Production and Operation Management
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Lecture 49
Facility Layout-II (Group Technology and other layouts)

Welcome friends. In our last session, we started discussions about another very important aspect of operations management that is how to design your facilities. We discussed that facilities can be of different type, these can be the manufacturing facility, the plant factory, then it can be a warehouse facility where you are stocking your goods, then it can be retail facility also.

And if I talk of service case, in that case, your office where customers are being served that is also a facility. Then another name for facilities can be the hospital building that is also a facility, the building of a school that is also a facility, the building of a bank that is also facility, the airport that is also a facility, so all these are the different types of examples of facilities.

We have to design the facility in such a manner that you can take maximum advantage of available space. And when we are saying the maximum advantage, we basically want two things, one is the cost of material handling, cost of movement is as low as possible and it should help in improving the productivity, it should help in improving efficiency of our value addition process. So, these are the two very important aspects in designing the facility layouts.

We discussed two very important types of or you can say two generic type of facility layouts in our previous session, one is product layout and the other is process layout. In the product layout, we discussed that how we are designing a particular layout for the requirement of a particular product. So, you are making very high volume of a particular product and you do repetitive task and therefore you have arranged your entire facility in a particular manner which is suitable to produce a particular product.

Then we discussed another kind of layout that is the process layout. In process layout, we discussed that volume of production is not so high but variety is very large and therefore when you are producing large amount of variety, you cannot have fixed operation of machines.

So, in this particular case, you arrange your machines in various clusters, so that you have enough flexibility that as per the requirement you can move your products using different roots within the plant, so these are the two extreme cases of product and products process layouts and both these are having some advantages and some limitations.

But in real life we have some different types of issues and therefore, we want to use some kind of combination of product and process layouts, so that to some extent we should be able to take advantage of both these types of layouts. And therefore, if you visit a plant, you will see that maybe in one particular section, in one particular department of the plant, the company is following the product layout but in the other section, the company maybe following the process layout.

Because when the product is suitable, when you have same type of product continuously under manufacturing then you make a product layout. But within that plant when you have a maintenance department, so each product, each tool may require different kind of maintenance requirements and therefore you will have the tool room or the maintenance section under the process layout, so these types of things are there. Now, to have those combinations and what are the other important aspects in our layout, we will discuss in these new sessions.

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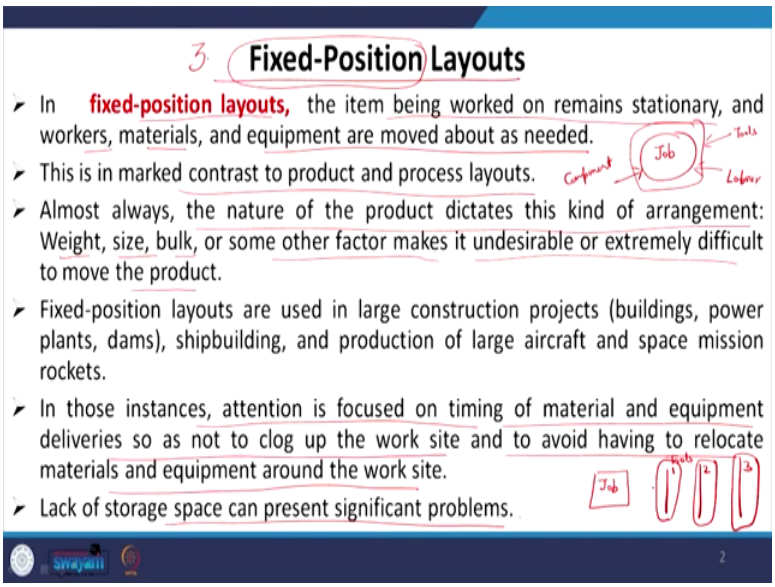

So now, another type of layout which is there, already two types of layout we have discussed, so this is the third type of layout that is fixed position layout. Now, fixed position layout and our earlier two layouts, the fundamental difference is that in that layouts our job, the work

that is moving from one machine to another machine, so all the tools, all the work centres, machines were stationary in our product or process layouts and the job was moving from one machine, one work centre to another work centre.

