

Production and Operation Management
Professor Rajat Agrawal
Department of Management Studies
Indian Institute of Technology, Roorkee
Lecture 25 - Improvements in MRP System

Welcome friends! In our last session, we started discussions about dependent demand management and we discussed the concept of Material Requirement Planning that how material requirement planning which is known as MRP will help us in managing the inventory of those items which have the characteristic of dependent demand. For your benefit we will quickly brush our discussions.

MRP has three important phases; the input of MRP, then the processing of MRP data and then the output in the form of different reports. We discussed that three different elements are used as input to the MRP. We discussed about master schedule. We discussed about bill of material, and when we were discussing about bill of material, we also discussed about product structure or product tree diagrams. Based on that, we are able to calculate that how many units of different type of subcomponents are needed.

We did some examples also. And the third is inventory records. Inventory record is about, if you remember in the last example, we have a particular situation where some X items are to be made and X are components of, for that B, C, D, E, F and we already had some inventory available with us in our stock. And then the final calculation was affected because of availability of those inventory in our stock.

Particularly if you recall, the discussion of C items where only 10 C items were required, and for making a C, we already know that some E and some F are required. But since only 10 Cs were required and all those 10 Cs were available with us in the stock so there is no need of further calculation of E and F.

So it is very important that we do that calculation in the diagram itself. Because when we do this calculation in the diagram, we can actually visualize what is happening. If we do this calculation independent of diagram, there are chances of making mistakes. So important thing is that we need to have a proper input system and we already discussed that out of three, we can do calculations very easily for bill of material and inventory records. But the whole success of MRP depends upon the accuracy of your master schedule, and for that purpose good forecast is very much necessary.

If you have good forecast available with you, you can do proper MRP planning and that is going to be further discussed in our today's session, that what additional we can do in MRP and how the reports of MRP look like.

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MRP PROCESSING

MRP processing takes the end item requirements specified by the master schedule and “explodes” them into time-phased requirements for assemblies, parts, and raw materials using the bill of materials offset by lead times.

- MRP processing combines the time phasing and “explosion” into a sequence of spreadsheet sections.

The diagram illustrates the MRP process flow and product structure. On the left, 'MRP Input' includes 'MPS', 'BOM', and 'Inv. Records'. An arrow labeled 'Processing' points to the middle section, which shows 'Output' for 'July' and 'April', with 'E' and 'Feb.' noted below. On the right, a product structure tree shows 'X' at the top, branching into 'B' and 'C'. 'B' branches into 'D' and 'E', while 'C' branches into 'E' and 'F'. A note indicates '28 Es' at the bottom right. A circled '1' is in the top right corner.

Last class we discussed about the input side of the MRP. Today, we will see the other side of MRP also. Now the remembrance you had that three important phases, MRP input where we discussed the use of master production schedule, bill of material which is known as BOM also and third is inventory record. So these three things are used for input purpose then processing and then output. These are the three stages in our MRP discussion.

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Because final product is X if you remember the last example; this X is made of B, C and B is made of D and E. D is made of E. C is made of E and F. So this type of product structure was there. Now for making 1 unit of X, we require some different units of Ds, Es, Fs etcetera.

You remember in our last case for making 1 unit of X we require 28 Es and these 28 Es are again required at different time because the assembly of E and F requires for C. Assembly of E is required for making D and D and E are required for making B. B and C put together are required for X. So maybe depending upon the lead time of E, if I want product X in July, it is quite possible that I have to start working on E in the month of February.

Then only I can deliver X in the month of July because so many intermediate products are there which are required for making final X and for making those intermediate products E is required, so each of them will also take some time. So E when comes in February, then maybe in the month of April I may start making B which will be completed, let us say in the month of May or June and then my X will be delivered in the month of July.

So I have to explode, I have to explode the information available to me with respect to time and with respect to quantities for each of subcomponents. That is the processing part which we will do with the help of these three information, MPS, BOM and inventory records.

