place in your inventory records.

You will receive inventories, you will use those inventories for the final item and on the basis of that the inventory transaction reports will go to the inventory record. That will be again used as input for my further processing of MRP. So inventory transactions are separately recorded that how much order you are receiving for a particular component, how much you are using out of that, and how much is available at the end of a particular period so that for the subsequent MRP development this can be used as inputs.

So these are three different phases. You provide input in the form of master schedule, bill of material and inventory records. These are processed by some computer algorithm and then output is created in the form of various reports which will help us in updating our inventory records on one side and will also help us to achieve our master schedule, that what time, how many quantities are required of the finished goods, we will only be able to do that when at the right time our subcomponents are readily available with us. So that is in detail about various stages of your MRP. Now when we see this development of MRP, there are various benefits and some of the prerequisites for developing a good MRP system.

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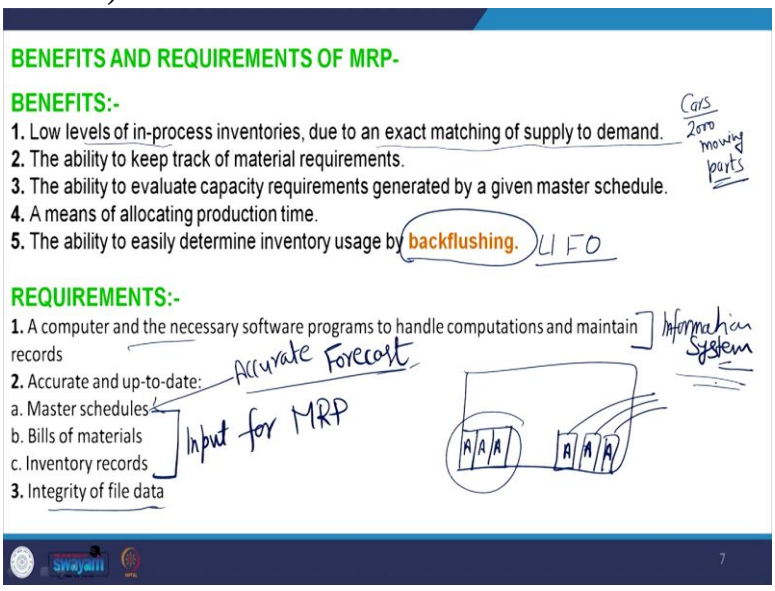

Now it will help you in achieving low level of in-process inventories due to an exact matching of supply to demand; in-process because as I say, like in an example of our current cars, somewhere around 2,000 moving parts are there. So when you are making a car, you need to have all these parts available with you, then only you can assemble a car. So you have to maintain inventory of such large number of components.

If you are not able to maintain proper inventories, maybe sometime you have excess inventory, maybe sometime you may run stock out and therefore, it will create lot of

disruptions in your production system. So by keeping low level of inventory, even then it will help you in matching the demand with supply. Then the second benefit is the ability to keep track of material requirement. So you are knowing when you have ordered and when the supply will come to you.

The ability to evaluate capacity requirements generated by a given master schedule, so depending upon the forecast and on the basis of that forecast, you convert it into the master schedule and on the basis of that how much capacity is required, that also is being evaluated regularly. A means of allocating production time that depending upon how much capacity is required from a particular machine you can use your machine's production time proper allocations. The ability to easily determine inventory uses by backflushing. Now backflushing means you can use your available inventory for fulfilling the requirement.

That is very important thing, this term backflushing, so that you are not using means, your stock is not ending into the dead stock. If sometimes it happens that whatever is coming first you start that. So many a times in our store systems we follow that Last in First out LIFO. So your stocks are like this. So many items which are coming at last, so you will start consuming them. But some item which are already there, they will remain in the stock.

So by using this concept of backflushing, we will be able to consume these items first and then we will use these items, that is possible with the help of MRP because you have very updated information about how many items are available in the stock.

Then what are the prerequisites for using MRP? The computer software programs to handle the computations and large amount of records, so one good, you can say Information System, this is one very important backbone for the success of MRP. Then you require, as these are the inputs, we have already discussed inputs for MRP, a proper master schedule and master schedule, the quality of master schedule is based on accurate forecast.

So a good forecast is required for developing a good master schedule and based on master schedule, bill of material and inventory record because developing bill of material and inventory records are very mechanical kind of activity. It does not require much of your efforts. But developing a sound master schedule is a very important thing because rest whole story is based on your ability to develop a good master schedule, and that is possible only when you have accurate forecast.

