**Principles of Industrial Engineering**
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**Lecture No. 22**
**Plant Layout: Process Layout Design II**

Hello, I welcome you all in this presentation related with the subject Principles of Industrial Engineering, and you know we are talking about the Plant Layouts. In the Plant Layouts we have seen that there are different types of the Plant Layouts, like the Process Layout, product layout, fixed layout, cellular layout, and a combination layout. We will be, we have talked a little bit about the way by which the process layout can be designed. And we will be looking into the further details related with the designing of the process layout.

Thereafter, we will see that how a product layout can be designed. We know that in the process layout, the facilities are arranged or clustered or grouped according to their functions. And in this case, we do not consider which type of the product will be processed through the facilities and that is why the movement of the material through the facilities with the change of the designs, with the change of product keeps on changing. So, because of the changing movements of the material through the different facilities, different resources, different work centres, there is no fixed path for the flow of the machines.

And therefore, it becomes important to see really what can be done as far as the arrangement of the machines and facilities is concerned. So that the extent of movement, across the centres can be reduced, which maybe in form of movement of the material or movement of the manpower, etc. So, what we do basically, we try to understand and estimate the kind of interactions which will be there across the facilities, and those interactions are quantified in terms of the number of the movements desired, and also the kind of the distances which are to be travelled.

Once we get the idea about that it becomes easy us, it becomes easy to come out with the kind of the designs that can be proposed and developed for the process layout.

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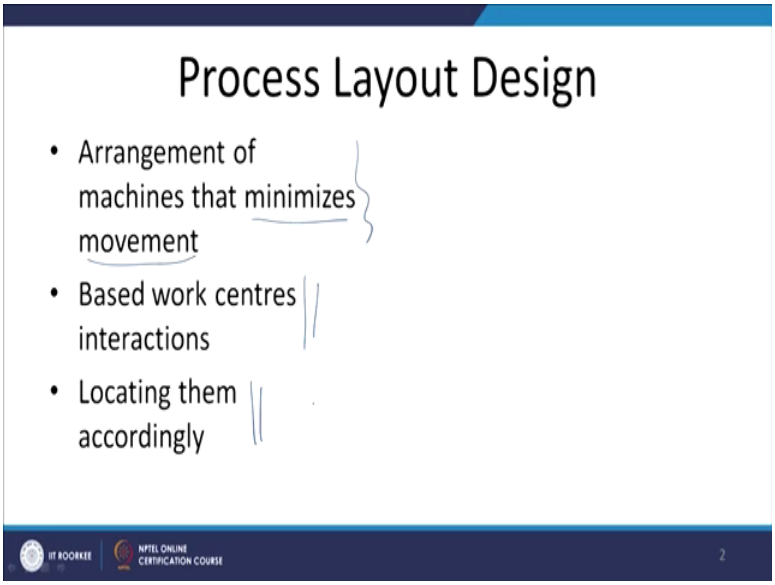


In general, if we see the general approach in the process layout design is that, we have to see that how the machines will be arranged so, that the movement, extent of the movement or the material handling which is to be carried out is reduced. And this will be based on the kind of interactions or the extent of movements which exist along with the distances to be travelled during the production process. And we will be locating these work centres and facilities, in such a way that the distances to be travelled, and the movement, and the material handling can be reduced.

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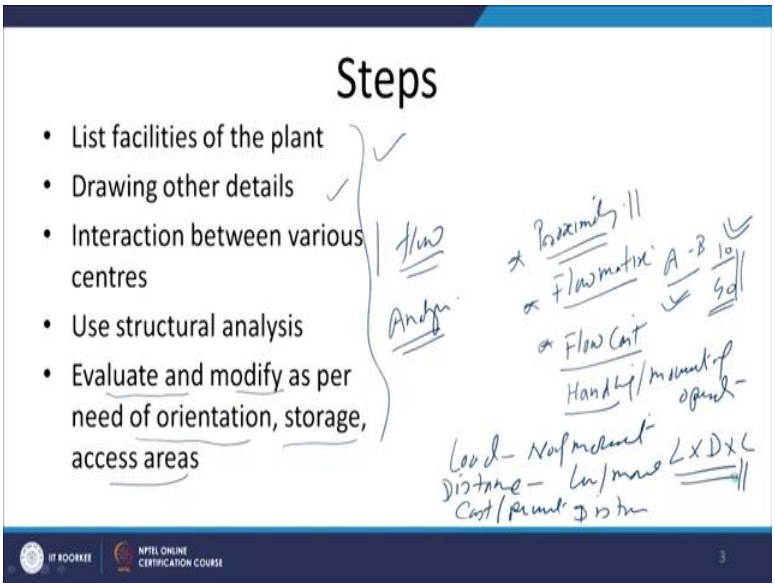


And for this purpose, we follow certain steps as I have already talked about, that what are the facilities we want to establish, what are the drawing details along with the area required to

accommodate these facilities, the kind of interactions which means the kind of flow which existed between the various facilities and the centres during the production process. And analysis of this information to see really how the things can be arranged so, that the distances to be travelled, and the cost coming on account of the cost, on account of the material handling is reduced.

