**Industrial Engineering**
**Prof. Inderdeep Singh**
**Department of Mechanical & Industrial Engineering**
**Indian Institute of Technology, Roorkee**

**Module - 4**
**Lecture - 13**
**Facility Design Part IV**

A very warm welcome to all of you in this lecture on facility design, we have been discussing various facets of facility design. We already had some lectures on facility design in which we have seen some of the basic aspects of facility design. We have seen that the there are. So, many factors that have to be considered for appropriate selection of a location for setting up of the plant facility or setting up of the service facility.

There are so many factors if we summarize we have seen their certain objective factors, certain subjective factors, but basically, the objective is to maximize the profit and minimize the cost involved in transforming the raw material into the final product. So, for the choice of a location we have to take a decision that the procurement should be add the minimum possible cost as well as the distribution of the final product of the processing or of the manufacturing facility should also be at reasonably low cost.

So, if we are able to minimize these cost function that is we are able to minimize the procurement cost and we are able to minimize the distribution cost. Adding to this, if we are also able minimize the processing cost of transforming the raw material into the final product we would be able to maximize our profit. So, that is the basic thing that is required in 1 of our lectures we have gone from top to the bottom like factors to be considered to select a geographical reason in which, we are going to set up our plant within that reason what is the appropriate community

Or site where we are we are going to setup of plant and within that community also we have gone down to the basics that which area would be best suitable. Then, we have seen that identifying the area that this is the area we are we are going to setup within that specified boundary how we are going to place our machines. So, that we are able to optimize the production. We have seen that there are different types of layouts available already existing in text books.

So, we have seen there can be product type of layout, there can be process type of layout, there can be fixed position type of layout. So, in today's lecture we are just going to go

into a little bit of analytical aspects of facility of design. We are going to find out that how do we solve the facility design problems? Or the location problems? And then we will see that what is cellular type of layout which is the most commonly used in present day work? And, then we will see the layout selection problem.

So, today we are going to windup are discussions on facility design. So, today's lecture basically is review of the best practice is of all the different aspects of facility design. So, let's start a discussion. Analytical Methods of location planning, so the various Analytical Methods of Location Planning are: affected by the way the distances are measured and the objective function is used.

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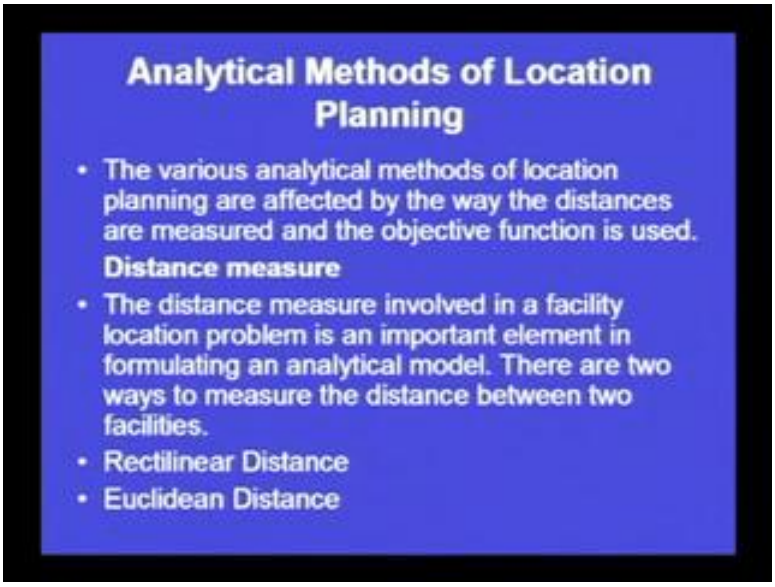


So, basically we want to minimize the distances between the vendors and the factory and between the factory and the consumers or between the factory and the distributors. Who are finally, going to let out the product to the retailers who are finally going to sell it to the customers. So, the distances always have to be minimized, if you remember in 1 of the previous classes or 1 of the previous lectures I have told.

That whenever a big manufacturer sets up his facility in a particular reason he negotiates with his vendors or with his subcontractors to setup their plants in his vicinity. So, that the transportation cost is minimized as well as the distances the risk is also minimized. Moreover, the supplies become more and more reliable. So, the distances are the most important point that have to be considered in the appropriate selection of the location. So far location planning what are the analytical methods use. So, this is a very simple

method which may not be directly used in any of the analysis, but it lays the foundation for some other sophisticated methods that can be used for location planning. So, on your screen you can read that the various analytical methods of location planning are: affected by the way the distances are measured and the objective functioning use.

So, the objective function can be profit maximization or cost minimization or it can be the distance minimization or the transportation cost minimization or the optimization or the distance and the transportation cost. So, different objective function can be there. So, but all these will depend upon the way the distances have been measured today we will see the 2 different methods of measuring the distance.

So, these are the rectilinear distance and the Euclidean distance. So, the distance measure can be accomplished in these two ways: Rectilinear and Euclidean. So, we the distance measure involved in a facility location problem is an important element in formulating an analytical model. Which I have already told the measurement of the distance is an important method or tool which is going to guide us in formulating the problem.

There are 2 ways to measure the distance between 2 facilities. Now, 2 ways are either it can be a Rectilinear Distance or it can be a Euclidean Distance. So, in this slide we have seen that distances play a very important role in formulation of the problem. Or the problem maybe a different objective function that we generate, and then we work on that objective function to achieve to our objective of maximization of the profit. 2 types of distances can be there: it can be a Rectilinear Distance or it can be a Euclidean Distance.

So, what a what do we mean by it can be a rectilinear distance and Euclidean distance? That we will see, what is rectilinear distance? When distance between 2 facilities is measured along the path that is orthogonal to each other, orthogonal each other means that 90 Degree. Then, that distance is termed as the Rectilinear Distance. So, we can say that whenever the distance measured is orthogonal to each other, then we say that it is Rectilinear Distance.

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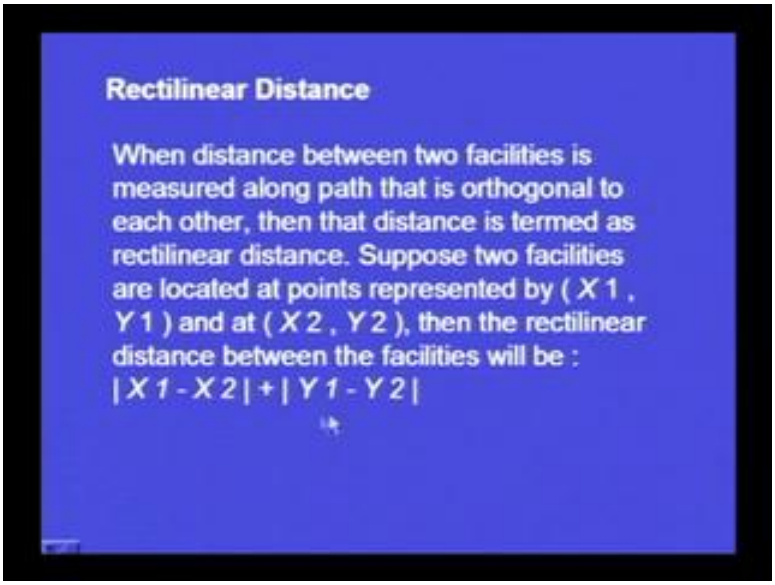


Suppose, this is 1 point, this is 1 point suppose and this is the other point. Then, we go along this path and then travel along this path and between these 2 paths there is angle of 90 Degree. So, this is a Orthogonal Distance. So, this will also try to understand with the help of a diagram, but we need to understand is that when, the distance between the 2 facilities is measured along the path that is orthogonal to each other.