And then integrity of file data; then how you are able to integrate all these different types of data, that master schedule data, bill of material data, inventory records, so these different types of file data need to integrate with each other. Then only your computer or IS, Information System will be able to process the information available in these different files and give you the output reports.

Now once we have understood that what all is available in MRP, now let us understand that what are the different components look like. So here the first thing is the master schedule.

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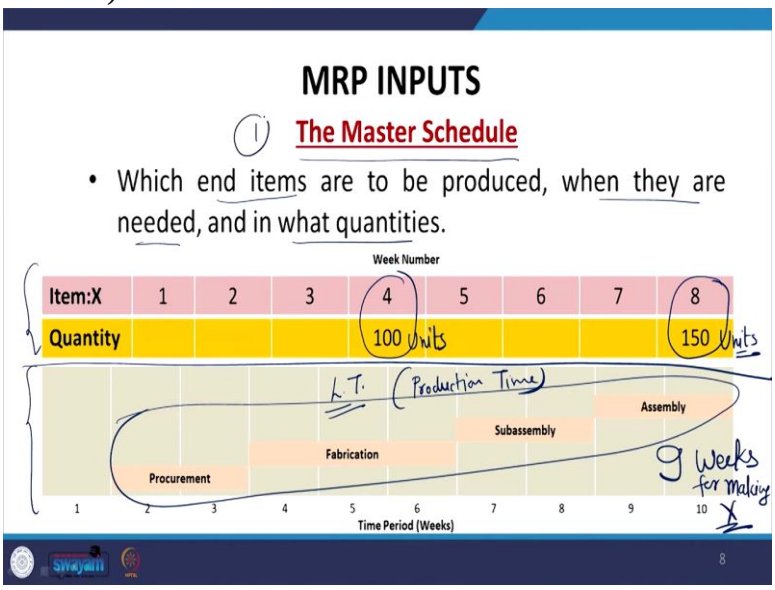

Let us see what is the shape of a master schedule. Now the master schedule is about this item X and these are about the, when they are needed and in what quantities. So here it is said that item X is required in the month, week number 4, and then in the week number eighth and these are the units. 100 units in week number 4 and 150 units in week number 8.

So here there are different types of processes which are required in making these X items, so from the procurement, then fabrication, subassembly, assembly these are different types of activities which are required for making X. Right now the, this part and this part, these are independent. These are independent but the purpose is to show you that it takes 9 weeks, 9 weeks for making X. So if I want 100 units in fourth week, I have to start this process 9 week before then only I can get these 100 units in this period.

If in eighth week I want 150 units of X item, I have to start some 9 period before then only in this period I will be able to get 150 units of item. So that will give you the idea. So you can say that this much is either the lead time or the production time. So this is one important input

for the MRP, the master schedule. The second important input, the first important input is the master schedule.

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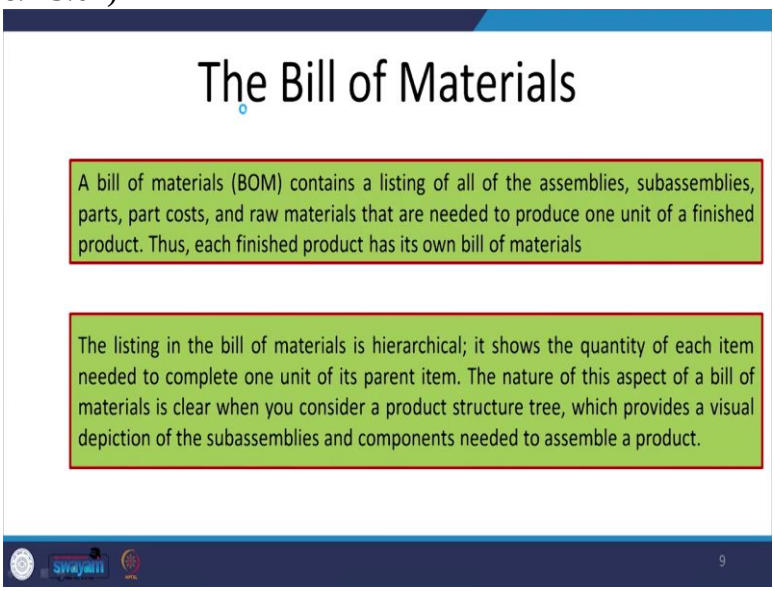