So, whatever after the analysis layout is proposed that is evaluated to see its effectiveness and if desired, it is modified. And at this stage only, will keep in mind if there is any specific orientation requirement, or space is required, or special access areas are to be given. We have seen that, analysis of the information about the kind of flow which exists across the centres. There are 3 approaches which are used in the, in the process layout design.

One was the proximity analysis, about which we have already talked, this is based on the kind of the affinity or the closeness which is desired between the 2 work centres to, next to, so, that they can be placed close to each other or they can be placed apart from each other. So, it is a like qualitative assessment of putting the facilities close to each other. Then there was flow matrix preparation, flow matrix preparation, a flow matrix gives us the idea about the extent of movement which exist in terms of the numbers. Like frequency of movement between the 2 stations A and B is, it is 10 or 90.

So, that will be indicating the extent of movement which exist. And if the movement between the 2 centres is too high, irrespective of the distance efforts are made, to put them close to each other. So, in this approach we do not consider the distance to be travelled, in this approach primarily the frequency of the movement is considered, for seeing the possibility if they can be brought together.

And next is the kind of the flow cost approach, which considers like the what kind of the cost that will be occurring on account of the handling or the movement, handling of the material or movement of the operator. So, for this what we consider, basically we can consider the kind of load which is basically in terms of the number of the movements required, and then kind of the distance to be travelled.

So, the second parameter here is, the distance to be travelled, it is less or more. And then third aspect here, is the cost per unit distance, cost per unit distance. So, these 3 things are considered. So, what we will be doing, the load into the distance into the cost, these 3 things

will be multiplied for, to see what will be the kind of the cost that will be occurring if the facilities are arranged in a particular fashion.

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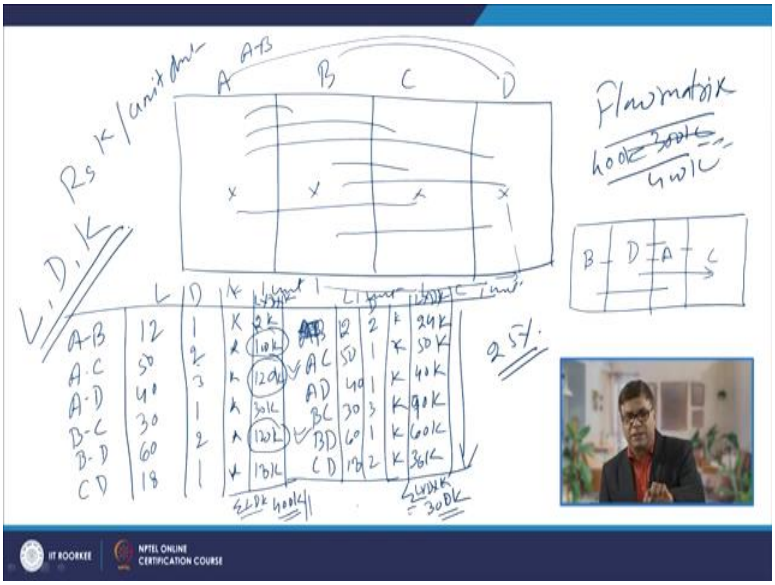


So here, I will be taking up one particular example, according to this example like say, the layout of the facility is like this. Where in there are 4 work centres, like A, B, C, and D, like A, B, C and D. This is the current layout and the extent of movement which exists between them obtained from the flow matrix, analysis is coming out like this. So, that is what we can make in tabular form. Like A to B movement, movement between the A, movement between the A and B work centre is of the, that we can write like a load, in terms of the frequency which is indicating the kind of the extent of movement which is desired is12.

Then say, so A to B movement is 12. And then say, A to C movement, A to C or C to A movement is 50, A to C or C to A movement is 50. Likewise, A to D or D to A movement is like say 40. So, these are like say A to B are the adjustment work centres, and A to C and A to D are like C and D, with respect to A are the non adjacent work centres. And these L is indicating the kind of the movement which is desired.

Then, if we consider B to A, B and A, this is what we have already seen then. B to C movement, B to C movement, B to C movement these are adjacent centres and the frequency of the movement is say, 30. And B to D movement or D to B movement either way, it is B to D or D to B it is 60, it is. So, very highest movement here it is showing the B to D movement. These are also non adjacent work centres, these are not located next to each other. Then, the

C to D movement or D to C movement. These are also the adjacent, these are the adjacent work centres and the load or the frequency of the moment is 18.

