Operations Management
Dr. Inderdeep Singh
Department of Mechanical & Industrial Engineering
Indian Institute of Technology, Roorkee

Lecture – 22
Facility Layout & Planning-II

[FL] friends. We are currently discussing the topic of Plant Layout or Facilities Layout. We are in week 5 of our discussion on the course on Operations Management and session wise today; we are having 22 session of our course. Just to have a brief overview of what we have covered already. We have already discussed for last 4 weeks, different aspects related to Operations Management. In week 1, we have discussed the objectives, scopes, functions of Operations Management.

Then, we have seen the Product Design and Development in week 2. In week 3, we have discuss the concept of Sales Forecasting and the different techniques used for making a forecast such as Quantitative Methods of forecasting like Averaging and Weighted Moving Average and exponential smoothing as well as Qualitative Methods of forecasting like Delphi method and estimates and survey technique.

In week 4, we have seen that what are the factors influencing our decision regarding the selection of a location for our manufacturing plant or facility? We have seen that how we can decide or what are the factors governing our decision related to the selection of location? Now location can be, we can say it can be globally; we can say it can be at selection of a particular country, within the country. It can be a selection of a particular state; within the state, it can be a selection of a particular district; within the district, it can be a selection of a particular teasel.

So, location will or the factors that affect the our decision related to the location of the manufacturing facility. We have covered in week 4 and in week 5, currently we are focusing on the layout that once we have decided the location; for example, we decide that our company is going to be based out of Uttarakhand or may be in the state of Uttarakhand at Haridwar.

So, once we have decided that our factory will be in Haridwar, we know that we have to procure a particular piece of land, where the factory will be or the facility will be created.

Now within the facility, how we are going to place, how we are going to we can say locate our various facilities or sub facilities that is what basically the layout is and if you remember, if where you have already seen session 21; you might have seen that there are factors influencing this decision also that what type of layout we must follow; that depends upon the type of industry; that depends upon the type of personal we are using; that depends upon the type of materials we are using; that depends upon the space that we are having; that depends upon the utilization of the space that we want to as foresee.

So, basically there are number of factors which will affect our decision related to the selection of a type of a layout. So, we have seen in the previous session, there are different types of layout. We have seen there is a product type of layout in which the manufacturing or the processing will follow a particular sequence of operations. One operation will definitely follow the other operation means the sequence is predefined the product will enter from the one end of the organization and the not the product sorry, the raw material will enter from one end of the product and the final product will be coming out from the other side.

So, basically the raw material will enter from one side into industry or the factory and it will come from the other side, I think I have said product. So, may be if you are attentive you will be able to identify this type of mistakes in the lectures delivery. So, again I am repeating that in line type of a product type of layouts, the raw material will enter from one end of the factory and the final product will come out from the other side; that we have seen in the previous session. We have seen that there is Work Centre 1, Work Centre 2, Work Centre 3.

So, the parts A, B and C are being manufactured independently by taking the raw material from the stores and all 3 are coming down on the assembly lines are getting assembled to get our product x which is then, going to the storage from where it is being dispatched to the market. So, we have seen in line or product type of layout we follow a particular sequence of operation. So, we will see in our subsequent sessions, what are the material flow patterns it can be U type, S type; I think I have explained in the previous session also.

Coming on to the other types of layout that we have to cover; in the last session 2 types of layouts were covered 1 was the product and the line type of the layout and the second

one was I think all of you must remember, what was the other type was? Other type was a very huge product an Aircraft or a Ship.

And the layout is called as the, I think all of you just can remember the type of layout that we have discussed that was the Fixed Position Layout in which the product remains stationary at one place only because of the nature because of the size of the product; it is a huge product. So, we cannot move the product from one workstation or work centre to the another work centre.

So, what will happen? The product remains at one place only, but the machines and people or equipment will travel to that product and the processing will be done there. Now, what type of machines and equipment are required portability of the machines and equipment becomes a very important parameter in deciding on the type of machines that can be used for a fixed position type of a layout.

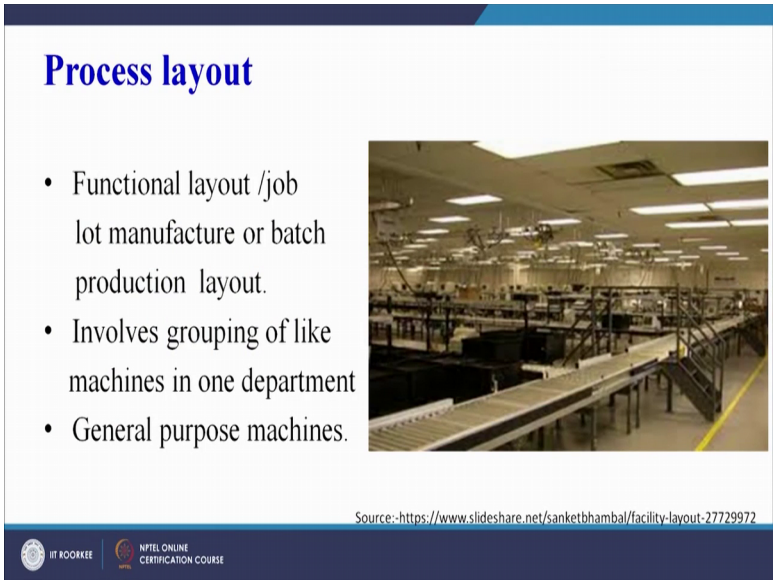
But the product remains at one place only; where as in case of a Line or Product type of layout, the product will move on the assembly line and I think I have given an example earlier also that manufacturing of automobiles usually follow a assembly line and the product or line type of layout. So, I think I have revised what we have already covered in the previous session.