Then, that distances termed as the Rectilinear Distance now, suppose 2 facilities are located at points represented by X1, Y1 and at X2, Y2. So, there are 2 points the location of first point is X1 Y1 and the location the second point is X2 Y2. Then, the Rectilinear Distance between the facilities will be: X1 minus X2 absolute of X1 minus X2 plus Y1 minus Y2.

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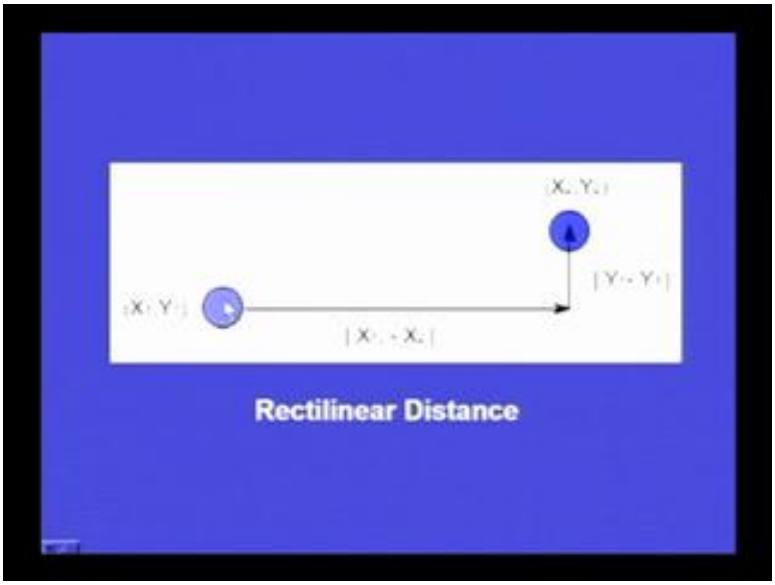


Now, on your screen you can see a very simple diagram this is the point, which depicts X1, Y1 this is the first point or the first facility this is the second location or X2, Y2. So, the Rectilinear Distance is measured on by the addition of the absolutes of X1 minus X 2 and Y1 minus Y2. So, this is what we call as the Rectilinear Distance. So, you can see that the angle here is 90 Degrees or it is orthogonal.

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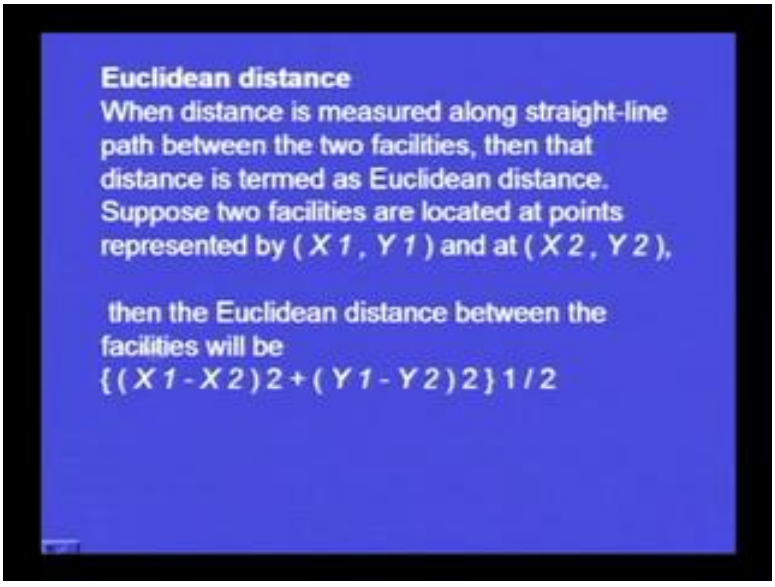


Now, coming on to the Euclidean Distance when, do the distance measured along straight line path between the 2 facilities. Now, it is not orthogonal it is straight line path between 2 facilities this, then that distance is termed as Euclidean Distance. So, that type

of a distance we call it as the Euclidean Distance. So, suppose 2 facilities are located at points represented by this already you have seen there are 2 points X1, Y1 and X2, Y2.

Then, the Euclidean distance between the 2 facilities will be given by X1 minus X2 by 2 multiplied by 2 plus Y1 minus Y2 multiplied 2 and this whole divided by 2. So, what is Euclidean Distance? Let us, try to understand it with the help of an example. Now, this the Euclidean Distance, Straight Line Distance or Straight Line Path being followed here not the orthogonal in which the 90 Degree was there that is not followed here.

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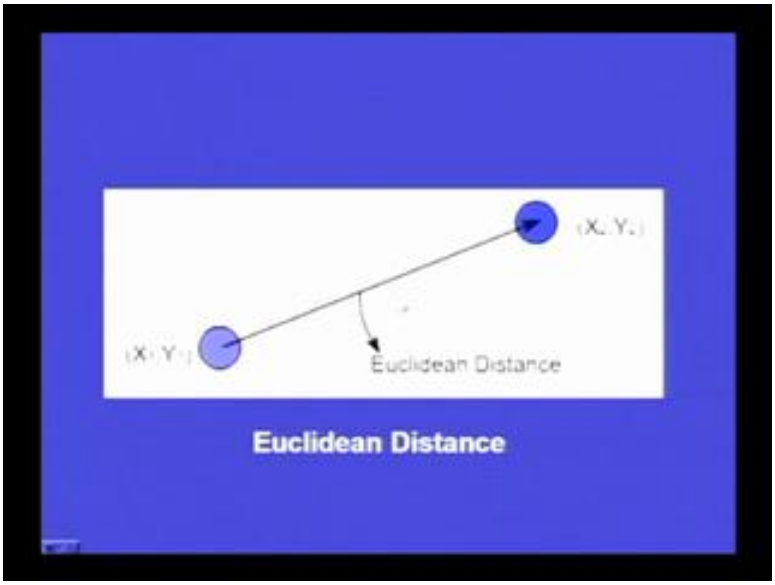


Here, the Straight Line Path is followed X1, Y1, X2, Y2 and this is the Euclidean Distance on your screen. And how do we calculated? We calculated by a X1 minus X2 into 2 plus Y1 minus Y Y2 into 2 and the whole divided by 1 by 2. So, we will see that how do we get these 2 expressions? The whole family of distance measure for the distance between 2 points X1, Y1 and X2, Y2 is defined by the following formula.

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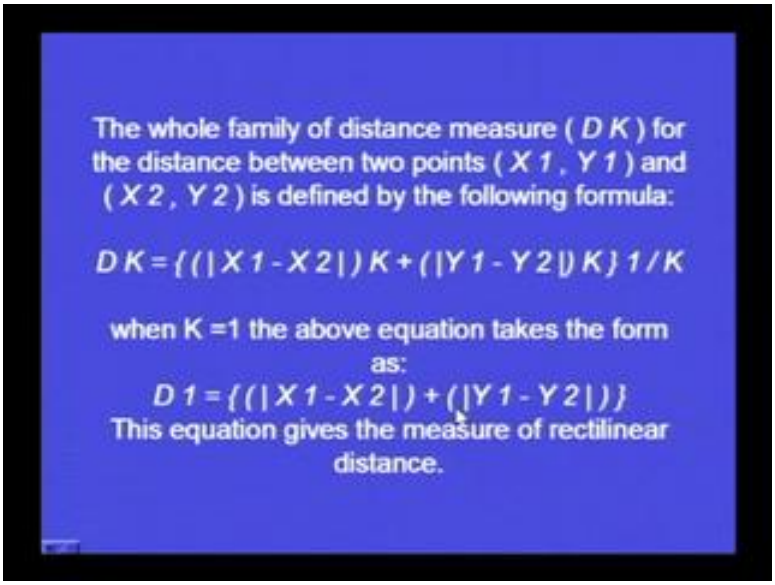


Now, this is the formula on your screen you can see this is the whole family of distance measure or we can say a generalized formula: for distance measure between 2 points. This is given by X1 minus X2 multiplied by K plus Y1 minus Y2 multiplied by K whole divided by K or multiplied by 1 by K. So, when K is equal to 1, if we put it in this expression when K is 1 K will be 1 here K will be 1 here as well as it will be 1 here.