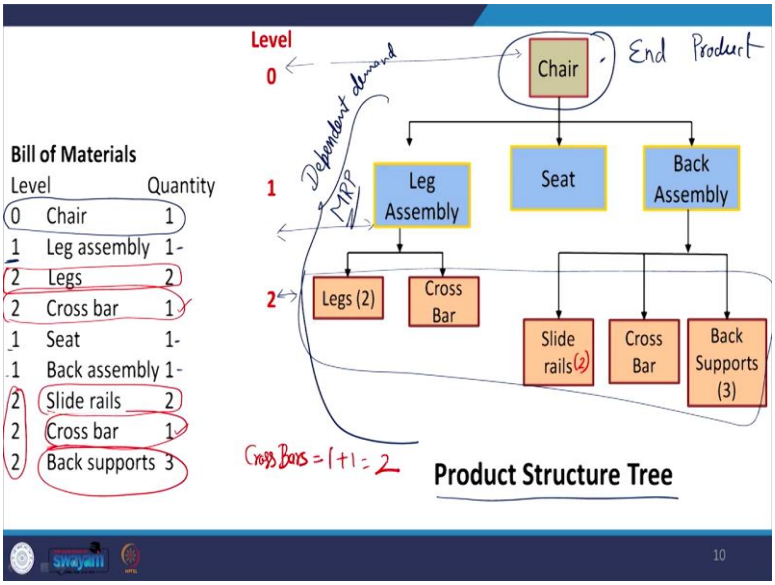

This is also MRP input and this is the second input of MRP that is the Bill of Materials. Now Bill of Material is all about how many quantities are required for making one final product. So let us see this particular example where we will also get introduced to this concept known as product structure tree, now here we have an example of chair. This chair is there. Now this chair has three main components; leg assembly, seat and back assembly. Now in the leg assembly, there are further components, 2 legs and 1 crossbar, and in back assembly we have three components; slide rails, crossbar and back supports which are three in number.

Now you see this structure is the structure of, this is the end product and all these are having the dependent demand. And for all these items we will use MRP because they are having dependent demand.

Now let us see that you can, you normally write the end product as your level 0 product, end product is as level 0 product. Now below that you have your level 1 product. So leg assembly, seat and back assemblies are your level 1 product. And below that, whatever is there, it is your level 2 product. So here you have in this particular product structure, three levels, level 0, 1 and 2. Maybe there can be further some kind of subassemblies or components that may be the part of level 3, level 4 etcetera. But in this product structure, we have only three levels; 0, 1, 2.

Now let us see the Bill of Material for these items. Now the bill of material for level 0, you see, for making 1 quantity of chair, you see leg assembly now, level 1 product, 1 leg assembly is required for making 1, and second level 1 product is seat, 1 seat is required, and 1 back assembly is required. Now coming to level 2 products, level 2 products, these are level 2 products. 2 legs are required for leg assembly. This is also level 2 product. 1 crossbar is required for level 2.

Now coming to this second product that is the 1 seat so there is no seat, there is no subcomponent of seat so there is no level 2 products below seat. Now for 1 back assembly, there are three level 2 products, then slide rails are required, 2 slide rails are required, so we should write 2 here, 1 crossbar is required, this is 1 crossbar and back supports 3, so 3 back supports so all these are level 2 products.

Now if you see that for making 1 chair, you require 1 crossbar here and 1 crossbar here, so actually crossbars which are required for making 1 chair, 1 plus 1 equals to 2. 2 legs then back supports 3, and that is how, and 1 seat; so that will be your bill of material, that how many types of components are finally required?