And today, we will carry forward our discussion in week 5 on the types of layout; we have already seen 2 types of layout. We will carry forward and see that what are the other types of layout and with some examples, we will try to understand that what are the parameters that affect the selection of a layout and what are the characteristics of some certain special type of layouts?

So, basically when we have to plan our manufacturing facility, the first decision that is related to the location of the facilities is the layouts and there we need to understand that what are the various types of layout? Also from examination point of view, this is an important question which I have seen in most competitive examinations related to the layout. Sometimes, there may be a question related to a characteristic of a particular type of a layout or the comparative table between the different types of layouts or the factors influencing the different types of layout or the objectives of a good layout or what is a ideal layout.

So, layout is an important topic in operations management and therefore, we must address it properly and we must all of the learners must know that what are the various types of layouts that are followed in industry. And now, we will take forward our discussions related to the other types of layouts that are usually followed in industry. So, 2 types of layouts already you know the first type is the product or the line type of layout and the second one is the cellular oh sorry, the fixed position type of layout. Today, we will cover the process type or functional type of layout and the cellular type of layout and the service type of layout.

(Refer Slide Time: 08:34)



So, let us start our discussion with the Process type of layout. Before we understand the process type of layout, I must question that what are the limitations of a product type of layout or a line type of layout? The advantages all of us know; because there is a particular sequence or not much planning is required.

You know that the raw material will come from one end; it will be processed in a sequence of operations one after the other and the final product will come out from the other side. So raw material is entering, final product is coming out from the line type of layout; not much planning problems are there.

But the problem comes when one of the machines or the work centers fails or breaks down. The whole line will stop its operation. So, 1 big challenge. The complete breakdown of the assembly line will lead to huge losses for the organization. So, that is 1

limitation of the line type of layout. Moreover, the slowest machine will decide the speed of the layout or the speed of the line.

There may be machines which are very quick, very efficient, very fast. But the slowest machine will define the output that is that we can expect from that assembly line. So, the machine of the slowest speed is an indicator of the speed of the line. So, these are the 2 major limitations; breakdown of a single machine will lead to the overall breakdown of the line as well as the slowest speed will dictate the overall output of the line.

These 2 limitations are over come in process type of layout. In process type of layout, we see that it is a functional type of layout and job lot manufacturer, batch production type of layout. The previous type of layout is what type of production we can envisage there or we can foresee there when we have a line type of layout?

We know the types of production systems already we have covered in our course on operations management only. If you remember we have intermittent type of production systems and we have continuous type or mass type of production systems. So, line type of layout will be followed in mass or continuous type of production systems; because we require continuous output from the line and therefore, we will use a line type of production system in case of our continuous production or we will use a line type of layout in place where we want a continuous production to take place.

Whereas, if we have a job shop type or a batch type of production system, we will follow the process type of layout. So, you can remember to things by now, line type of layout line or product type of layout used interchangeably; Line or product type of layout continuous production or mass production; Process type of layout or functional type of layout job shop or batch type of production.

So, we can correlate the 2 things; we can equate the 2 things that in case of continuous production we are going to use line or product type of layout. In case of job shop or batch type of production, we are going to use process or functional type of layout.

So, these 2 things all the learners must remember and it is specifically mentioned here also that for job lot manufacture or batch manufacture batch manufacturing we are going to use process type of layout. What is this type of layout? We know that for job shop or batch we are going to use process; for line type of layout we are going to use mass

manufacturing and for mass manufacturing we are going to use product or line type of layout.

All of us know by now, what is line type of layout, but what is process type of layout. It is a clearly explained in point 2 that it involves grouping of like machines in 1 department. It involves grouping of similar machines in 1 department. We will see with the help of a diagram. Now suppose, the workshops in your colleges wherever we have studied engineering, most of the workshops follow the process type of layout.

All of you will see that there will be carpentry shop 3 or 4 or 5 depending upon the strength of student. There will be a carpentry shop there will be some number of machines there. There will be a foundry shop where all operations related to foundry and casting will be displayed or experiments will be conducted. There will be a machine shop where you will have all the lathe machines, drilling machines, milling machines, planers, shapers, C and C cutting machines.