So, the final expression will become as D1 is equal to X1 minus X2 absolute plus Y1 minus Y2 absolute and this is going to give us the Rectilinear Distance. So, this is the rectilinear distance between 2 points X1, Y1 and X2, Y2. So, generalized equation we have transformed into a specific Rectilinear Distance equation by putting K is equal to 1. Similarly, we will see that how it can be transformed into a Euclidean Distance equation?

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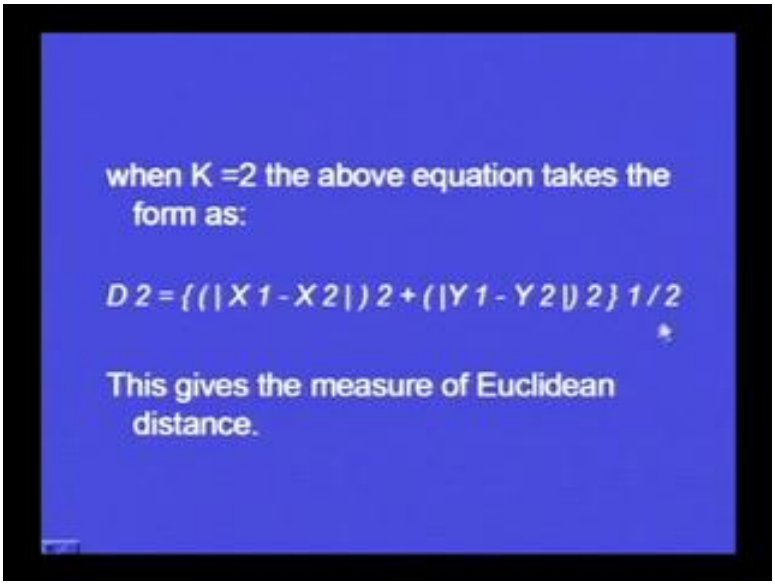


Now, when we put K is equal to 2 the above equation takes the form as D2 X1 minus X2 into 2 plus Y1 minus Y2 into 2 multiplied by 1 by 2 or the whole can be divided by we can say it is divided by 2. So, this gives the measure of the Euclidean Distance. So, although we are not solving any problem based on these distances, but these distances help us in order to find out the distances and those distances would further help us to estimate the procurement cost. For example: that distance is large the maybe the transportation costs would be high and the distance maybe less the transportation cost would be subsequently less.

So, these distances are used in formulation of the objective function which would further, lead into the optimization of the procurement process. So, we have seen that there are 2 types of distances: the Rectilinear Distance and the Euclidean Distance. Now, we can take a study regarding the facility location that how to make a judicious decision regarding the location of a facility?

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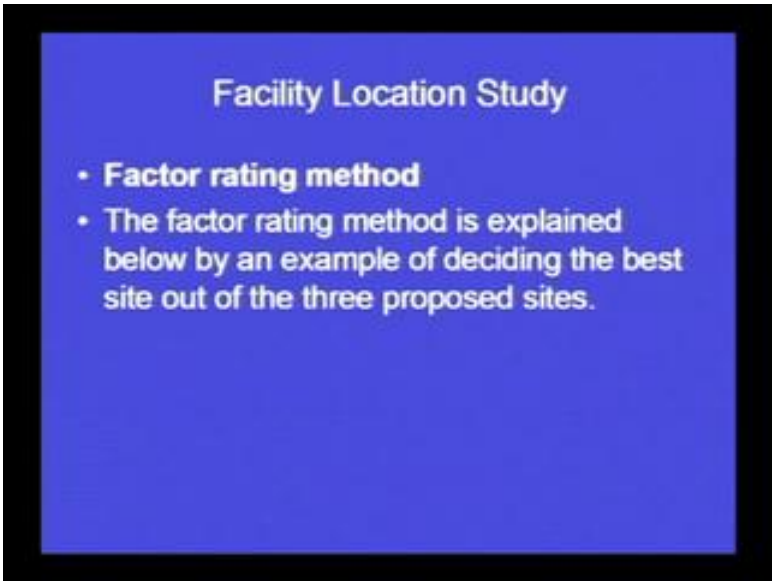


Now, the factor rating method is one of the method, which is use for making a decision when, we have choice among different locations. Suppose, we have we have choice that we can setup our facility in 5 different locations. We have to choose the most optimal location which would give us the maximum profit. So, for that we can use this factor rating plan in which we was to identify of factors and then we give the relative weight age 2 these factors.

And, then for individual location we do the analysis and then finally, we are able to choose the best location based on the factor rating method. So, the factor rating method here is explained with the example of deciding the best site out of 3 proposed sites. So, subsequently we are going to see this example in which there are 3 proposed sites, so the choice is among 3 proposed sites there exist a choice with us that we have to select 1 best out of the 3 proposed sites.

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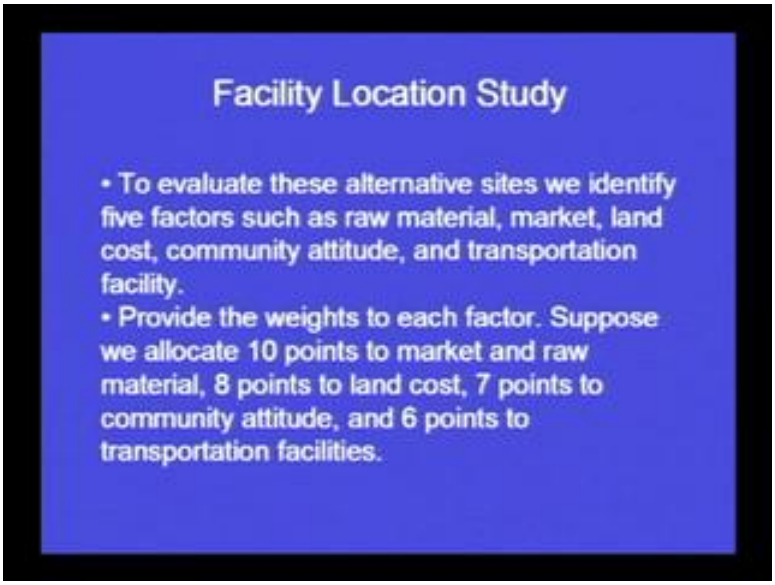


So, we will see this example how to go about this particular problem? To evaluate this alternatives Like, 3 choices that we have we identify 5 factors such as now we have identified 5 factors on the basis of which we are going to solve this facility location problem. Now, to evaluate these alternative sites there are 3 alternative sites: that already I have told when we studied the problem in the previous slide.

We identify 5 factors: such as raw material that is the first factor market that is the second factor, Land cost that is third factor, community attitude that is the fourth factor and transportation facility that is fifth factor. So, we have taken 5 different factors on the basis of which we are going to make a decision regarding the best location out of the 3 proposed sites.

Now, provide the weight to each factor now 5 factor are there: some factors maybe more significant to our decision as related to the other factors. Now, the factors which are more significant we are going to give the more weight, but the factors which are less significant to those we are going to give lesser weights. So, provide weights to each factor suppose we have locate 10 points to market because, market governs the business.