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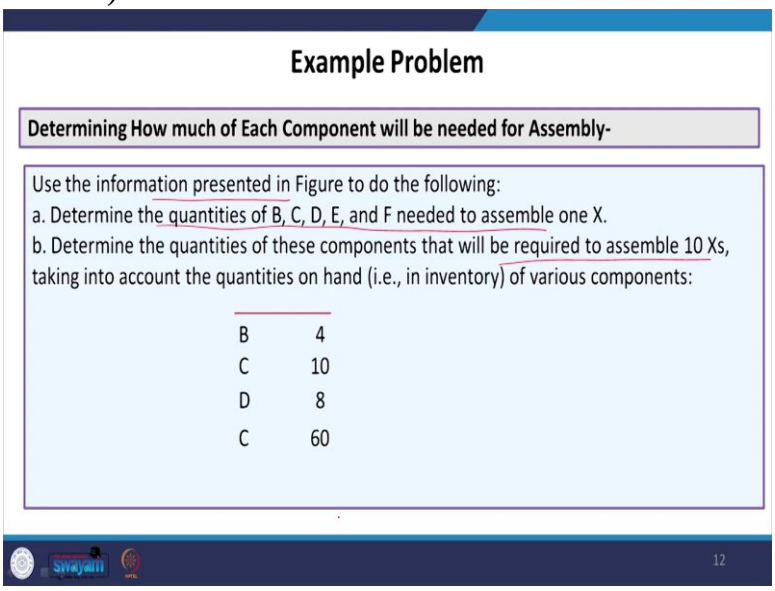

Now for this purpose that how do we determine the bill of material, we have one example problem with us and then with the help of this example we will be able to understand that how do we do this. Now using the information presented here, we need to do the following: The quantities of B, C, D, E, F needed to assemble 1 X.

So there are different types of components which we require to assemble 1 X. Now determine the quantities of these components that will be required to assemble 10 X. We need to requirement for assembling the 10 X, taking into account the quantities on hand of various components. So these are the quantities which are available in hand.

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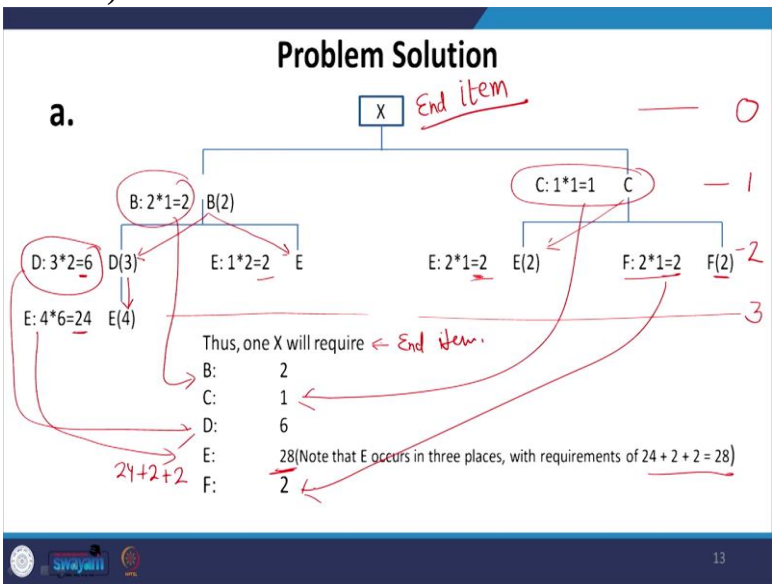

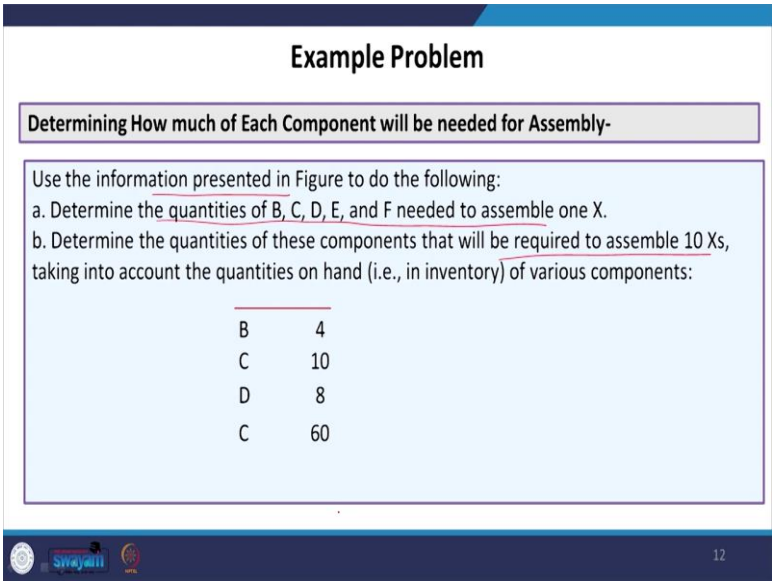

Now you see the solution of this problem and here itself you will be able to see the product structure. Now X is the end item, X is the end item and X is used, X is using B, C, D, E, F; so there are 5 different types of components which are being used by X.