So, machine shop will have all operations related to machining or all machines related to the machining operation. Carpentry will have all machines related to wood working or carpentry. So, specific functional areas are identified. So, that is an example of process type of layout. Now here you can see it has an advantage. The major advantage is that suppose, there is a breakdown of a particular machine in the carpentry shop. It will not affect the over or output of the layout, why? Because the other machines can perform their function and that machine can be stopped over for a period of time and the work can be shifted to some other machine or it can be outsourced.

So, basically a breakdown of a specific machine will not stop the overall production process in process type of layout and that is one of the advantages of this type of layout. And second type, second advantage is that here also the slowest machine may not affect the overall productivity of the organization.

Because we may have number of series or series of such machines available which can take care of the demand or the require or the production requirement. Because there will be a group of machines in every section or every functional group or every functional area. So, drilling section may have number of drilling machines; lathe section may have number of lathe machines and therefore, the work can be over all managed properly.

Because we have number of duplicates of these machines available in a particular section or a department. So, it that overcomes the limitations of the line or product type of layout; but this type of layout will also have its own limitations. What can be the limitations? We see, we have seen that not much planning acumen, not much planning mind is required in case of line type of layout because the raw material is entering from one end and it is getting converted into the product at the other end. But here we have to do our production planning and control properly. We have to see that which batch is moving from which department to which department. So, all that planning has to be done properly.

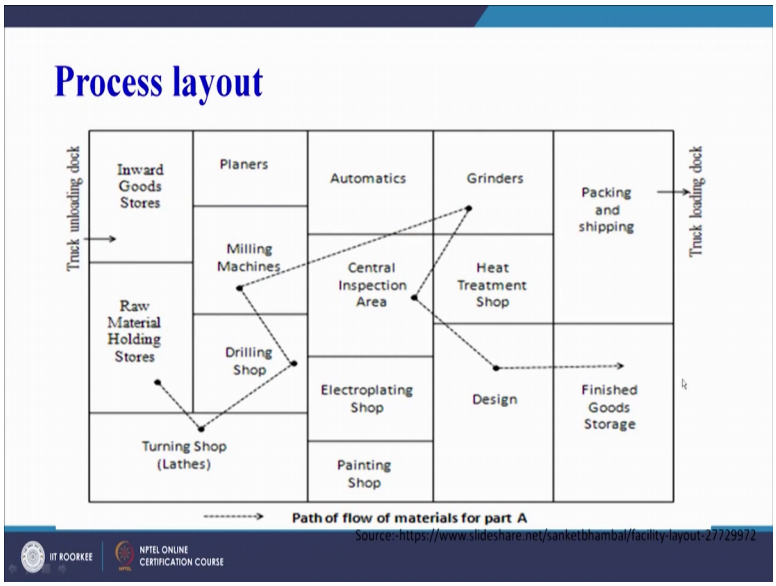
So, the task of production planning and control becomes more rigorous and more involving as compared to the product or line type of layout, one additional aspect that I missed here is that we have to have general purpose machines here. A product or line type of layout, the product design will be more or less consistent more or less constant. For example, a company is producing a car. So, the design of the car is not going to change may be in a year or 1 and half year or 2 years time.

So, once a line or a product line is dedicated for assembly of a particular brand of car or a particular module of a car; the all the machines in that line may not be very versatile. They may be dedicated machines for a specific set of operations only. But here in case of process type of layout, frequent design changes. Because batches of products will come and the designs of these products made be different. So, since the product design will keep on changing and there will be a wide variety of products that are produced.

So, the machines need to be general purpose machines in case of process type of layout and these general purpose machines will be able to adapt to the design changes in the most efficient or time efficient manner and will help in improving the overall productivity of an organization.

So, 3 important characteristics we can remember related to process type of layout. First one being that it is used for job shopper batch type of production systems. Specific sets or specific departments are based on specific type of machines. So, the it involves grouping of similar types of machines in specific department. And finally, it makes use of general purpose machines as the product design change is regular or the product design changes on a regular basis.

(Refer Slide Time: 18:03)



Now, let us see an example of a process type of layout on your screen. So, here we see that we have a Turning Shop; where all the Lathe machines are there. We have a Drilling Shops; where all the Drilling machines are there. We have all the Milling Machines here. We have Planners here. We have Automatic machines here. There is a Central Inspection Area. There is a Design cell. There is a Heat Treatment Shop; there are Grinders. So, you see specific machines are grouped together into specific areas or into specific departments. And then, 1 batch of material, 1 movement of material is depicted here with dotted lines you can see.

So, this is a raw material section. This is a Truck unloading dock. It is a outside from outside, we are getting the raw material. Trucks will bring the material, it is getting unloaded here. This is the Inward Goods Store where, maybe some quality inspection may be done of incoming raw material. This is the Raw Material Holding Stores where, we are keeping our raw materials. Then it the first operation is on Lathe machine turning shop; then, there is whole drilling or whole making operation. Then milling operation; then, finally, finishing or grinding operation. Finally, it comes for inspection and then, to the design and finished goods store.