So, we give the maximum weight age to the nearness to the market or to the market we can say and raw material also very important. So, 10 points or 10 weight age of 10 is given to market raw material 8 points to land cost which was 1 of our factors. You can see land cost on your screen is 1 of the factors which has been identified. So, a weight

age of 8 points has been given to the land cost 7 points to the community attitude and 6 points to the transpiration facility.

So, we are giving the maximum weight age to the market and the raw material and the minimum weight age we are giving to the transportation facilities. So, what we have done till now is let us, first see what is the problem at hand? So, the problem at hand is that we have 3 proposed sites and we have to select the best possible site. Now, for that selection we are doing a study in that study we have seen that 5 different factors has been identified and the relative weight age to each and every factor has been given.

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Now, on your screen you can see we have tabulated the entire problem we have also. The solution, but by and by we will see that how we have achieved or arrived to this particular solution. So, what are the factors? The factors are: Raw material, Market, Land cost, Community attitude, Transportation facilities. So, what are the weighs assign to these? Raw Material has been given a weight of 10, Market has been given weight of 10.

Land cost the weight age is given 8 points, Community attitude 7, Transportation facilities 6. Now, we see how to do the calculations? Now, we have at hand location 1, location 2 and location 3 or we can call these as location A, location B and location C. Now, out of these we have to select the best location now how to go about it? Now, rate each alternative for each factor on a scale of 10.

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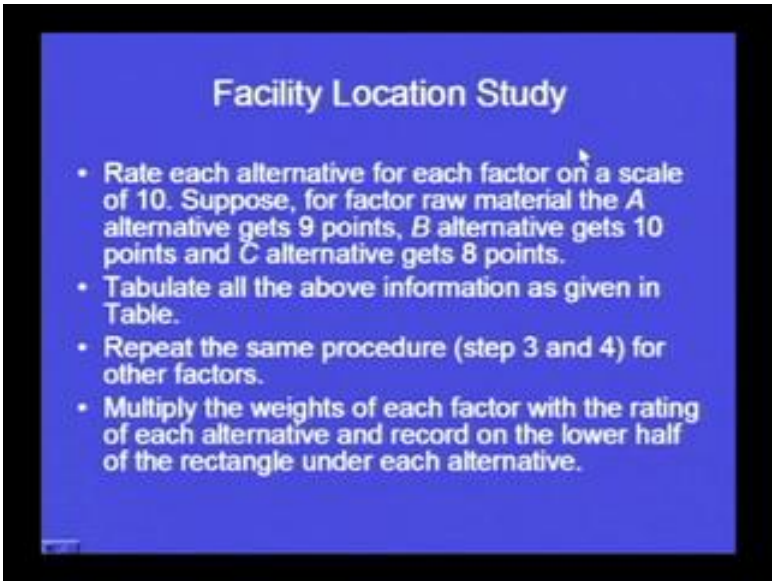


Already, but we have done we have given the relative weight age to each of these factors. Now, we have 3 alternatives: alternative A, alternative B, alternative C or we can say location A, location B and location C. Now, we will rate each alternative that is maybe location A we will rate it on all these factors on scale of 10 Out of 10 we will see that from market point of view location A how much points it earn? Maybe, if the market is very closed to this particular location, then we can say it its stands 10 on 10 or it can be 9 on 10 or it can be 8 on 10.

So, depending upon different factors that we have identified each location would now be given marks out of 10. Suppose, for factor Raw Material: the A alternative gets 9 points, B alternative gets 10 points and C alternative gets 8 points. Now, you can see for Raw Material location A gets 9 points, location B gets 10 points and location C gets 8 points. That is what I have explained.

So, B alternative gets 10 points and C alternative gets 8 points tabulate all the above information as given in table. So, in table we have tabulated all the above information. Now, repeat the same procedure step 3 and 4 for other factor. So, for all other factors we are going to do the tabulation giving the marks out of 10 for each and every factor to the different locations.

Now, we have location A, B and C and we have 5 different factors. So, for each factor we are going to given or relative score to all the location. Then, multiply the weights of

each factor with the rating of each alternative and record on the lower half of the rectangle under each alternative. Let me, repeat multiply the weights of each factor.

Now, weights of each factor if you remember we have given relative weight age to all the factors. If, you remember raw material we have given the weight 10. Similarly, market the rate the weight age is 10, but other factors like the land cost or the attitude have been given lesser weight age. So, multiply the weights of each factor with the rating of each alternative. Now, we have given the rating to each alternative for each and every factor and record on the lower half of the triangle under each alternative.

Now, you can see Raw Material has been the given the weight age 10, Community has been given the weight age 7, Community attitude Land cost has been given the weight age 8, Transportation facilities have been given the weight age 6. So, relative weights are given marks are given out of 10 for each location. Now, for Raw Material location A has been given 9 marks, locating B has been given 10 marks and locating C has been given 8 marks.

Similarly, on Community attitude location A has been given 10 marks, location B has been given 9 marks and location C has been given 10 marks. Now, we are going or we can say I have been using the word marks we can also say these to be points that with so many points have been given to these particular location. Now, we multiply the weight age with the points that have been given to that particular alternative. Now, location A has got 9 in Raw Material and total weight age given is 10.

So, 10 multiplied by 9 we get 90 here. Similarly, 10 marks or 10 marks or 10 points have been for location B. So, 10 multiplied by 10 gives 100. So, 100 points have been got by location B on the factor Raw Material. Similarly, location C has been given 8. So, 10 multiplied by 8 we get 80. Similarly, for each and every factor we are going to multiply the weight age with the points which we have given to the different alternatives and we are going to calculate this particular figure 10 into 8 80, 10 into 8 80, 10 into 9 90.

Similarly, for Transportation facilities let us, see you can remember it 6 into 8 48, 6 into 7 42, 6 into 10 60. So then finally, we add up all these points earned by each and every location. Now, location A has got a total point on all these 5 factors as 347, location B had got 349 a summation of all these point. Similarly, location C has got a summation of 364. So, 347 for location A, total points 349 for location B and 364 for location C.

So, we have seen that by very simple method we have been able to find out that which location is going to give us the maximum points. Now, add the score of each alternative and record in front of the table that we have already seen the best alternative is that alternative which has the maximum score.

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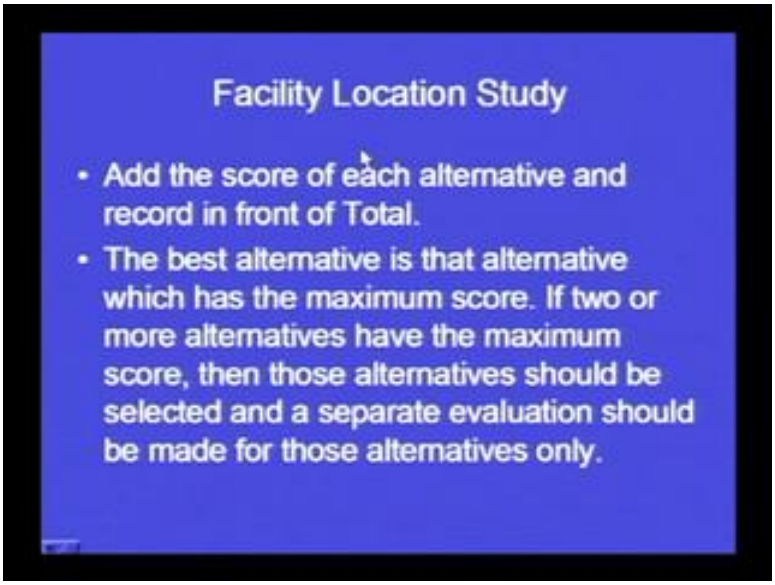


If, 2 or more alternatives have the maximum score, then those alternative should be selected and separate evaluation should be made for those alternatives. So, most of the times we maybe in a situation that we are only getting the 1 best alternative, but sometimes it may, so happen that there are 2 alternatives having the same score. In such a scenario, we have to do further Exhaustive Method we have to use some further Exhaustive tools and Techniques to reach to the Unit Solution are the Unity Solution or Scalar Solution.