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Week Number	Beg. Inv.	1	2	3	4	5	6	7	8
Item: ✓ Part No.									
Gross requirements		-	-	-	-	400			
Scheduled receipts			100						
Projected on hand				100	100	100			
Net requirements						300			
Planned-order receipts						300			
Planned-order releases				300	0	0			

Now this is how the sheet look like. Here what does you have? These are the items for which item you are talking. So normally in our setup we give components a particular number. So you know each item with its part number. So all these components B, C, D, E, F etcetera, are not used in the industrial setup.

In industrial setup we use part numbers. Then these are the important entries in the MRP output. What is the gross requirement? What is the scheduled receipts? Because when you are starting your work, some orders are already placed. Some orders are already placed, we assume in that way. So when those orders are going to be received, in which particular period, first, second, third, fourth, fifth, sixth, eighth, so you have a very long kind of table and in that maybe some order which you have placed already will be arriving in the second week or in the fifth week, so you know that this much quantity will be available to me on this particular week.

Projected on hand; so based on that you will see that how much will available in your hand. Then what is your net requirement? Now since you are already getting something, there is some your gross requirement, so what is now finally your net requirement? So your receipts on hand that will decide that how much additionally you will require. So gross requirement minus projected on hand will give you net requirements.

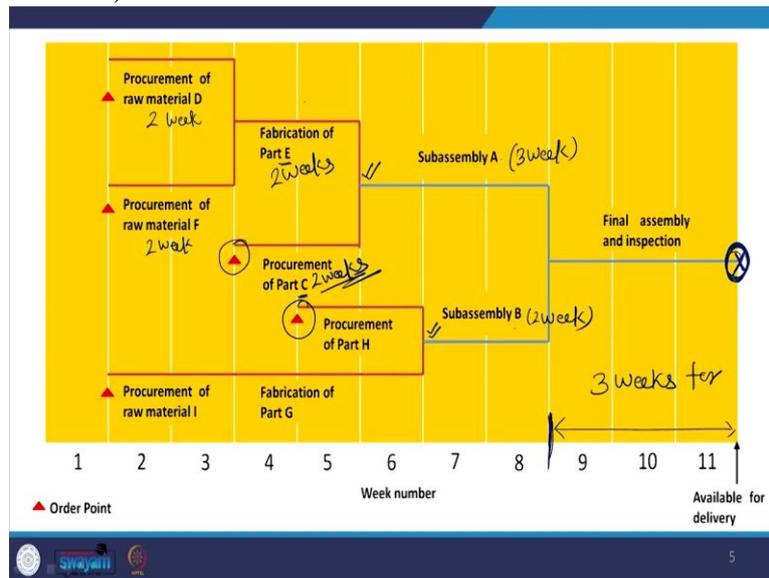
Then based on net requirement you will give planned-order release and planned-order receipts. So for an example, you have, I just give you some data so that you can understand that how we are going to have it. For example, your gross requirement is 400 unit in fifth period. There is a scheduled receipts for 100 items in second week. So in the second, third week projected on hand will be 100 units. That will continue in the fourth week also. Now for this fourth week, this 100 will again go into the fifth week.

Net requirement for the fifth week is 300 units. Net requirement for the fifth week, because your gross requirement in the fourth week there is no requirement in these periods. There is requirement in these periods. You require only 500 units in the fifth period, only 400 units and projected on hand in that fifth period will be 100 units and net requirement therefore becomes 300 units. So you have to receive 300 units on this particular day. Then only you can fulfill the requirement of 400 on fifth week. Maybe it takes 2 week to make these items, or to procure these items.

So you have to give your order in such a manner that it takes 1 week, second week and in the third week it is available to you. So that is the planned-order release. You have released order on the third week and this order will be received by you on the fifth week because the net requirement was 300 units and therefore you will be able to fulfill the gross requirement of 400 units.