If we assume, that the distance between the centre to centre distance between these work centres is of the same. Like say A to B distance is of the 1 unit, likewise B to C is another 1 unit, C to D is again another 1 unit right. So, in that case, A to B distance is, so here what we will write distance A to B is 1 unit. Then A to C is, will be 2 units like this. So, here 2 unit distance. A to D will be 3 unit distance, B to C will be 1 unit distance, and then B to D 2 unit distances, and C to Do is 1 unit distance.

And if we determine the, like say if the cost, distance cost on account of the distance to be travelled per unit length, is say C or K we can write anything. So, say if the write K is the, the cost in rupee K per unit distance. Then that we can simply multiply K here with all these parameters, it can be one or anything else also, we can assume suitably. So, our the value which will come out like, load into distance into the cost per unit distance K. So, here it will be 12K first, then 100K, 12, 12 into 1 into K 12K 50 into 2, that is 100K.

Then, 40 into 3 into K 120K, then 30 into 1 30K, then 60 into 2 into K 120 K and 18 into 1 18K. So, our sum of all these load into distance into the cost per unit length, will be coming out say 400K. So, in this setup when the facilities are arranged A, B, C, D in sequence, the kind of the cost that will be occurring in this layout, on count of the all types of the movement that is coming say 400K.

If this arrangement is shifted little bit and the shift is made differently like the work centres, which are having the high load into the distance values, they can be brought close to each other or those work centres which are causing higher cost, they can be brought close to each other. So, if we see this data the centre A and D, the cost is 120K and the centre 120D, centre B and D. These are also non adjacent centre B and D, and A and D are the non adjacent centres and causing very high cost 120K each, in both cases. So, now efforts can be made we will be identifying those centres, which are causing higher cost first and the efforts are made to bring them closer.

So, that the cost on account of the movement can be reduced. Next, after this the non adjacent centre A and C also causing the high cost like 100K. So, now, first of all we will be bringing the, these centres which are causing the higher cost and they will be brought close to each other by making them adjustment work centres. So like say, if we propose in the modified

form, if the, if the layout is a redesigned in such a way like first of all, we have the B work facilities, then we have the D work facilities. So, that B and D which were causing the 120K, the cost on account of the movement has been brought close to each other.

And then, D and A are also non adjacent centres and causing the high cost of 120. So, like say it has been brought next to the D and thereafter will have the C work centre. So, the centres which are causing the higher cost like A and C, were causing the high cost of 100. So, they have been brought next to each other, D and A were causing the high cost of 120. So, they have been brought next to each other, likewise B and D.

So, now, the kind of the movement that we have between, now the movements will, the extent of the, the distances to be travelled, load will remain same but the distances to be travelled will get modified. Like say, A and B, the load, load is how much. Now, A and B, the kind of movement which is needed for A and B, the distance to be travelled between A and B is of the 2 units. Or we can, maybe we can, let us say. So, here A and B, AC, AD, these are the kind of movements which exists BC, BD, and CD, these are the different movements.

So, in the revised setup, AB movement is of the 2 units' distance. The load that exists of the 12, load is 12, AC 50, AD 40, BC 30, BD 60, and CD18 movement. Then the kind of distances now, because of the revision of the layout distances to be travelled will get modified. Like B, AB distance now has changed from 1 to 2. And AC distance, AC distance has reduced from 2 to 1. AD distance now, from 3 to 8 has been reduced to 1. BC has been increased to from 1 to 3. And A to BD distance, distance between B and D has been reduced from 2 to 1.

And CD distance, distance between the C and D work centres has been increased from 1 to 2. So, 1 to 2 D to, A to D to A to D is 1, like this. Now, if the, the cost per unit distance is same K in all the cases. Then product of all these 3 load into the distance into the cost, that will be giving us the different quantity. So, 12 into 2 into K 24K 50 into 1 into K 50K 40 into 1 into K that is 40K 30 into 3 90K 60 into 1 60K and then 12 into 2 then 36K. So, sum of all this load into distance into K, for this will be coming out like say 300K. So, if we see this sum of all this will be 300K.

So, there is reduction of the like say, 100K minus 300K divided by 400K. So, this will be causing the reduction in the cost by 25 percent. So, significant improvement will be there with the revision of the layout. So here, the consideration of the frequency of the movement,

the kind of the distance to be travelled, and the cost that we have to pay for per unit distance to be travelled, consideration of have all these three factors in development of the process layout will in general help us in reducing the costs required on account, the cost will be incurred on account of the movement between the different work centres.