So at, this is level 0, B and C these are at level 1; D, E and F these are at level 2 and this is for making D we require E, so this is at level 3. So this particular product structure has 4 levels, 0, 1, 2, 3 and now when I see the calculation, for making 1 X, 2 Bs are required. For making 1 X, 1 C is required. So for making 1 X, 2 Bs are required. So 2 into 1 equals to 2. 1 C means 1 into 1 equals to 1.

Now for making 1 B, 3 Ds are required. For making 1 B, 3 Ds are required. So for making 2 Bs, 3 into 2, 6 Ds are required. For making 1 B, 1 E is required. So for making 2 B, 2 into 1, 2 Es are required. Now for making 1 D, 4 Es are required. So for making 6 Ds, 4 into 6, 24 Es are required. Now coming to this side, for making C, 1 C, 2 Es are required. So 1 into 2, 2 Es are required. For making 1 C, 2 F are required, so 2 into 1, 2.

So now if I summarize the bill of material, you say that for 1 unit of X end item, how many B, this information is coming here, 2 Bs are required. Then how many C, 1 C, how many Ds? 6 Ds, now you see how many Es? 24 plus 2 plus 2, so 24 plus 2 plus 2 that is 28 E. And F that is 2. So that is the total bill of material for making 1 unit of A, X, you require 2 Bs, 1 Cs, 6 Ds, 28 E and 2 F.

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Example Problem

Determining How much of Each Component will be needed for Assembly-

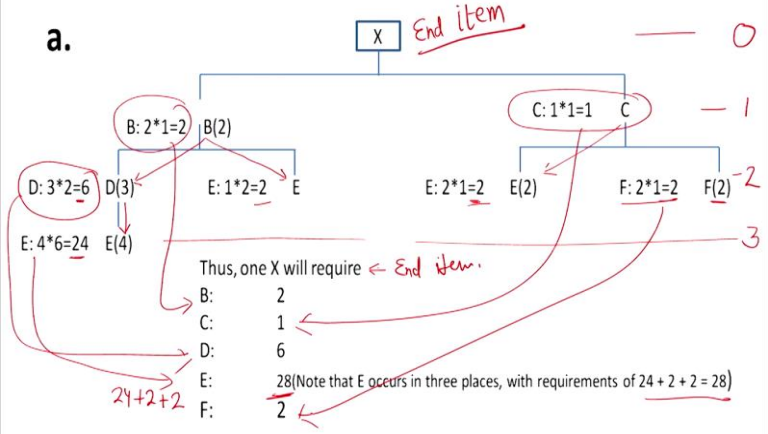
Use the information presented in Figure to do the following:
a. Determine the quantities of B, C, D, E, and F needed to assemble one X.
b. Determine the quantities of these components that will be required to assemble 10 Xs, taking into account the quantities on hand (i.e., in inventory) of various components:

B	4
C	10
D	8
E	60

12

Problem Solution

a.



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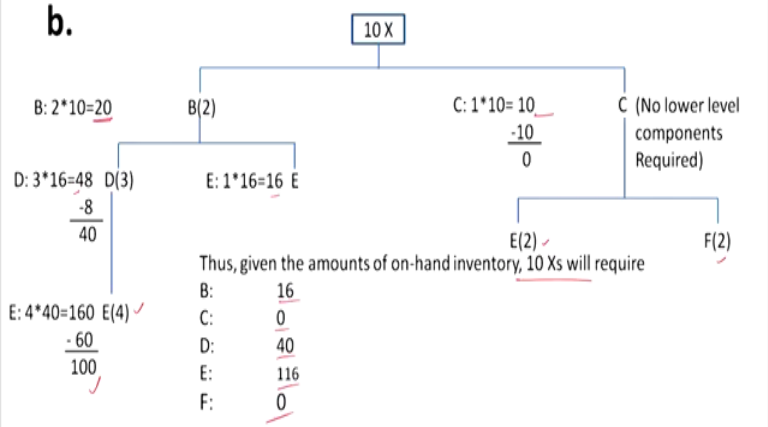
Problem Solution

b.