Already some scheduled receipts were there. Therefore, your net requirement became 300 units. If there is no scheduled receipts this net requirement would have been 400 units and then your planned-order release would be of 400 units. So this type of information will be the part of your MRP output.

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So here you see that how things are happening in the form of diagram whatever I just explained you that there is a particular component and this is the final assembly and inspection and here at the end of eleventh week, at the end of eleventh week this is available for dispatch. Here it is available for dispatch.

This is your product X. This is available for dispatch at the end of eleventh week. Now when you are giving the order for various components and, you see it is taking 3 weeks for final assembly and inspection. So once subassemblies A and B are available to you, once these 2 subassemblies are available to you at the end of eighth period or in the beginning of ninth period then you took 3 weeks time for final assembly and inspection of X item.

Now assembly A is taking 3 week, assembly B is taking 2 week. Now for us it is very important, if I want to start the assembly of my product X on the ninth week, if I want to start the assembly of my product at the ninth week, I must start assembly of product A on sixth week and assembly of product B on seventh week.

Otherwise for an example, if I start assembly of A also on the seventh week, it will delay the assembly of my entire product by 1 week. If I start assembly of B on the sixth week then it will unnecessarily be available to me for 1 week because my A will not be readily available. So it will be waiting, and that is a cost.

So I have planned in such a manner that it is starting here. I am putting 2 right signal so that I can indicate that these 2 items are from the same level but they have different lead time. They have different production time, therefore the starting time of their subassemblies are different.

One is starting at the beginning of the sixth week; another is starting at the beginning of seventh week.

Then come to another components. Subassembly A is made of E and C. Subassembly A is made of E and C. Now E and C, you see both these are taking almost similar time, 2 weeks. Both these components are taking 2 weeks time. So you have ensured that both these items fabrication E and C starts at the beginning of fourth week so that at the end of fifth week or in the beginning of sixth week, you can start assembly of A.

Now coming to D and F. D and F again takes 2 week in procurement because E is made of raw material D and F. And for the procurement of D and F, 2 weeks are required. So I have started ordering of these 2 or the process of purchasing these 2 items at the end of first week and at the end of third week D and F are available to me so that I can start fabrication of E.

Then comes the H. H is to be procured from outside. It takes 2 week time. Now I have delayed the order, I have delayed the order of H by the end of fourth week because there are two other parts. One is G and for making G, the raw material I is required. Unless until G is available, I cannot start this assembly of B. I can do the order of H maybe at the end of first week or second or third, but deliberately I am doing the ordering of these 2 parts C and H at different times so that my cost of inventory is less.

So I am placing the order of different types of parts to be procured at different times so that my inventory holding cost is low, and therefore, you can see from this diagram that how I have arranged various orders and fabrication work in my shop floor so that everything is available at the time when I want it.

And this is actually the explosion of, explosion of your Master Schedule into the Material Requirement Planning and this is done on the basis of time fencing also, that which item requires how much lead time, which item requires how much time to procure. On the basis of that this entire diagram is being prepared.

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Terms Used in MRP Processing

for each item

- Gross requirements
- Scheduled receipts
- Projected on hand
- Net requirements
- Planned-order receipts
- Planned-order releases

	1	2	3	4
G.R.				
S.R.				
P-on H.				
N.R.				
Receipts (Planned)				
Release (Planned)				

So once we have understood this particular diagram and based on the figure which we have table, you can now understand that we have this kind of tabular arrangement and in this tabular arrangement, we have different types of things which are required. So these are the periods 1, 2, 3, 4 etcetera. The first row has the gross requirement.

How much is required, so that was the quantity of your item which you are discussing. So for each item, for each item you have to have a, for each item, so if there are 7 components in your assembly so you will have 7 such tables, one for each. So first table will have gross requirement, second row will have scheduled receipts then projected on hand, then your net requirement, planned-order receipts and release planned. So these are the various terminologies which we will be using in developing our MRP output.