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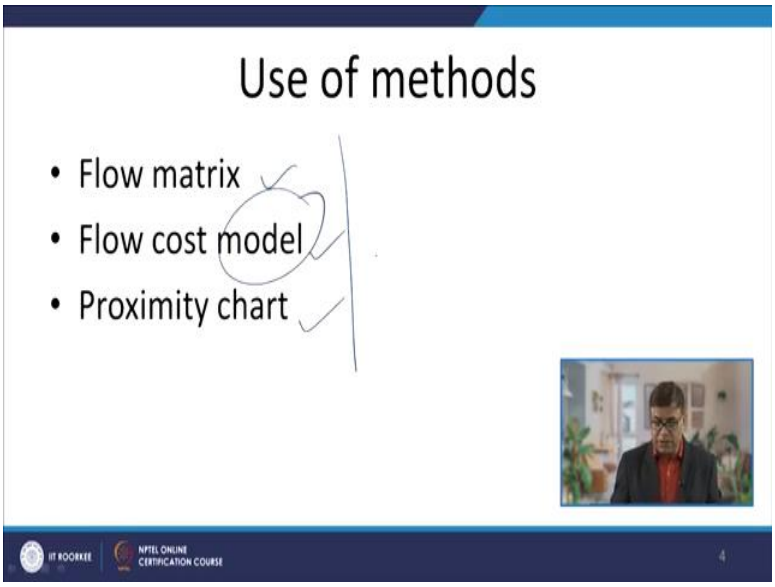


So, related with this only I will give the another example. Like about these methods, we have already talked like flow matrix, flow cost models. So, just now I have talked about the flow cost model and the proximity chart about this I have already talked.

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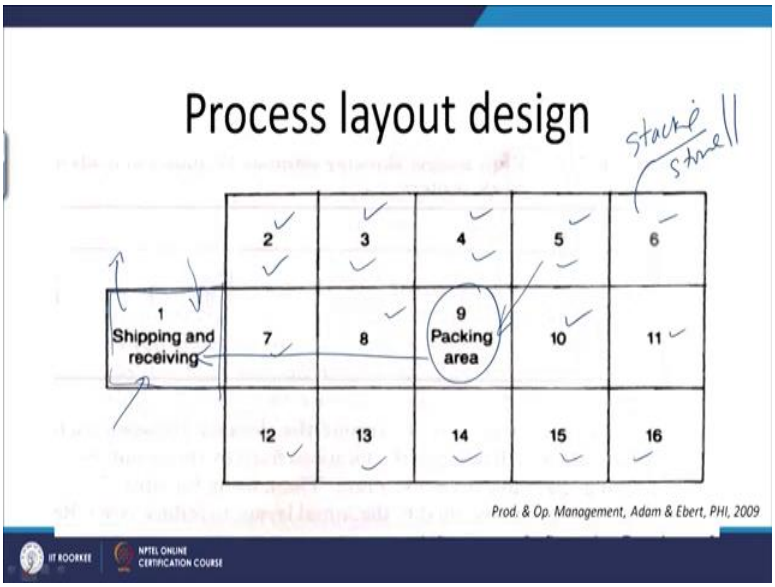