So, where we will only have a single particular alternative, which is having the maximum score. So, we have seen that whenever we are faced with a problem or whenever we encounter problem in which there are 3 different alternatives are 5 different alternatives available with us. We would first identify the factors on the basis of which we are going to base our selection, then for those factors we are going to give the relative weight age. What is the relative weight age for all these factors?

Then, we are going to grade all these choice values or all these alternatives that are that are available with us and then finally, add up the total points for each and every alternative. And, then the alternative that gave give us or that is scores the highest points

would be the selected alternative. So, this is the very simple method which is going to help us in selecting optimal location out of 3 or 4 different locations. Now, we can see maximum marks has been score by alternative C. So, location C is getting 364 points. So, we are going to select alternative C in this particular case.

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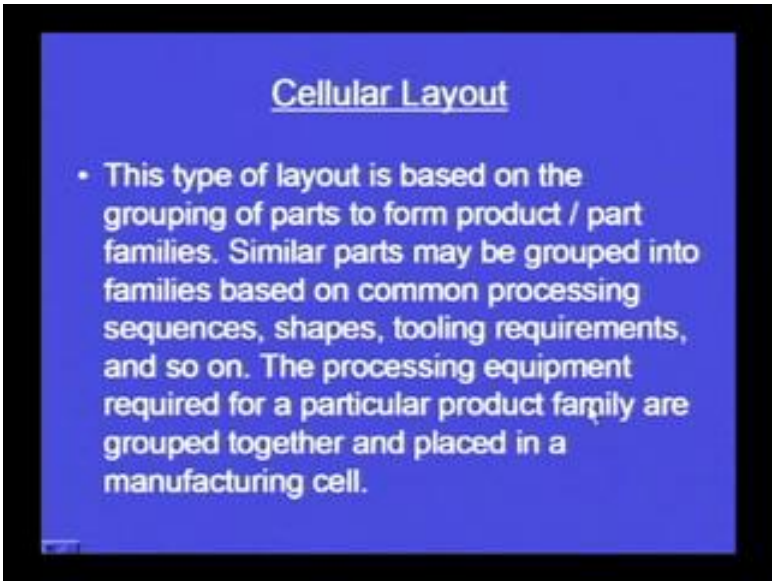


Now, we come on to another important subject that is the kind of layouts that we are going to use just to briefly, summarize what we have already covered in types of layouts? We have covered that there are 3 important types of layouts that exist in any manufacturing plant. What are these 3 types layout? These 3 types of layouts are: the product layout, the process layout as well as the fixed position layout all these things already we have covered.

Now, we are going to covered what is the latest type of layout being used in industry these days? And that is the Cellular type of Layout. So, if it we see whatever we have discuss till now, if we link it with what we have discussed just now we had a problem at hand at which we had 3 different alternative available with us. Now, these alternatives were there 3 locations or the locations that are available with us and we have to select the best location out of these 3 locations.

We have seen method by which we can select the best location out of these 3 locations on a scale of different factors, relative weight age of different factors we have been able to find out the best alternative out of these 3 alternative that were available with us. Now,

once we have identified that this is the alternative or this is the location where we are going to setup our plant or setup our facility.

Then, we are faced or then we are encounter another important problem that is what type of layout of the machines and equipment we have to put in that particular plant? So, location has been identified. Now, within the location how to place our different machines and equipment. So, basically layout gives us birds I view of the different facilities within the plant or the different services or different machines or different equipment or different rooms for different sections or different shops within the floor.

So, we have already seen the advantages as well as the disadvantages of certain basic types of layouts. So, today we will see that what is the Cellular type of Layout? And what are the advantages and disadvantages of the Cellular type of Layout? So, this type of layout is based on the grouping of parts to form product or part families. Similar parts maybe grouped into families based on common processing sequences shapes tooling requirements and so on.

Now, let us break this definition into 2 3 important points: now, the first important point is that this is a layout which is based on a certain form of products or parts families. So, grouping of parts into different products are part families is the first important thing which is carried out in Cellular Layout. Now, what are the basis on the base of which we are going to classify these part? The basis is the parts would be club together in 1 family. If, they have the similar type of processing sequence maybe circular parts they require maybe grinding or there maybe requiring whole.

So, maybe on the basis of geometry, on the basis of the processing sequence or on the basis of we can say tooling requirement or there can be other criterion. Let us, see these 3 important grouping criteria 1 by 1 first 1 I started with the processing sequence. Now, suppose there is part which requires 5 different operations and there is another part which requires only 4 out of those 5 different operations. And there is another part which require 6 operations out of which 5 are the same as part 1.

So, these 3 parts require similar type of operation or the sequence of operation is also the same. Then, these parts can be clubbed into 1 part family on the basis of the processing sequence or common processing sequence, so on the basis of the common processing sequence the parts can be clubbed together, if they require similar operations as well as in the same sequence this will be 1 criteria for classifying the parts into part families.

Then, the second criteria is which already I have given you a brief introduction that is the shape. All the circular parts may require same types of operation they can be clubbed together into 1 part family. Or we can say all the similar type of components having similar geometrical features can be clubbed together into one part family. So, we have seen that 2 criteria we have already considered first one is the commonness in the processing sequence, second one is the commonness in the geometrical features and third 1 is the tooling requirement, which may be holding or relatively lesser weight age as compared to the previous 2 points.

So, the tooling requirement means the parts which require the similar kind of tools or similar kind of jigs and fixtures maybe clubbed together into a particular part families. So, basically what is done in cellular type of layout? Is in the first face all the parts that are manufactured within the manufacturing plant they are divided into different part families. So, the criteria for this division is the commonness in the processing sequence, it can be the geometrical features or it can be the tooling requirement.

So now, what we have got? Is that we have got different part families in which we have parts which are related 1 another on the basis of 1 or the other criteria. The processing equipment required for a particular product family are grouped together and placed in a manufacturing self. Now, once we have made the part families now the processing equipment required or the machines or the tools or the equipment that is required for that particular product family are grouped together and placed in 1 particular cell.

Now, 1 part family will be going to that particular cell for processing. Because, all the tools equipment machines required for processing that part family have been placed together in the form of particular cell. So, we would like to understand it with the help of very simple diagram the cells, then Become in effect miniature versions of product layout.

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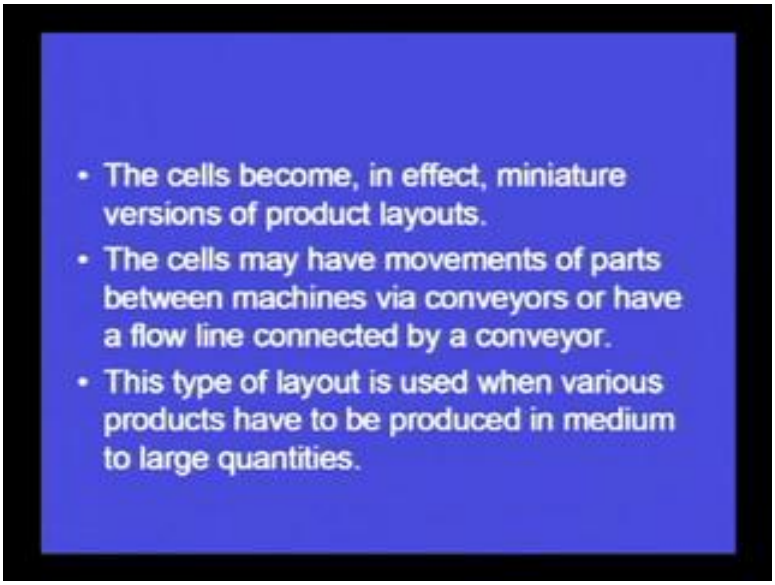


Now, these cells which we have identified 1 manufacturing cell has been dedicated to 1 part family, another particular cell has been dedicated to another part family or a third cell maybe dedicated to another type of part family or another type of product. So, these cells then become a type of products layout if you remember what do you mean by a product layout? A product layout is layout in which all the machines are in the processing sequence.