So, design may be the overall may be checking up of the product or may be the quality control department. So, this is showing the path of flow of materials for part A and this is a Truck loading. This is the packaging and the shipping. So, the raw material is coming;

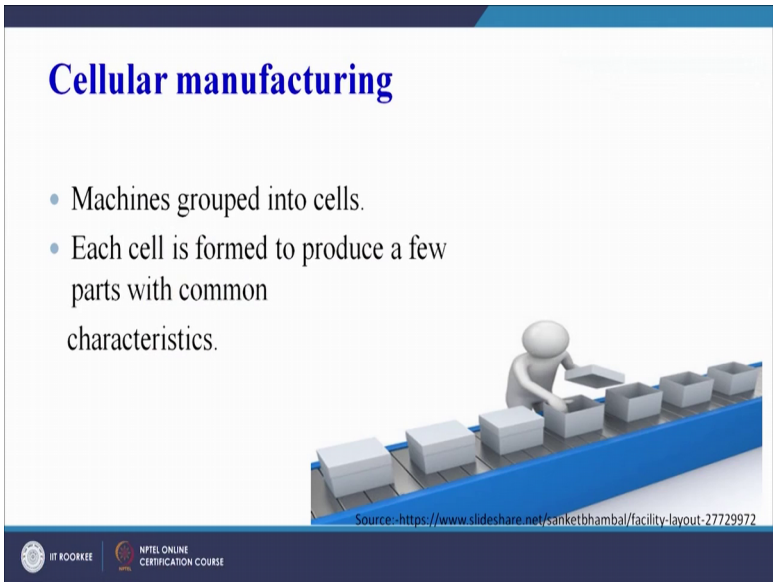
it is traveling to the various sections within the organization or within the factory and it is being dispatched; after being converted into the final product. So, here, we see that it is not following a straight line or a sequence. Another product may be such that it may require electro plating operation after milling.

So, this path line would then, instead of moving to grinding; it will first move to electroplating shop and then, maybe going to the heat treatment shop. So, sequence will be dependent upon the requirements of the product and there are specific dedicated areas for similar types of machines in process type of layout. So, 1 single line of operations or may be continuous operations 1 after the other is not the case, in case of process type of layout.

Some of you may wonder that here also 1 line we are having, but that line is not consistent not constant for all types of product that are manufactured in a process type of layout. Suppose the company has a product mix of 7 different products; each product may have a different lines and depending upon the design changes, this line of operations or sequence of operations make keep on changing in process type of layout. But ONE thing we must keep in mind that in product or line type of layout, the sequence of operations is fixed and it remains fixed for a specific product and that line is dedicated for that product only.

So, the that is the basic difference between the product and the process type of layout. Then, there is a specific type of layout that we call as cellular type of layout and the manufacturing based on this cells is the usually called as Cellular manufacturing.

(Refer Slide Time: 21:34)



Now, in cellular type of layout, we have machines which are grouped into cells. So, we will try to understand this with the help of a diagram and each cell is formed to produce a few parts with common characteristics. Before explaining the concept of cellular manufacturing, I would like to invoke another word that is group technology; because here we are producing few parts with common characteristics.

So, the word group comes into picture; we try to group the parts the company is producing into a part family and that family has some or certain common characteristics. For example, all the ax symmetric parts of a specific length can be grouped into 1 part family and that part family can be processed in 1 cell. Now some of you may be wondering, why? What is the requirement of making these families? When we have a process type of layout, we can make batches of these components and maybe a 1 path can be identified and they can just be processed into the different departments and finally, into the final product.

We need to take advantage of the similarities of the product that we are producing and another important point, why this type of layout has been developed is the time taken to set up a machine for a particular operation.

Usually, it is observed; all of you may have done experiments on lathe machine maximum time goes in setting up the job in the chuck than the centering of the tool. So, if you are do, if you have done the job with your own hands; you will remember, the

actual machining time is just a fraction of the overall cycle time. The overall cycle time involves setting up the machine, fixing the job, setting the tool, fixing the tool, bringing the tool and work piece together setting or centering the job and the tools. And finally, performing the operation the actual operation is very very less time taking or is very very quick, but the overall cycle time is high.

So, if we have similar products, similar shaped products, similar sized products; we need not spend too much of time in setting up the machine for performing a particular task. So, a cellular type of layout saves a lot of time which is usually spent in setting up the machines for different product. Because here we have a group of product or we have a part family which will go to a specific cell and that cell will have a dedicated machine for this type of products only and may not require or I must not say may not require, will definitely will not require high or larger time or maybe more time for setting up in order to perform the operation.

So, in order to reduce the setup times, we group the products in to part families and we put the machines in specific cells which are dedicated to a particular part family. And this part family will go to that particular section or that particular cell and will get processed here. Now must I address some of you may be wondering that then, what is the difference between a process and a cellular type of layout? Here also we are having cells which will have machines.