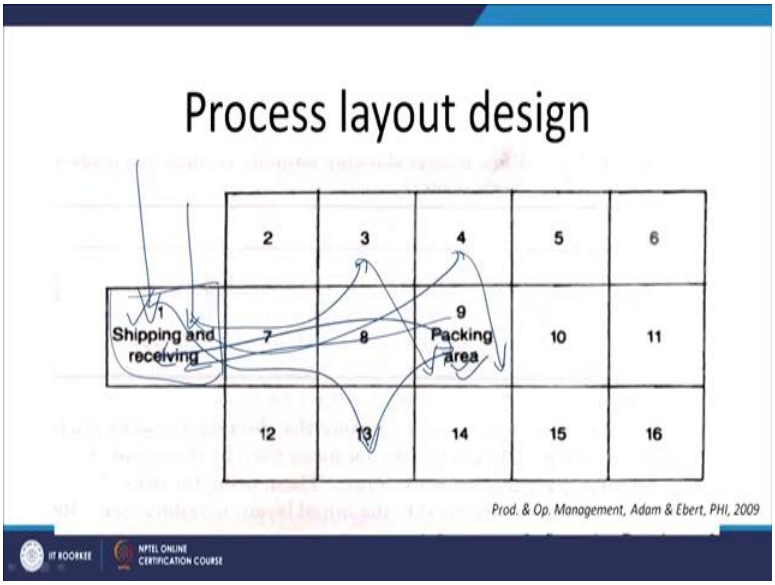


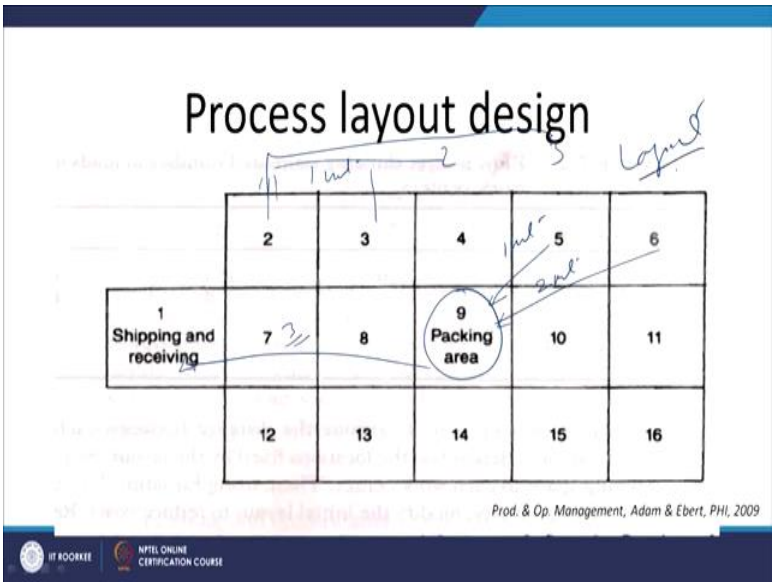


Let us take another example related with this. Like say, this is the area where area 1 where the material is received and it is dispatched or the shipped from here. And the other areas like 2, 3, 4, 5, 6 through 7, 8, this is the packing area. 10, 11, 12, 13, 14, 15, 16 all these are the stores or the stacking locations or the store locations. So, what is done normally material is received, and it is staged at these stores, and then it is brought down and abroad for shipping. It is taken from these stores brought to the packing area, here they are packed and then transported to the area 1 for shipping.

So, it goes in very simple way. I will explain here the kind of movement which exist, like the material is received then it is stacked different stores. Whenever the order is received material is taken out from these stores, and then brought to the packing area, from packing area material is packed, and then it is brought to the again section, area 1, where from it is

shipped. So, this is the kind of movement, material is received, then it is stored, then it is brought to the packing area, from packing area brought to the area 1, and then it is shift.

So, this is the kind of the existing setup, which, in this existing setup say inter centre distance is like equal to the 1 unit. So, 1, 2, 2 to 3 distance is 1 unit, 2 to 4 distance is 2 units, 2 to 5 distance is 3 units, like this. But what kind of movement that we are having, like we are from the stores, the material is brought to the packing area 9. So, if it is brought from the store 6 to the 9, then the distance to be travel is 2 units. If it is, if it is brought from the store number 5 then distance to be travelled is 1 unit.

And when the material packed at the packing area 9 and brought to the store 1, the distance to travel is 3 units. So, like this the distance to be travelled are counted. So, now here it is just showing the current layout.

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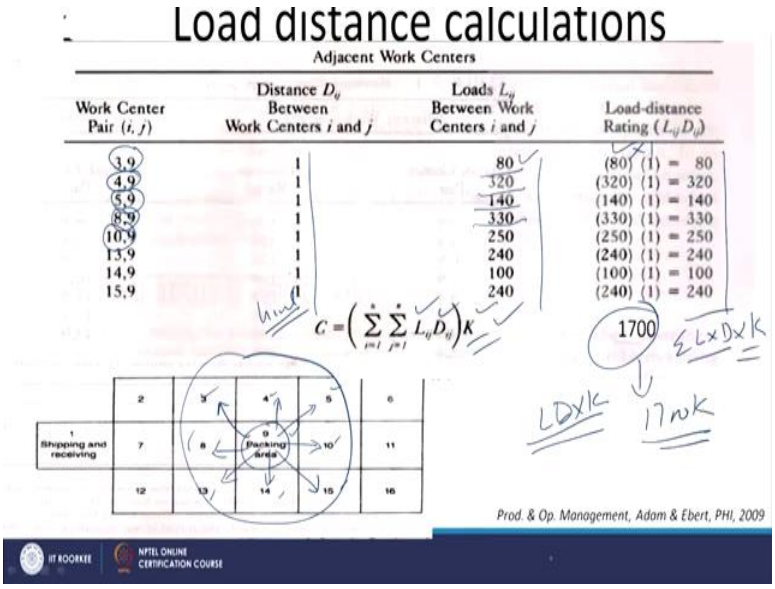


Now, if we see the kind of the movement which is needed between these centres and the packing area. So, what we consider here, like the adjacent work centres load is considered first and non adjacent work centres load is considered later. So, what are the adjustment centres, like about the packing area 9 adjusting centre is this 4, 9, 5, 15, 4, 13, 8, and 3. So, these are like say, what is the movement from 9 to 3, 4 to 9, 5 to 9, 8 to 9, 10 to 9. So, all these 3, 4, 5, 10, 15, 14, 13 and 8 these are the adjacent areas.

The distance to travel here will be minimum. So, what we do, the distance to be travelled say in all these cases, these are the adjacent centres, so, we will consider that distance is of 1 unit only. Now we will see, what is the kind of the load which is being transported from the

different stores 3 to 4, 5, 8, 13, 14, 15 and 10, to area 9. That is shown here 8 like 9, 3 to 9 is the 80 load, 4 to 9, 320 load, 5 to 9, 140 load, 8 to 9, 330 load. Likewise, the different loads, which is generally observed the kind of movement which exists between the centres and the, between these stores and the packing area is here.