So, now in this particular case 1 particular cell would be dedicated for similar type of products and it may so happen, that all the machines are aligned in logical sequence of operations only. So, each particular cell can be set to have the advantages of the product type of layout the cells may have movement of parts between machines via conveyors or have a flow line connected by a conveyor.

So, this basically deals regarding the material handling within a particular cell. So, within a particular cell the material may move from 1 particular to 1 particular location to another particular location. We have cells may have movement of parts between machines via conveyors or have a flow line connected by a conveyor. Also, this type of layout is used when various products have to be produced in medium to large quantities.

So, where this type of product a this type of layout is used that is also specified in this point. So, this type of layout is used on various products have to be produced in medium or large quantity. So, it means that wherever the variety is there. If, we are producing only a single product, then this type of layout may not be feasible, but when we have

large variety of products to be made in that particular kind of scenario this type of Cellular Layout would be beneficial. So, way improve variety or wherever the variety required is more we may off for cellular type of a layout. And why this is important in present the scenario? Because, now the customer wants different or products according to their own choice. So, customer want variety and whenever the manufacturing company has to produce the products in variety they may have to go for cellular type of layout.

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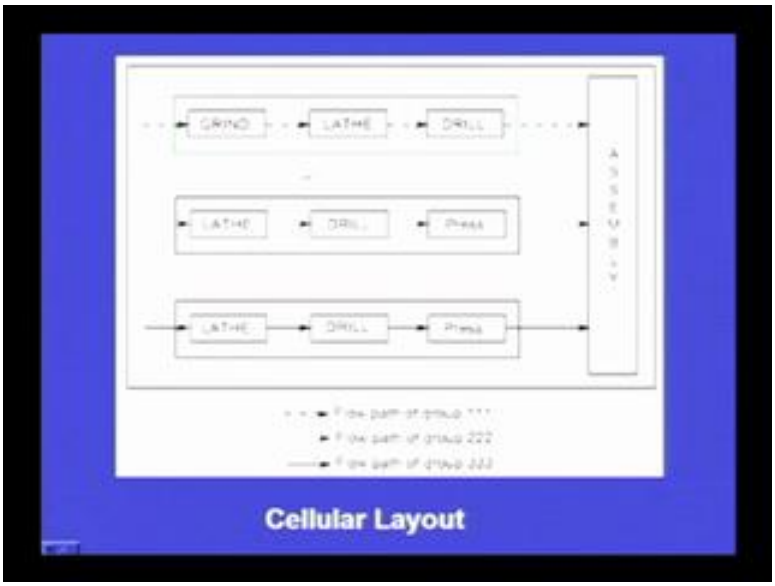


Now, on your screen you can see a cellular type of layout. So, here we see now this particular region in green can be for 1 type of product like, slow path of group 1 1 1. So, this is a flow path for group 1 1 1. So, 1 part family or 1 group has been coded as 1 1 1. So, group 1 1 1 would enter here it would be going through the grinding section lathe and finally, the drilling section and then it would go for the assembly.

Similarly, flow path of group 2 2 2 there is another part family or another product family which is going through this particular cell lathe, drill and press. Then, there is another flow path for group 3 3 3. So, there is another part family or product family which is following these particular path and finally, this sub assemblies here are assembled to get the final product.

So, if we see that this is representing this cell is representing a product type of layout. Because, after 1 operation, second operation and then finally, the third operation and here the sub assembly is ready which is finally assembled into the final assembly. So,

different cells are there and each cell is dedicated to a specific group of part which would be manufactured there in. So, now this type of layout would have its inherent advantages as well as some of the limitations. So, now we will see what are the advantages and limitations of the cellular type of layout?

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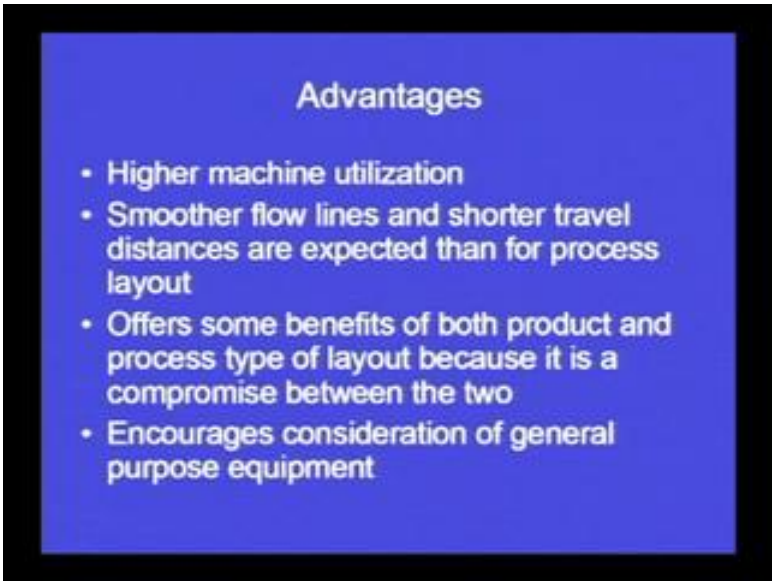


So, on your screen you can see the advantages of the cellular type of layout. Now, this results in higher machine utilization, because the machine would always be working on the parts which are dedicated to that particular manufacturing cell. So, the machine utilization would definitely improve in cellular type of layout. Similarly, smoother flow lines and shorter travel distances are expected then for process type of layout.

So, this advantage is in comparison to the process type of layout. So, smoother flow lines would be there and the travel distances would also we minimize. So, the raw material which is under process or work in process material would be minimum means, the traveling distance would be minimum not the material I have set the material would be minimum.

It could no be the material that is minimum, but it would be the distance that the material has to travel that would be minimum. Similarly, it offered some benefits of both Product and Process type of layout, because it is compromise between the 2. Now, we can see that this is compromise between the 2 types of layouts that we have already studied in the previous class that was the Product type of layout and Process type of layout.

So, both were having their own advantages as well as their limitations. So, no cellular type of layouts offers the advantages as well as reduces some of the limitations of these 2 types of Layout. So, it compromises on the advantages of the both. So, it adds on to the advantages. So, offer some benefits of both Product and Process type of Layout. If, you remember that for different types of groups or part families I will again show you for different types of part families: This is one part family this is getting processed here we are we call it as the flow path of group 1 1 1.

So, this we are saying this is the type of Product layout. Because, there is logical sequence of operations the raw material is coming from here getting processed and then finally, sub assembly is ready here. So, this is having all that advantages of Products type of Layout. And similarly, in Process type of Layout we have dedicated sections for that the different process is we may have within the machining shop.

So, we may have drilling section, we may have machining section or we may have shaping section, we may have turning section, we may have different types sections within the machining center. So, dedication is there a dedicated shops are there for each and every type of operation. So, that is the advantage of a Process type of Layout. So, here we have dedicated cells also and we have taking the care of the Product type of advantages also.