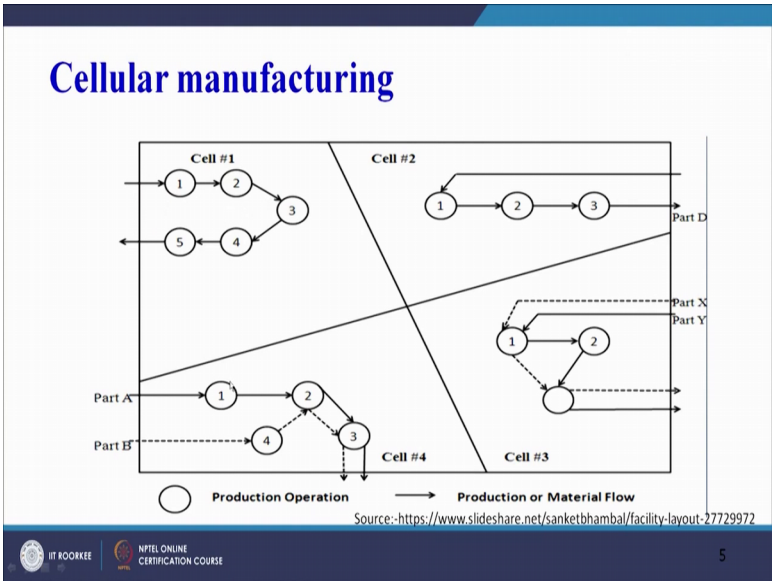
So, in process type of layout the sections of departments are based on similar type of machines; for example, in turning we may have all lathe machines, in drilling we will have all drilling machines, in milling we will have all milling machines, in carpentry we will have all woodworking machines. But in case of a cellular type of layout each cell may have a lathe machine also; it may have a drilling machine also; it may have a grinder also, but this type of machines will be such that a particular part family will get all operations done within that cell only and the final product will come out from that cell.

So, we will try to I think I have tried to explain the concept of group technology that why do we group the parts together in order to reduce the setup times and what is the criteria for grouping the a products in 2 parts. So, we can classify your, we can group the parts

together based on the shape of the product, based on the size of the product, based on the similarity in the operations required on that product.

For example, there is a part family which may require only turning and drilling operation only. So, we will make a part family of the parts which only required these 2 operations and in that cell, we will have only turning machines as well as the drilling machines. So, that this part family goes there into that cell sequence of operations is followed and then, it goes to the next may be if it is a final product it may go into the dispatch.

(Refer Slide Time: 27:08)



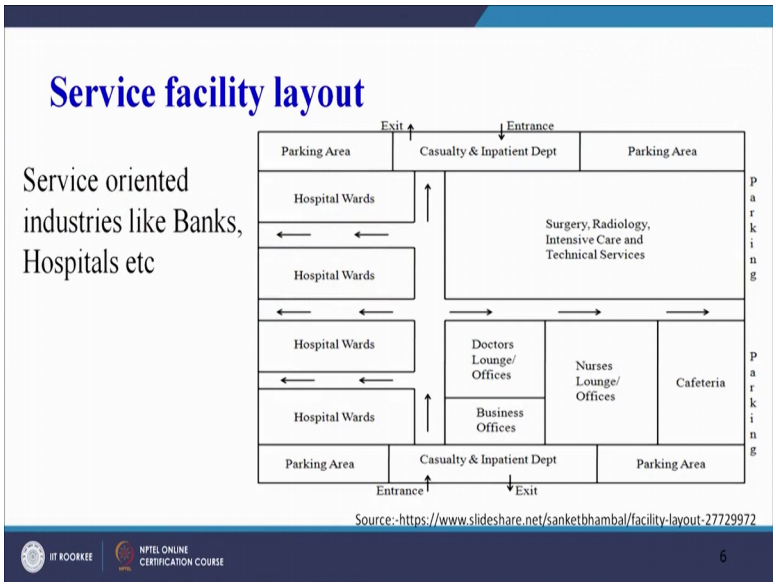
Here we see, for your reference. This is cell 1, the solid line shows the production or material flow.

So, we see the material enters, it goes to machine 1, 2, 3, 4, 5 and then, it goes out. Similarly this is may be for part A, it goes to machine 1, 2 and part B comes dotted line goes to 4 and then, maybe they goes to 3 and then, maybe this is a Cell; this is 1 particular Cell. Cell 4; this is Cell 3; this is 2; this is Cell 1. So, Cell 2 is dedicated for Part D only, you can see Part D comes here. 1, 2 and 3 are the operations. So, 3 operations are done maybe these may be different operations, it may involve turning drilling and grinding.