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Example Problem (1)
MRP schedule with lot-for-lot ordering-

Week number	Beg. Inv.	1	2	3	4	5	6	7	8
Quantity					100				150
Shutters: LT = 1 week	Gross requirements				100				150
	Scheduled receipts								
	Projected on hand								
	Net requirements				100				150
	Planned-order receipts				100				150
	Planned-order releases			100				150	
Frames: LT = 2 weeks	Gross requirements		200				300		
	Scheduled receipts								
	Projected on hand								
	Net requirements		200				300		
	Planned-order receipts		200				300		
	Planned-order releases			200				300	
Wood sections: LT = 1 week	Gross requirements		400				600		
	Scheduled receipts	70							
	Projected on hand	70	70	70					
	Net requirements		330				600		
	Planned-order receipts		330				600		
	Planned-order releases			330				600	

Now if I see this particular example, it will give us a very good understanding about this working of MRP system. Now here you see that master schedule for a particular product. Now for this product in the fourth week, fourth week you have the requirement of 100 units. In eighth week, you have the requirement of 150 units. Now it will be, it will be transferred into different kind of subcomponents. This is the final requirement that 100 and 150.

Now for this 100 and 150 in this, this is first period, second period, third, fourth, fifth, sixth, sorry, there is some issue with respect to naming of, so this is 1, 2, 3, 4, 5, 6, 7 and 8. Now for the shutters the lead time is 1 week. For the shutters, lead time is 1 week. Now you see in this first particular part, this much part is for one component, there is no scheduled receipts. All these are blank. So there will not be any projected on hand also. So finally, the net requirement will be 100 in the fourth week and 150 in the eighth week. So you want to have 100 on the fourth week and 150 on the eighth week.

Since the lead time is 1 week, you will place an order, you will place an order, this is planned-order release based on your requirement in the fourth week. In fourth week, you are requiring 100 units. So you will place order in the third week. In eighth week, you require 150 units, so here you will require, you will place order for 150 units. So whatever you are requiring in a particular month, in a particular period, based on the lead time, suppose in this case we have taken 1 week as the lead time. But if lead time would have been 2 weeks, I will place order here and for this, here.

So it depends. If LT is 2, if LT is 2, right now I have taken LT as 1 week so these are the placed in third and seventh week. Now for shutters the component which is required is frame. That may be level 1 component. Now 2 frames are required for 1 shutter, 2 frames are required for 1 shutter, 2 times, 2 times.

So because we want, we want 100 in third week and 150 in the seventh, so automatically this will become the gross requirement of shutters in third and seventh week respectively. Two times is required because 1 unit of shutter requires 2 frames. So I have the gross requirement of frame in third week as 200 and in seventh week as 300.

Now for making this 200, again there is no planned schedule receipts. So there is no projected on hand. So net requirement is also coming directly from here and here as it is. Then the planned-order receipts I want 200 in the third week and 300 in the seventh week. Now the lead time is 2 week. So here I can write lead time is 2 weeks. Lead time is 2 week.

So what I want in the third week, I will place order for that in the first week. What I want in the seventh week, for that I will place order in the fifth week. So I will place order in the first week and in the third week for my frames so that these frames are available to me in the third week and then only I can make my shutters because the order for shutter is in the third week.

Now for making shutters I also require some wood. So the units of wood which are required are 4 times than the number of shutters. So this is also my level 1 requirement. So 100 into 4, because 4 time is the requirement of wood so 400 units are required in the third week and 600 units are required in the seventh week.