So, we have Product type of Layout submerged in a process type of layouts. So, we can think of getting a compromise of advantages of both. So, offer some benefits of both, so we are going to get benefits of both Product type advantages also we are getting Process type of Layout advantages also we are getting. It is a compromise between the 2 encourages consideration of general purpose equipment. So, we can have general purpose equipment or we can have in other words we can say we can have a flexible equipment.

So, flexible equipment means that which can be very easily adapted to any change in the product design. So, we can have flexible equipment we can have general purpose equipment. So, this type of equipment would help us to adapt to the changes in the product design. So, as soon as the product design changes we would be very easily able to adapt to its design change and we would be able to produce it minimizing the total lead time.

So, there are certain advantages which are offered by Cellular Layout and that is why it being preferred by many organizations these days. Now, what are the disadvantages? We have seen advantages. What are the disadvantages now we are going to see?

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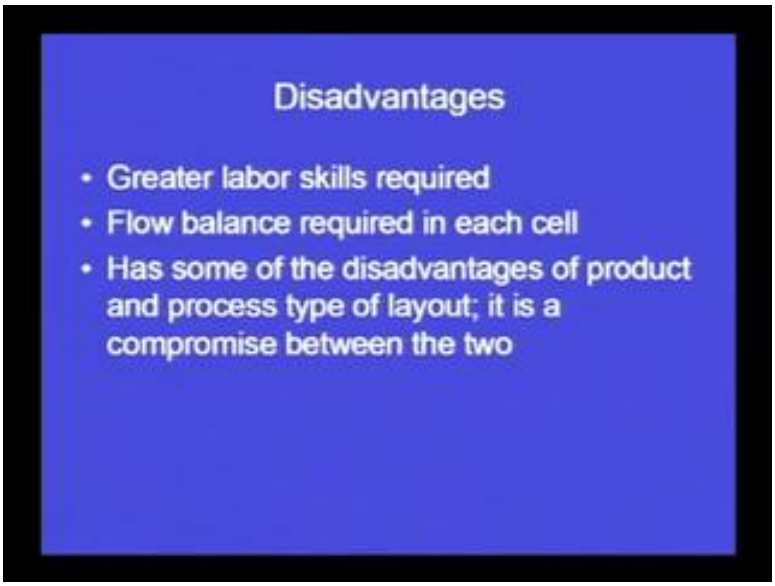


So, greater labor skill required. So, labor skill required would be increased in cellular type of layout. Because initially, when a person was in one particular section in process type of Layouts say. He would be requiring certain skills set, but in Cellular type of Layout within each cell there are different machines there are different equipments. So, he needs to be and expert of all those equipments.

So, greater labor skills would be required in Cellular type of Layout. So, Flow balance required in each cell. So, in the problem you have see that there were 3 operations carried out on different work groups. Now, if they are not working at that same pace, then 1 particular cell is making the product set of faster pace another cell is making is the product set a slower pace.

So, at higher pace wherever the products are being produced or where the our the subassemblies are being produced. They that particular section would churn out the parts at faster pace through the parts have to wait for the final assembly. Because, until and unless the other particular cells are not matching the speed of that particular cell which is producing at faster pace the complete assembly cannot be made.

So, Flow balance required in each cells. So, a balance is required, so that if 10 parts are coming out of cell 1. 10 part should also come out of cell 2 and cell 3. And these parts, if

need to be assembled to get the final product the pace would be same. So, the Flow balance would be there it is not always desirable that the pace should be same, but it should be comparable maybe varying within certain degree of accuracy or certain degree a specified level. So, if we want that 100 parts per week should be produced. So, different manufacturing cells should stick to this particular target of 100. And they should have a Flow balance. So, that they are manufacturing at the rate of 100 parts per week. So, that the final product is coming out at the rate of 100 per week. So, it has some of the disadvantages of the Products and Process type of Layout it is compromise the between 2.

So, already we have seen when, it is going to offer certain advantages of Product and Process types of Layout this would also adapt to certain disadvantages of these 2 type of layouts also. So, we have seen that Cellular type of Layout has certain distinct advantages which has made it 1 of the most important types of Layout being used in the manufacturing industry. Now, we come on to another important point that is the Layout Selection.

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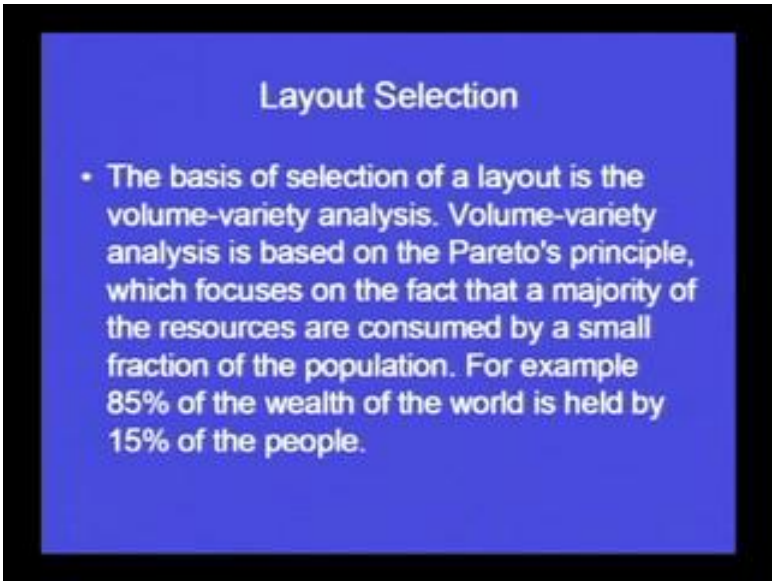


So, on your screen you can read. That what do you mean by Layout Selection? So, the basis of selection of Layout is the volume-variety analysis. So, this can be carried out. So, this means Layout Selection, so Layout Selection can be carried out by doing the volume-variety analysis. So, volume means how much of product we are producing and variety means how many different types of products we are producing.

So, when we do this volume-variety analysis? We are able to find out that in which scenario? Which type of layout we should select? To till now, we have understood 4 different types of Layout. So, the first 1 was the Product type of Layout, second 1 was the Process type of Layout. Then, we saw the Fixed Position type of Layout and today we have seen the Cellular type of Layout. Now, we have 4 different layouts available with us and we have to make a selection that which type of layout should be used in which particular scenario. So, this problem will be solved using the volume-variety analysis.

So, you can see volume-variety analysis is based on the Pareto's principle, which focuses on the fact that a majority of the resources are consumed by a small fraction of the population. For example: 85 percent of the wealth of the world is held by 15 percent of the people. So, we what we mean to say? Here is, that the majority of the resources are consumed by a small fraction of the population.

So, this is the Pareto's principle and this has been explained with the help of an example that 85 percent of the wealth of the world is held by only 15 percent of the people. So, this principle would be used in doing the Layout Selection. So, this rule also applies to. Facilities Design that is 85 percent of the production volume is attributed to 15 percent of the product line.