So, you have done turning; then, drilling; then, grinding and all these parts go out. So, Part D similarly part X and Y are here both of them come and they get assembled and

then finally, they come out from here. So, basically we can see that there are dedicated cells 4 cells here. Cell 1, Cell 2, Cell 3 and Cell 4 for specific type of parts. So, part A and B are being processed in Cell 4; part X and Y are being processed in Cell 3. Part D is being processed in Cell 2. So, this is way, this is the way that different part families are processed in different cells. So, this type of layout usually we call as a Cellular type of layout.

(Refer Slide Time: 28:37)

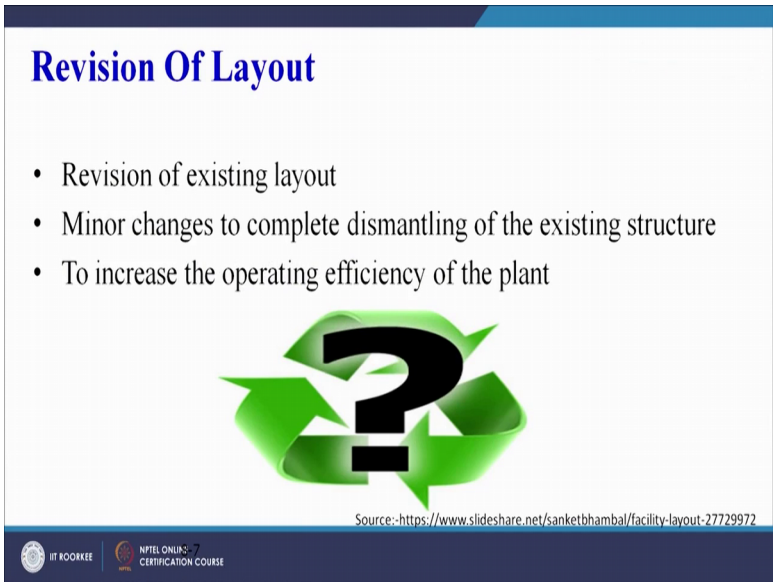


Then, we have service facility type of layout also and this is can be followed in case of banks or hospitals.

So, here we can see ,this is the layout of a Hospital. Hospital Wards; this is again, Wards, Wards and Wards. So, there we have all the Wards in 1 section of the hospital. Then, the Surgery and Radiology and Intensive Care and Technical Services.

This is the area, this is the Parking, the Cafeteria, Doctors Lounges, Business Offices, Casualty and Inpatient Department, Entrance and Exit. So, you can see for any hospital or a bank we have a specific type of layout. Let us try to see few examples now. Since, there can be a layout which we are already following; many times we may need to revise the layout also. Why do we need a revision?

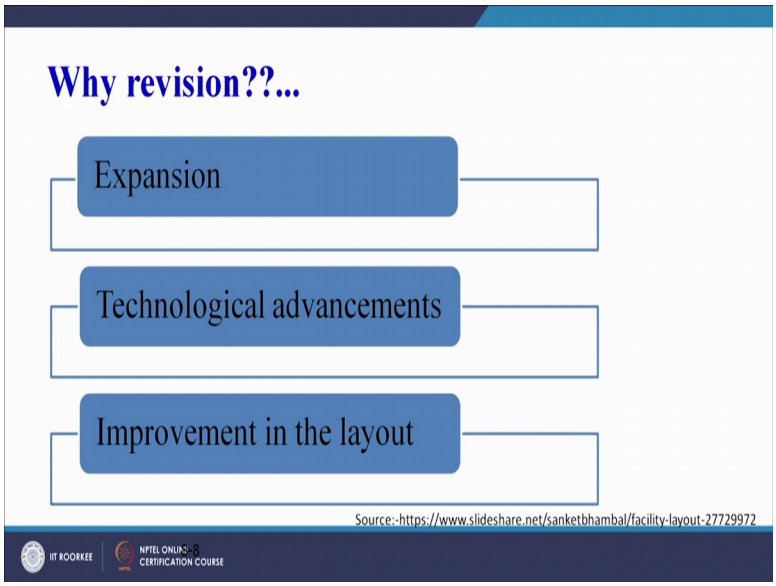
(Refer Slide Time: 29:30)



A revision of an existing layout can be done. Minor changes to complete dismantling of the existing layout is also possible and why do we do that? We do that to increase the operating efficiency of the plant. If you remember in our previous session, that is session number 21, in week 5 ,we have covered that what are the, what is the ideal layout or what are the goals or objectives of a good layout or what are the goals and objectives of a layout?

So, there we have seen, we need to improve the production efficiency; we need to make the things easier for the work people, for the work personal who are performing the task. So, basically revision of layout is also possible and most of the companies keep on revising the layouts in order to improve their production efficiency.