But the fixed position layout, here the job is stationary, the job is stationary that is the meaning of fixed position, the job is stationary while tool is moving. The tool which is required to perform some kind of operation will go to the job and perform the operation and then again go back to its original place. So, in this particular case, the job is stationary while tools are moving, coming to workplace, coming to that particular job and then once they have done their work, will go to some resting place.

So, it is a very reverse kind of arrangement. So, as now you can understand when job is stationery and tools are moving. So, normally, you will find the application of fixed position layout wherever the size of job is excessively large. It is not economical; it is not worthwhile to move job from one place to another place and a very common example, we all see in the real estate industry, when we are constructing our house. So, that house that apartment is a kind of example of job work.

And workers are coming, workers are moving within that job. Tools are coming, sometime woodwork tools are coming, sometime mercenary tools are coming, sometime electrical tools are coming, sometime plumbing tools are coming, so tools are coming to that workplace and workplace that work or the job remains is stationary.

So, that is the key point with respect to fixed position layout that item being worked on remains stationary and the workers, materials, equipments are moved about as needed. So, you job is fixed and tools then labour, then other component, all these things are coming to this particular job as and when things are required. So, this is completely in contrast to product and process layout as we have already discussed.

Almost always the nature of product dictates this kind of arrangement. So, like already we have told, weight, size, bulkiness that makes the undesirable or extremely difficult to move the product.

So, I gave the example of housing projects, similarly if you see in manufacturing, examples like aeroplane industry, wherever you have ship building, so these are the kind of products which are very very large in size, very bulky, so it is almost impossible to move them from

one place to another place, so their job remains stationary and items are, the tools are coming and going.

So, if you visit any ship building facility, you will see that kind of fixed position layout. So, we have already discussed these, so now in this particular case, attention is focused on timing of material and equipment deliveries so as not to clog up the work site and to avoid having to relocate materials and equipment around the work site.

Lack of storage spaces can present significant problem, because around the workplace, around this job, tools are coming and going, so you have to design the place in such a manner that around this job, congestion should not take place. If congestion will take place then it will be difficult to move these tools, materials, labours, etcetera, so that is the only important point.

The other important point with respect to fixed position layout is that that there will be few tools which will be used frequently again and again, maybe almost on the daily basis. And there may be few tools which will be required not so frequently, maybe once in a week or once in a fortnight kind of thing. So, the distance from job to various tools, these are the tools 1, 2, 3, so tool once tools which are in this category they are used very frequently, tools which are at 2 these are used less frequently and tools which are at 3 they are having very rare frequency of uses.

So, the point is that we should place our tools with respect to job in such a manner that those which are frequently used should be placed closer and those which are not so frequently used can be placed at a distant location, so that you can minimize their movement. If you place frequently used tools at a distant place then it will have larger movement. So, that principle of minimization of distance movement, that is applicable even in this fixed position layout also. So, that is about the fixed position layout. Then we use combination layouts.

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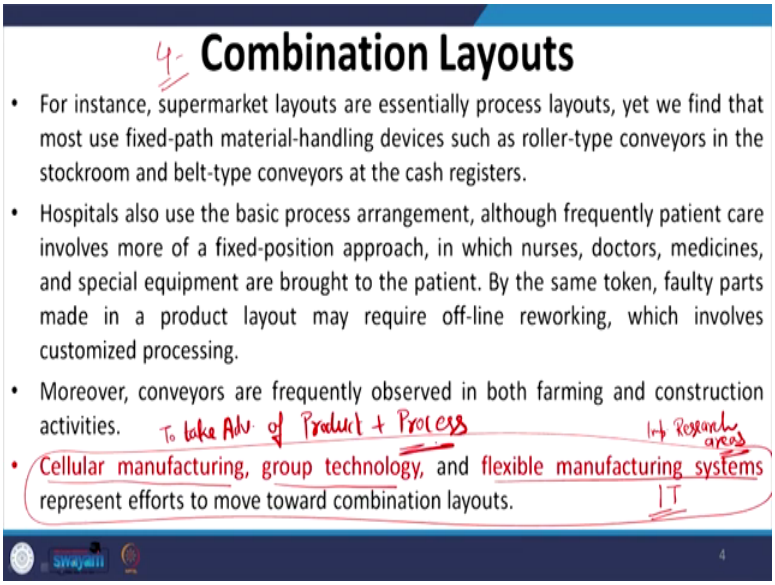

Now, the combination layouts are in a sense combination of product and process layouts. Now, here we have different type of names for the combination layouts, these are worth knowing that cellular manufacturing, group technology or flexible manufacturing systems, these are some of the very popular names, these are used very regularly whenever we are talking of advanced manufacturing techniques.