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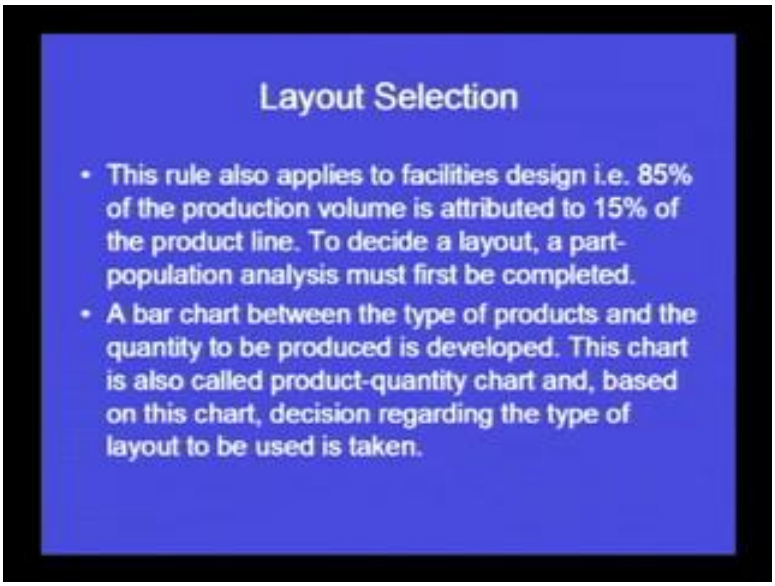


So, 1 product line when it is dedicated to 1 particular type of product. So, the maximum volume will come out of that product line. So, that this rule also have applies to the

facility design that is 85 percent of the population volume is attributed to 15 percent of the product line. To decide layout, a part-population analysis must first be completed. So, this is the same as the product-variety analysis or the variety volume-analysis that we have seen in the previous slide. Just we can say the volume-variety analysis we have to carried out. Then, we have seen that a part-population analysis we must be completed. When, we have to make selection regarding the type of layout that we are going to adapt in our manufacturing plant. A bar chart between the products or the types of products a bar chart between the type of products and the quantity to be produced is developed.

So, how we are going to do this analysis? This is the explained in this point. A bar chart between the type of products and the quantity to be produced is developed. This chart we will see in the subsequent slide and try to understand that how this analysis is done? This chart is also called the product-quantity chart and based on this chart decision regarding the type of layout to be used is taken.

So, basically why we are going to do this analysis? We are doing this analysis in order to find out that which type of layout we should use in our industry? So, basically what we are doing is? We are drawing a bar chart. So, what is the bar chart? On your screen you can see the bar chart on X axis we have the different products and on Y axis we haves the we have the quantity or the volume.

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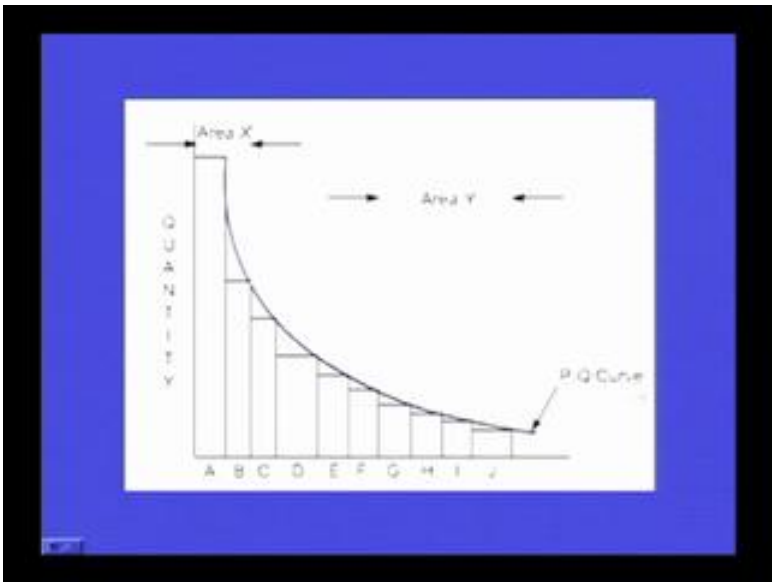


So, the volume is there on the Y axis and the product or the types of product are there on the X axis. So, this we call as PQ curve. So, Q is the quantity P is the product. So, we

have area X earmarked here and we have area Y earmarked here. So, this we call as area Y and this we call area X. So, in area X if we see the quantity is more, but the products are less only 2 products are there A and B. But the quantity of these products is relatively higher, but on the contrary if we say for area Y. There are 1, 2, 3, 4; 4 different types of product that is product G, product H, product I and product J.

But the volume of these products is comparatively less. Maybe to and this product G maybe having 25 percent or maybe even less than 25 percent of the volume of the product A. So, what we have seen here in this bar chart is? That we represent the volume or the quantity on the Y axis and we represent the type of products on X axis.

And, then we see that what is the volume of a particular product that is produced. Then, on the basis of this bar chart we have to make a decision that which type of layout should be used? So, the Layouts Selection will be carried forward for the products lying in the area X.

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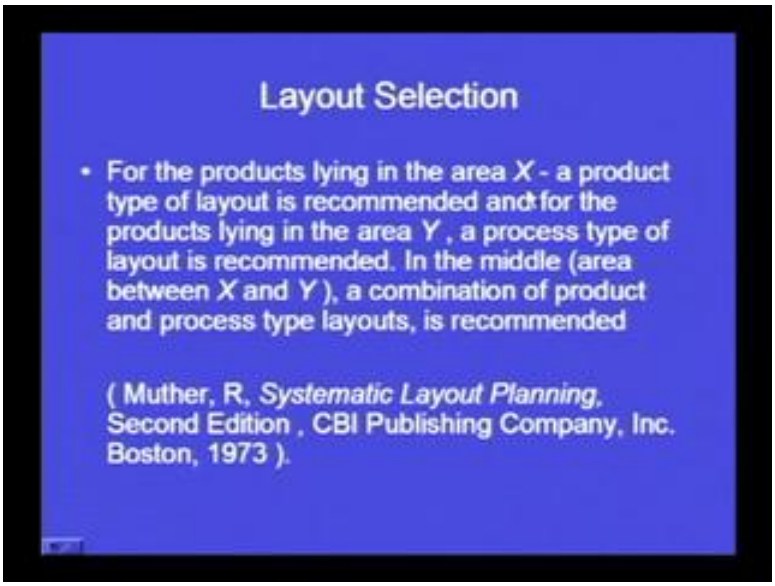


So, we have seen area X as well as there is area Y. Now, for the products lying in the area X a product type of layout is recommended. So, product type of layout is recommended for those products for which the volume is more. If you remember in area X the volume was more and the variety was less. So, Product type of Layout is recommended and for the products lying in area Y a Process type of Layout is recommended.

So, we can say wherever the volume is less, but the variety is more, because in area Y there were 4 different types of products. So, wherever the variety is more and the volume is less a Process type of Layout recommended. So, in between the area X and area Y we have to make decision that which type of layout should be chosen. So, on your screen you can see a combination of Product and Process type of Layout is recommended.

So, we have seen that wherever the volume is large the variety is less Product type of Layout is recommended. Wherever, the variety is more, but the volume is less Process type of Layout is recommended and in between the 2 best of or the combination of Product and Process type of Layouts can be used. So, in today's class we have seen that distances play a very important role in a appropriate selection of a location in which have seen that there are 2 types distance that are usually used to form a objective function.

In which we have seen what to do we means by Rectilinear Distance? What to do we means by Euclidean Distance? And these 2 types of distances help us to formulate our objective functions, functions which could be profit maximization or minimization of the total procurement or distribution cost. Then, we have seen a problem in which there were 3 locations and we have to choose the most optimal location. So, the problem was solved considering 5 different factors each and every factor was given relative weight age.

So, then 3 locations or 3 alternatives were given the points based on these 3 these 5 factors. Then, the particular location which scored highest points was selected as the most optimal location. Thereafter, after the selection of the location we have seen that what is the type of Layout? Cellular Layout was considered today 3 different Layouts we have covered in the previous lecture. We have seen what to do we mean by Cellular Layout? We have also considered the advantages and disadvantages of the Cellular type of Layout.

Then finally when we are faced to be the problem of selecting the most optimal type of layout out of the 4 types of Layout, what is the criteria? We should follow for that? We have seen a method which helps us in order to identify or order to select the most optimal type of Layout. So, we will carry forward or discussion relative to some other aspects of Industrial Engineering in the subsequent lectures.

Thank you.