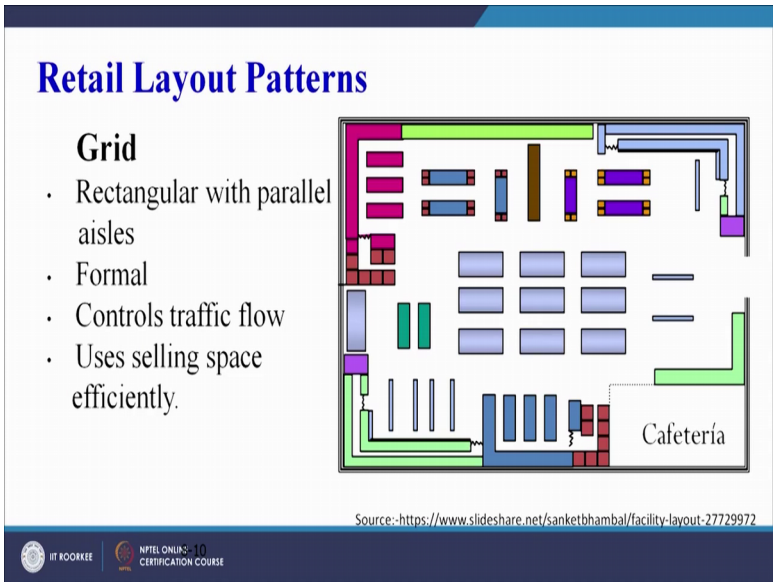
(Refer Slide Time: 30:22)



Now, why revision is required? As I have already explained in the previous slide, sometimes the companies may need to expand or they need to put in or bring in more machine. So, they need better utilization of the space existing with the company or there can be technological advancements it may. So, happen that the 4, the task of 4 machines may now be able to be done or because of the technological advancement we can do it on single machine also.

So, we will try to revise our layout002C remove those 4 machines or maybe we can sell off those machines and put a single machine in place of those 4 machines; again, we need to revise our layout and then, we can have a sole purpose of improvement of the layout. We feel that the space is not been utilized properly. We need to improve the space utilization and therefore, we need to revise a change our layout. Now just layout planning is another term which is used.

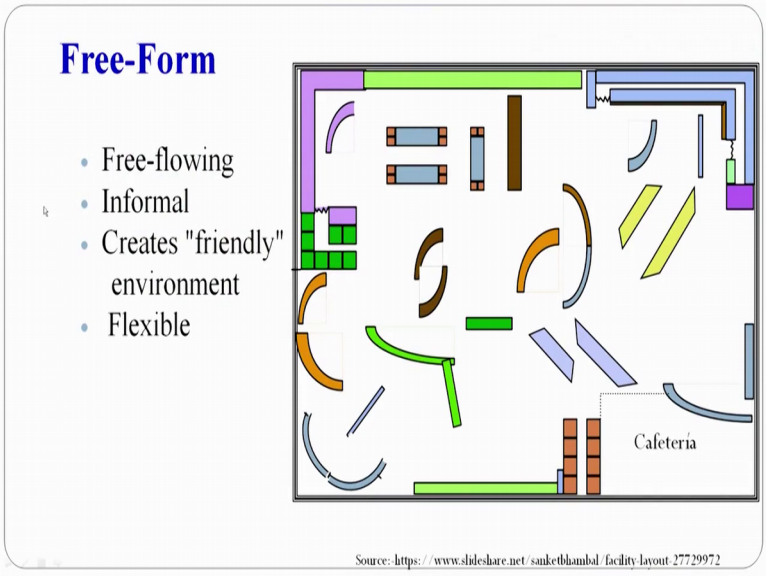
(Refer Slide Time: 31:19)



And we can see here, this is Retail Layout Patterns. This is an example where, Rectangular with parallel aisles. These are the Rectangular facilities Grid type of layout this is more Formal. Controls the traffic flow. Uses spelling selling space efficiently. So, this can be a retail, if we see if we go to a shopping mall there is a retail store there. So, this is usually a layout because there what is the target? The target is the customer must be able to see the display of the retail items or the retail goods.

So, we have to ensure that the movement is such that the customer moves around in an open space and the displays are such they are parallel. So, that the customer can see, just pick up the thing and put in his basket. So, the it we have to manage layout in such a way that the traffic flow is constant or it is a we can say uniform as well as smooth for the customers formal uses the selling space efficiently. So, the displays of the various retail goods are arranged in such a way that the customer is easily able to see them and select them in the shortest possible time.

(Refer Slide Time: 32:48)