So, when we talk about advanced manufacturing techniques, one of the important thing is whether you have adopted cellular manufacturing, whether you have FMS in your organisation, whether you have group technology in your organisation and these things are very important research areas also.

Nowadays the advanced research in the facility layouts are happening with respect to cellular manufacturing, group technology and flexible manufacturing systems. Whether you have appropriate decision rules for all these types of systems, there are important terms like part families, etcetera, so how to design a particular part family, so these are the kind of issues which are very much in use and this research is properly supported by the use of IT.

So, because in these systems, the advancement of IT is very very important driver for the successful implementation of cellular technologies, group behaviour and then flexible manufacturing system in the organizations. So, IT and the latest research which is helping in development of these kind of combination layouts.

So, in the combination layouts, the idea is basically to take advantage of product plus process, that is basically the idea of this particular system that how we can take the advantage of,

because product layout gives you very high level of economies of scale. You can remember these key points that product layouts offer you high economies of scale because of repetitive nature of your work. So, cost of production per unit is very low, so that is something, we actually want that how can we reduce the cost of production per unit.

The process layouts offer you good amounts of flexibility. Flexibility is almost 0, you can say in a product layout. So, product layouts are very rigid. So, we do not want rigidity but we want low cost of production. Process layouts offer good flexibility but the cost of production is high in this particular case because of lack of economies of scale.

So, as a user, I want to have both these benefits, I want to have flexibility and I also want to have lower cost of production per unit. So, that is what being offered by these combination layouts which are cellular, group or flexible manufacturing systems. So, now we will see that how we are going to develop these different types of layout.

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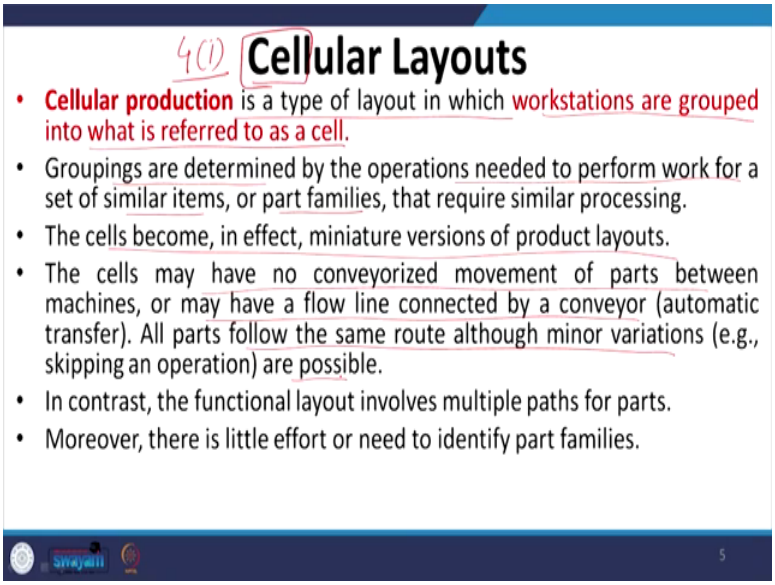