So now, the load into the distance is multiplied what we get, load into the distance that all these are a adjacent center. So, they are multiplied by the 1 unit distance. So, what we will be having, this value and sum of this will be giving is the load into distance only. If we multiplied with sum cost K, cost K on account of the distance to be travelled per unit area. Then it will be giving us like so, the L into D into the K cost per unit, which is constant. So, the load or the costs or can say, the load into distance into the cost for adjacent centres in this situation is coming out to be 1700K.

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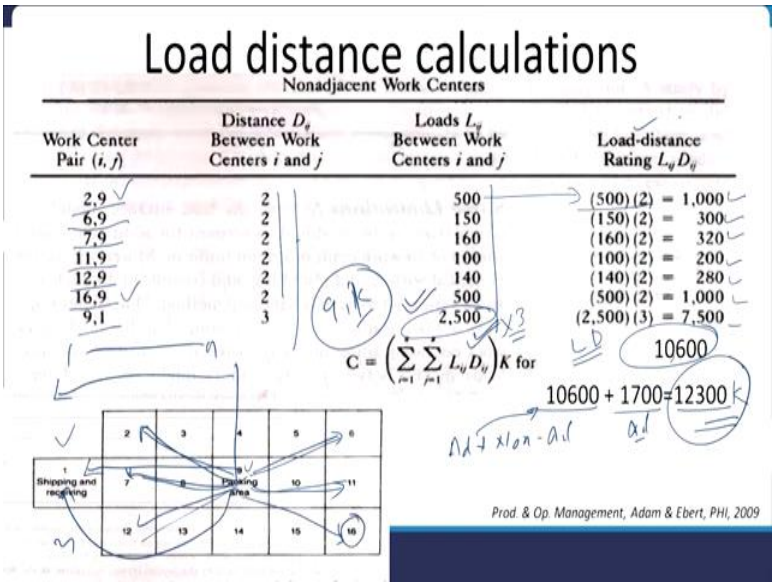

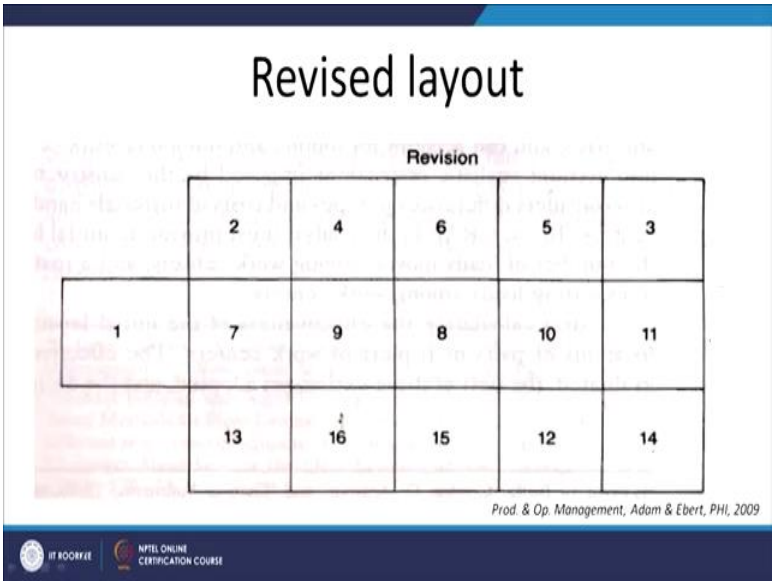


Now, if we consider the nonadjacent centres which are located far apart. Like say nonadjacent centre is, 16, 11, 16, 6, 11, 16, then 2, 7 and 12. So, now again we will be considering the kind of movement which exist from 2 to 9, 6 to 9, 7 to 9, 11 to 9, 12 to 9, 16 9 and 9 to 1, 9 to 1 movement is also a non adjacent work centres movement. And so here in all these cases, like say, the distance to be travelled in case of the 9 to 1 is 3. While in all other cases, the distance to be travelled is to only like 9 to 16, 9 to 11, 9 to 6, 9 to 11, 9 to 16 or 9 to 2, 9 to 7 or 9 to 12.

In all these cases, distance to be travelled is 2 only. The 3 unit distance is travelled, to be travelled for all movements from 9 to 1. So, these are the distances to be travelled from the, from the different stores to the packing area, and then from one packing area, packing area 9 to the shipping area and this is showing the kind of the load which exists.

So, whatever is packed has to be transported to the shipping area 1, that is why this value is extremely high and the distance to be travelled is also maximum for this case. So, if we consider the load into distance rating for this situation, so 500 into 2 that is the load into the distance which is 1000, then 13 and 300, 320, 200, 280, 1000 and 7500.