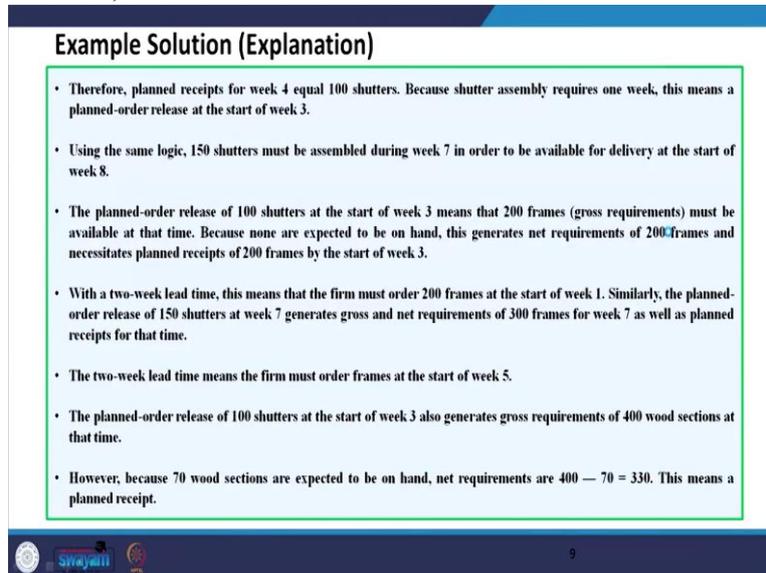
Now lead time is 1 week. Here I have some; here I have some planned receipts already. So 70 units are going to come to me on first week. 70 units are going to come on first week. So 70 units will become projected on hand at the end of the first week. These 70 will continue in the second week also, 70 will continue in the third week also.

Now in the third week, my gross requirement was 400 units. So out of 400, 70 units are already available because I have some scheduled receipts. 400 minus 70, my net requirement becomes 330. So 330 I want to have in the third week. The lead time is 1 week. So I will place order of 330 units in the second week, and these 330 will be received by me in the third week. And similarly, now I have already exhausted whatever was projected on hand.

So I do not have anything after this. I want 600 units in the seventh week. So 600 will come here and therefore planned-order receipts will be 600. Lead time is 1 week so I will place the order of 600 units in the sixth week so that these quantities become available to me in the seventh week and then I will use them for making 150 units of shutters which required in the eighth week.

So this is how you can explode, you can develop as many rows depending upon how many components are there in your end product. So in your end product in this particular case, we had 2 components, frames and wood. Different lead times were there and accordingly, we have planned them so that when my final requirement is there, I should be able to fulfill that final requirement.

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Example Solution (Explanation)

- Therefore, planned receipts for week 4 equal 100 shutters. Because shutter assembly requires one week, this means a planned-order release at the start of week 3.
- Using the same logic, 150 shutters must be assembled during week 7 in order to be available for delivery at the start of week 8.
- The planned-order release of 100 shutters at the start of week 3 means that 200 frames (gross requirements) must be available at that time. Because none are expected to be on hand, this generates net requirements of 200 frames and necessitates planned receipts of 200 frames by the start of week 3.
- With a two-week lead time, this means that the firm must order 200 frames at the start of week 1. Similarly, the planned-order release of 150 shutters at week 7 generates gross and net requirements of 300 frames for week 7 as well as planned receipts for that time.
- The two-week lead time means the firm must order frames at the start of week 5.
- The planned-order release of 100 shutters at the start of week 3 also generates gross requirements of 400 wood sections at that time.
- However, because 70 wood sections are expected to be on hand, net requirements are $400 - 70 = 330$. This means a planned receipt.

So this is the explanation of what we have already discussed. So I think we need not go into this discussion of explanation of this example but this you can read because it will help you in understanding that how these calculations are made.

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Example Problem (2)

Juno lighting makes special lights that are popular in new homes. Juno expects demand for two popular lights to be the following over the next eight weeks.

	WEEK							
Part No	1	2	3	4	5	6	7	8
VH1-234	34	37	41	45	48	48	48	48
VH2-100	104	134	144	155	134	140	141	145

A key component in both lights is a socket that the bulb is screwed into the base fixture. Each light has one of these sockets. Given the following information, plan the production of lights and purchases of sockets.