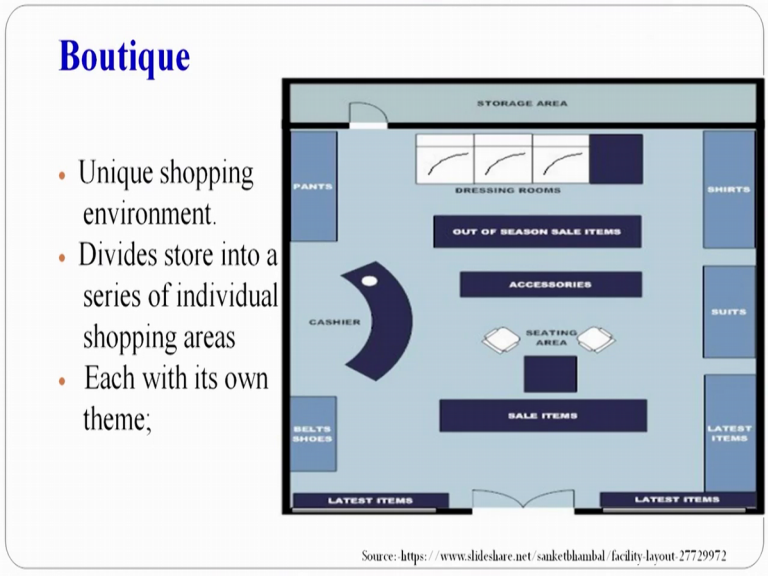


So, this is just a layout, a general layout of a of a retail outlet. Then, Free-Form also sometimes, this many these companies these days many startups use a Free-Form type of layout where, it is Free-flowing; there is no standard pattern and it is usually in formal type of layout.

Moreover, it creates a friendly environment and it is Flexible, sometimes you may not use rigid structures there you may use flexible structure. So, that every now and then, you can keep on changing the layout; maybe we can take an example of a hostel room you have a bed, a table and a chair. It is the flexible type of layout, you can organt your table, chair maybe every month you can change the reorient or you can change the orientation of your furniture in the room.

So, you are changing the layout and you have a feeling of change that is necessary in our monotonous life. So, this Free-Form type of layout is usually in formal and is more flexible. So, that you can change it or revise it. We have seen, what are the different types of layouts and why do we need to revise the layout? So, once we have a flexible type of layout, we can very easily revise it. There is one small case study.

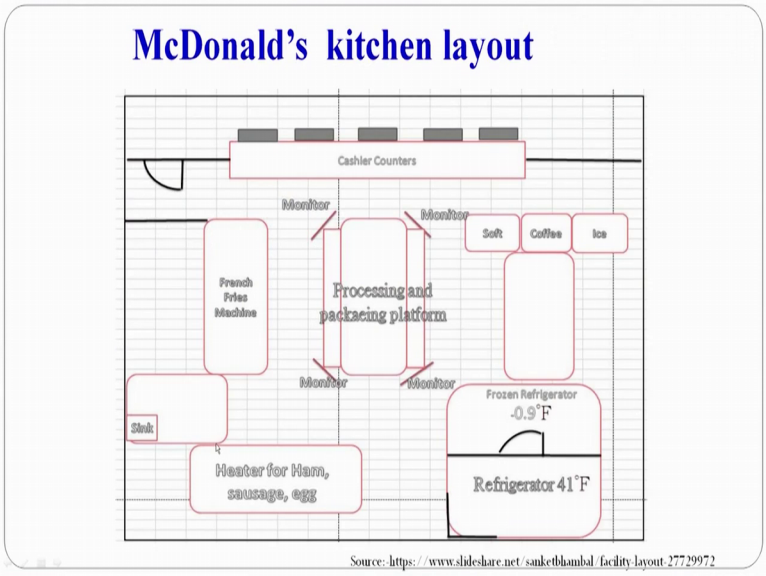
(Refer Slide Time: 33:58)



This is another example of a Boutique; where, we can see where are the, where what are the facilities in within a boutique, there is a dressing room here, there is a pant section here; this is cashier; this is seating area, accessories, sale items, out of season sale scenes; these are shirts, suits, latest items.

So, we can see once this, once we customer enters the showroom; latest items are usually displayed in the beginning. You can experience this whenever you go to a particular apparel store, you can see the latest items will be at the beginning only. So, the latest item and the items which are out of fashion maybe towards the end. So, these are out of season sale items here. This is a cashier a general format for of boutique unique shopping environment divide store into series of individual shopping areas each with its own theme.

(Refer Slide Time: 34:57)



Now, we can see a case study of a McDonald. This is just Kitchen layout for a McDonalds Kitchen. So, we can see we have a French Fries Machine here. There is a Refrigerator for storing the raw materials. There is a Heater for Ham, sausages and egg. There is a Sink for washing the utensil. There is a processing and packaging platforms.

This is the, these are the Cashier Counters; where, the customers can come and place their order and then, this is the area where we have written McDonalds Kitchen where, the customers can take their food and sit and enjoy the food. So, this is a typical layout of a Kitchen. So, with this I think, I have already exhausted my 30 minutes time for this session and we have already jumped the time window of 30 minutes.

So, I will end the session here today, but we have tried to understand the different types of layouts and in the very brief session, I have tried to compare the different types of layouts also. So, I request all of you to remember the 4 types of layout; the product or line type of layout; the process type of layout; the cellular type of layout and the fixed position type of layout.

Because these are the 4 major types of layouts that are used in industry and we have seen specific examples of a McDonalds Kitchen, A Hospital, A Boutique and A Retail Outlet. So that you can relate, what we have studied theoretically with the practical experiences that all of us have, when we venture out of our houses.

So, with this we close today’s session.

Thank you.