So, the load into the distance, some of this for all non adjacent centres is coming 10, 6, 100, 10600. And if we sum up the cost occurring on account of the adjacent centres and a nonadjacent centres. In that case, it will be like 10, 600 plus 1700 which was for the adjacent centres and this was for non adjacent centres. So, it is coming 12300K. So, this is the kind of the total cost in the current scenario of the layout.

If we see, if the considering the total cost which is coming maximum for non adjacent centres 9, 1 this is one thing. 9, 1 movement, 9 to 1 area, movement is maximum. So, we will be thinking of to reduce this value. Thereafter, the other movements like then 2 to 9 and the 16 to 9 movements are also high. So, we will be making efforts to reduce the, to move or relocate the centres which are non adjacent and having the high load in terms of the frequency of the movement. So, in the revised the layout since the 16.

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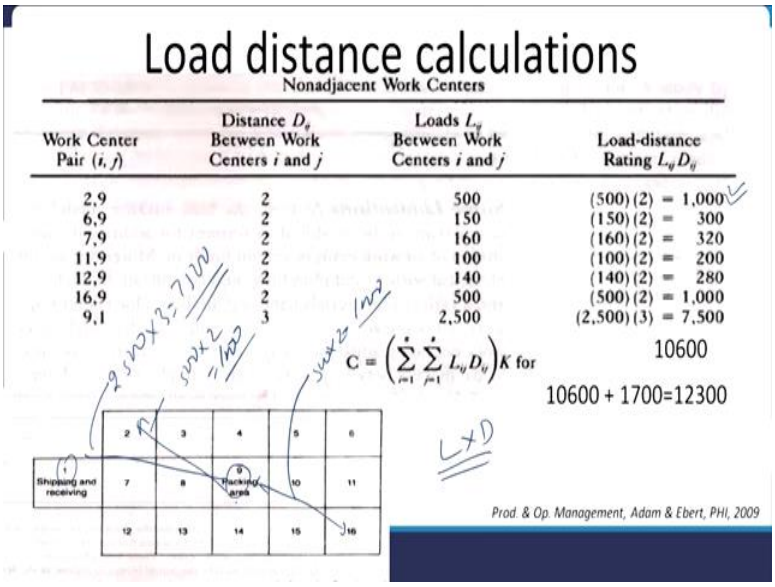


If you see here, since the movement between 9 and 1, this is the highest of the value 2500 unit into 3 causing thus load into distance is, 7500 value. On the other hand, the another highest is the 16 to 9 movement, that is of the 500 into 2 1000. And on another highest load into the distance centres is like, 2 to 9, 2 to 9. So, 500 to 2 causing the 1000. So, what will we thinking of, first of all to reduce this load into the distance factors by relocating the centres in, such a way that the total load into distance into the cost factor is reduced. So, shifting of the centres is highly suggested.

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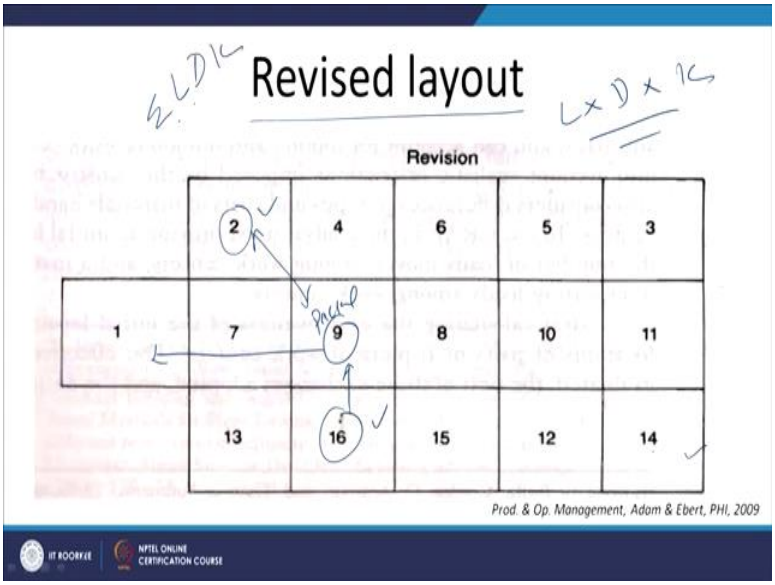


So here in the revised the layout, what has been done, like that the center 9, the packing area now has been brought close to the shipping area 1. And so, now the center and the now, center 16 which was located at the corner here, now has been brought close to the packing area 9. And in this way shifting of the packing area 9 towards the shipping area, has reduced to the distance between the store 9 and the packing area also.

So, in this way the packing area and the store 16 and 9 under the shipping area, which you are causing the very high cost on account of the load into the distance into the cost factors all that has been reduced. So, it is expected that it will be reducing the total cost also. To see the effectiveness of the revise the layout again, we have to determine the load into the distance into the cost consideration in the revised the situation.