14

Now the question says that we need to make 10 units of X. We need to make 10 units of X, so you can multiply all these components by 10, and then you see how much inventory is available for these different components, and that, so for making 10, you require different components. So for this purpose it is 20, it is 10, it is 48, it is 16, it is again given E and F, and this is 160 and so on. So here you will see that since already with you, 10 Cs are available. If you see the data, 10 Cs are available with you.

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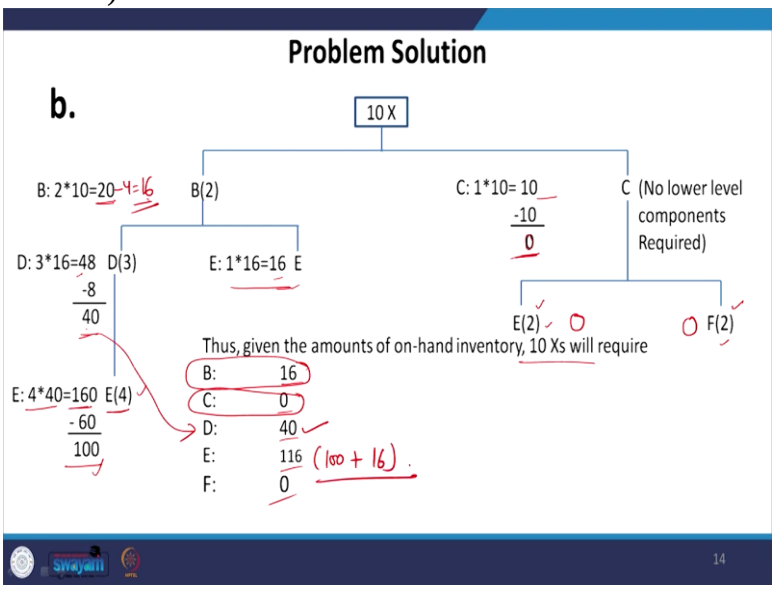

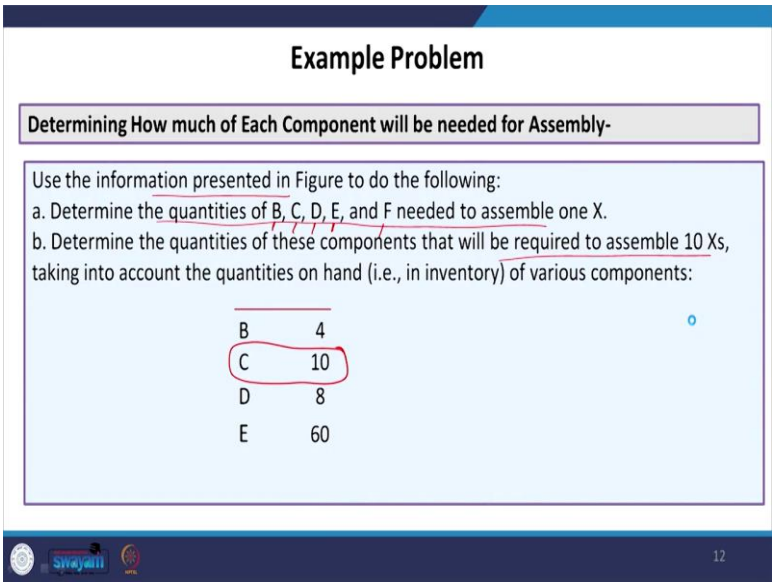

So when we are seeing the availability of C, 0 Cs are required. So when no C is required, these Es and these F will also not be required, because these Es and Fs are required for making this C, so here also it will go to 0. Now coming to this side as per the data we have 4 B available with us.

We have 4 B available with us, so 20 minus 4, you require 16 B. C already we have done 0, so 20 minus 4 equals to 16. Then you have 48 D required, you have 16 into 3, 48 D which are required and 48, out of that if you see the data, 8 Ds are already available so you require 40 D. This calculation gives you 40 D. Since each B require 1 unit of E, so 16 B will require 16 E. Here 1 unit of D requires 4 units of E, so 40 will require 40 into 4, 160 E and already 60 Es are available with you. So you see these 60 Es, these are E.

You will subtract these from here so 100 Es. So 100 plus 16 this is 100 plus 16. So with this the final requirement of various components are available to us. So this is a very useful tool for developing our dependent inventory management system. There are more input which are required particularly in the form of inventory records and then we need to see how it is processed, that all we will discuss in our coming session. Thank you very much.