Inv Record	VH1-234 ✓	VH2-100 ✓	LIGHT SOCKET ✓
On Hand	85 ✓	358 ✓	425 ✓
Q	200 (the production lot size)	400 (the production lot size)	500 (purchase quantity)
Lead time	1 week	1 week	3 weeks
Safety stock	0 units	0 units	20 units

Similarly, we can have another simple problem where we have these two products and these are the weekly requirement for these two popular type of lights. These are the part numbers as I told you, that everything will be written in the part number basis; so 34, 104, 37 and so on for 8 weeks.

Now a key component in both lights is a socket that the bulb is screwed into the base fixture. Each light has one of these sockets. Given the following information, plan the production of lights and purchase of sockets. Now VH1-234 and VH2-100, both these have some quantities available to you in stock, 85 and 358, and both these lights use a particular type of socket. And you have some, so this is, you can say, is your inventory record. Now you have some quantities, the production lot size of these are, means whenever you are going to order, you will order either 200 units or 400 units. And light sockets you will purchase in the 500 units.

Lead times are also given, 1 week, 1 week and 3 week. The safety stock we have already discussed in our independent inventory system that safety stock is required for meeting the fluctuation. So safety stock conditions are also mentioned that for first type of model no safety stock is required, for second type of model again no safety stock is required but for light socket you want to maintain a safety stock of 20 units.

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ITEM		WEEK							
		1	2	3	4	5	6	7	8
<i>I</i> VH1-234 Q=200 LT=1 OH=85 SS=0	Gross requirements	34	37	41	45	48	48	48	48
	Scheduled receipts	-	-	-	-	-	-	-	-
	Projected available balance	85	51	14	173				
	Net requirements	0	0	27	0				
	Planned-order receipts	0	0	200	0				
	Planned-order releases	0	200	0					
<i>II</i> VH2-100 Q=400 LT=1 OH=358 SS=0	Gross requirements								
	Scheduled receipts								
	Projected available balance								
	Net requirements								
	Planned-order receipts								
	Planned-order releases								
<i>Socket</i> SOCKET Q=500 LT=3 OH=425 SS=20	Gross requirements								
	Scheduled receipts								
	Projected available balance								
	Net requirements								
	Planned-order receipts								
	Planned-order releases								

So for this we can have this type of table. We can have this type of table where you see we have 3 important components. The first item, the second item and this is socket. So for all of these we have same lines, gross requirements, schedule receipts, available balance, net requirement, planned-order receipts and planned-order release.

So all these same components are available for, all 6 lines are available for all these and you need to know that how much you will like to have here. So for that purpose, to start this discussion, like 34, 37, 41; So here you write 34, 37, 41, 45, 48, 48; 45, 48, 48; 45, 48, 48, 48, 48. Now the on hand inventory is 85. Available balance is 85 on day 1, there is no schedule receipts.

So net requirement is 0 here, 0. Now from 85, you have consumed 34 in the first period. So the remaining will be available here; so 51 minus, 5, 4, 1; 8, 3, 5. Again, there will not be any requirement and there will not be any receipts for this matter.

Now from 51, you will consume 37; 14. Now you see, 41 is the requirement here, 41 is the requirement here, 14 is already available to you. So you require 27. Net requirement is 27. You want to have 27 available to you here. Now you see that lead time is 1. Lead time is 1. But there is one more problem given to you. That the order quantity or production quantity should be 200 units. So though you require 27 but you will be giving an order of 200 units. So in place of 27 you will receive 200 units here.

You will receive 200 units here and then out of 200, 27 will be consumed in this particular week, and the remaining, that means 173 will be available to you on the subsequent week and

then there will not be any requirement, 0, 0, 0 and further, you can consume from this 173 and you will go like this. So whenever there will be a requirement, you will order 200 units.

Similarly, now I request all the participants to complete, this is the lower part of this table, please complete. So this is kind of an assignment for us to complete this table and the screen shot of this you can share on the forum so that we know which solution is correct.

We will also upload but we will upload at the end, before that I request you that please upload this screenshot of this table after completing this table on the forum. So this will give us good idea that how MRP tables are prepared. So we close this session with this example. Thank you very much.