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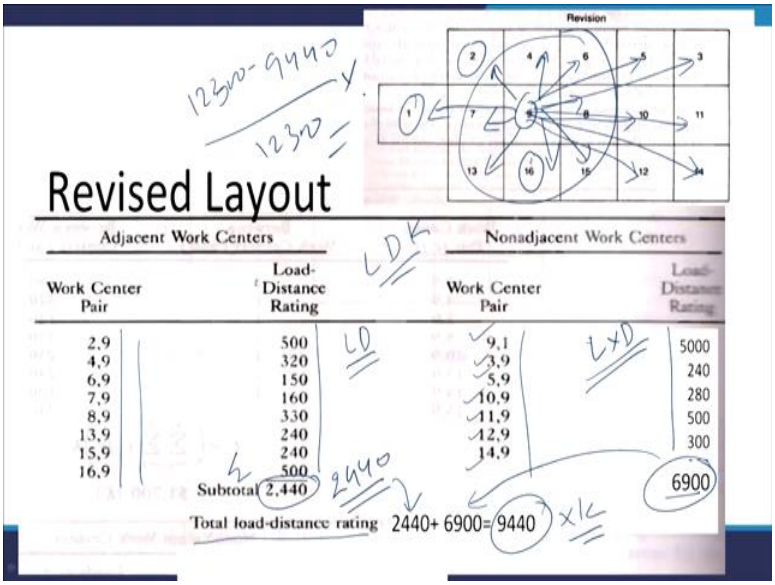


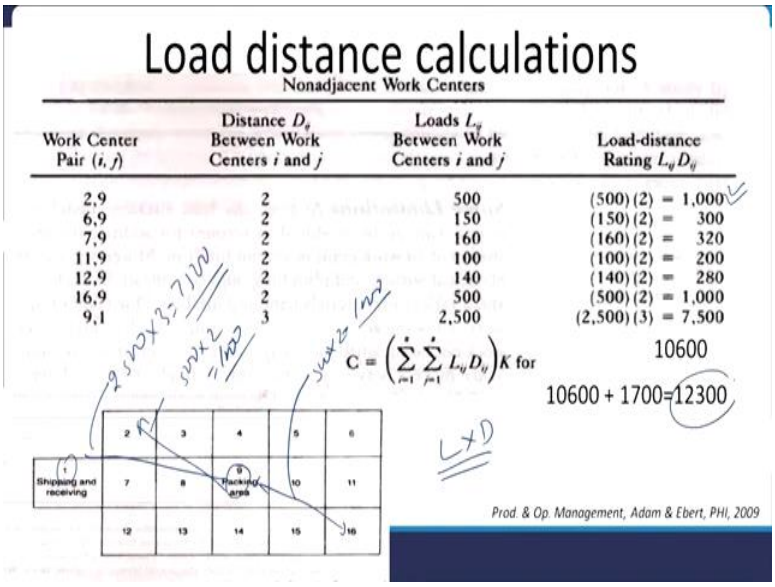


So, here this is the revised layout only. So, the 2, 9 and 16 and works 1 shipping area which were causing the high cost. So, we will be considering the adjacent centres load, load into distance into the cost factors and then non adjacent centre. So, non adjacent centres are like 9 4, 9 2, 9 7, 9 13, 9 16, 9 15, 9 8 and 9 6, whatever movement is needed from these stores to the packing area 9 they will be the adjacent centres. So accordingly, this is the load is same, only the distances have been reduced.

So accordingly, the load into the distance ratings will get modified. So, in the revised format load into distance rating, sum of the load into the distance factor for the, adjacent centres is coming out to be 2440. Now we can see the non adjacent centres like, 9 to 1, 9 to 5, 9 to 10, 9 to 12, 9 to 3, 9 to 11, 9 to 14. So, 9, 3, 5, 10, 11, 12, 14, again we will be considering the load

into the distance factor rating for that non adjacent centres. And what will be getting, sum of all these load into distance factors for the revised the layout is say, for non adjacent work centres is like say, 6900. So, sum of the total load distance ratings for adjacent centres is 2440 and for non adjacent centre 6900. So, sum will be like 9440.

So here, now what we will see, now what we will see here is that if you multiply with some common cost factors, we can compare the costing easily. So, the load into distance rating which was there earlier significantly high of the 12300. Now, it has been in, after the revising the layout, it has been reduced to the 9440.

So, if you want to see the effectiveness the percentage reduction in the costing which will be taking place, so that we can see, like 12000, how much it was, 12300. 12300 minus 9440 divided by 12300, so this will be giving us the percentage of the saving that will be occurring on account of the movement, which is needed between the different work centres.

So, now we will summarize this presentation. In this presentation basically I have talked about the, the procedure for designing the process layout considering the, the frequency of the movement, distance to be travelled, and the cost which will be occurring on account of the per unit distance to be travelled. Thank you for your attention.