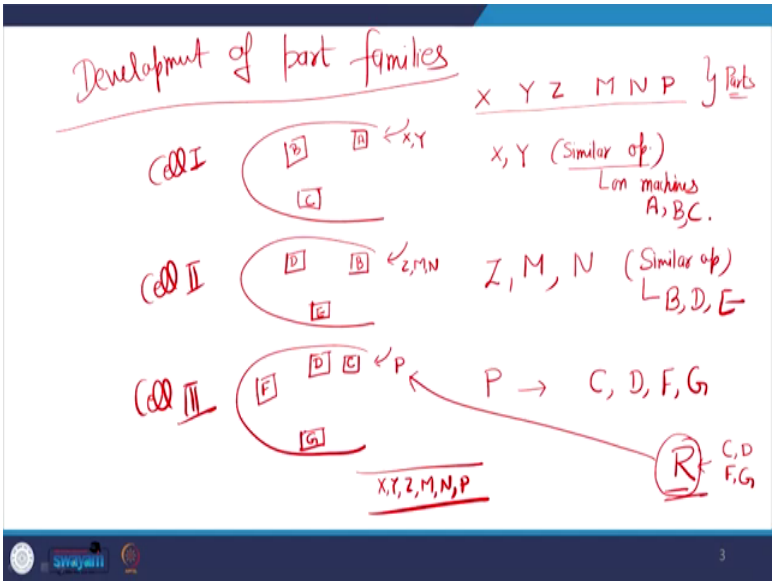

So, one of the important type of layout is cellular layout where the concept is like, we develop layout in the form of cells, we develop layout in the form of cells that different types of cells are generated and as I have written also that it is a type of layout in which work stations are grouped into cells. So, you have to develop cell.

Now, how good you are in developing a cell that will determine the efficiency of your cellular layout. And many organizations have done tremendously well, tremendously well, in India particularly, if I say that one organization which has mastered that is a public sector undertaking but HAL Hindustan Aeronautics Limited that is one of the organisation which has mastered the art of cellular layouts and earlier they were using the product layout where the movements were very long, in more than 50 60 kilometres kind of assembly line they used to have.

But by using cellular layouts, they actually cut down their movement from 60 70 kilometres to just less than 10 kilometres, so, you can understand, now if you translate this reduction in distance travelled into time, into money, you can directly understand that how much benefit you are going to get by adopting the cellular layouts. Now, how we are doing this development of cell? For that groupings are determined by the operations needed to perform work for a set of similar items or part family.

So, like if I go back, if I see that development of part families because in our cellular layout what happens, we develop different types of cells. In these cells, some machines are installed. These are A, B, C, in this I have B, D, E, in this I have C, D, F, G, these are the 3 cells. A, B, C, D, E, F, G, these are the names of machines. Now, in my production, there are different

types of components X, Y, Z, M, N, P, these are the different types of parts which I have to produce.

Now, out of these X, Y, Z, M, N, P, X and Y similar operations, they require similar operations and these similar operations can be performed on machines A, B, C. Then Z, M, N these require again similar operations and the machines require for these similar operations are B, D, E. Then another product is P and the machines require for making P, these are C, D, F, G.

So, you have three part families on the basis of, this is my way of development of part families, there can be multiple other ways because you see that B machine is used in 1st part family and the 2nd part family, C machine is used in 1st part family and 3rd part family, D is used in 2nd and 3rd also, so there is some kind of repetition, these are not completely exclusive cells. So, you can have that kind of, then IT plays important role. Should I have D in both these cells or should I have D separately wherever D is required, so that part will go to D machine.

Now, these X and Y will be produced here, Z, M, N will be produced in this second cell and then P will be produced in the third cell. And then finally you will have the assembly of X, Y, Z, M, N, P. So, this is how three cells, cell 1, cell 2, cell 3, these three cells are there and these three cells will make you three different part families. So, now any new part, any new part, let us say a new part R is to be introduced, you want to make one new part R and that R has requirements similar to P C, D, F, G, you require machining of this R on these 4 machines C, D, F, G.

So, it this new part R will join this part family, this will become a member of this cell 3. And that is how we develop the part families and that is how we are able to take the, now within this, within this cell, it is like a product layout, within a cell it is like a product layout, but when we see cell 1 to cell 2, cell 2 to cell 3, cell 3 to cell 1 then it looks like a process layout.

So, you have within a cell it is like a product and then it is a process. So, it is a very useful way of developing that combination layout where you can get the advantage of product and process layout. So, the cells becomes in fact the miniature versions of product layout, so within cells you have a product layout and then the cells may have no conveyorized movement of parts between machines, or may have flow line connected by a conveyor. All parts follow the same root, although minor variations are possible.

So, within a cell some parts may have minor variations but normally within a part family, all parts require similar kind of operations. And in case of our earlier functional layouts, we have already seen that how for producing different types of products, multiple paths are required. So, you have actually eliminated the role of those multiple path by dividing your different types of parts into different kind of part family.

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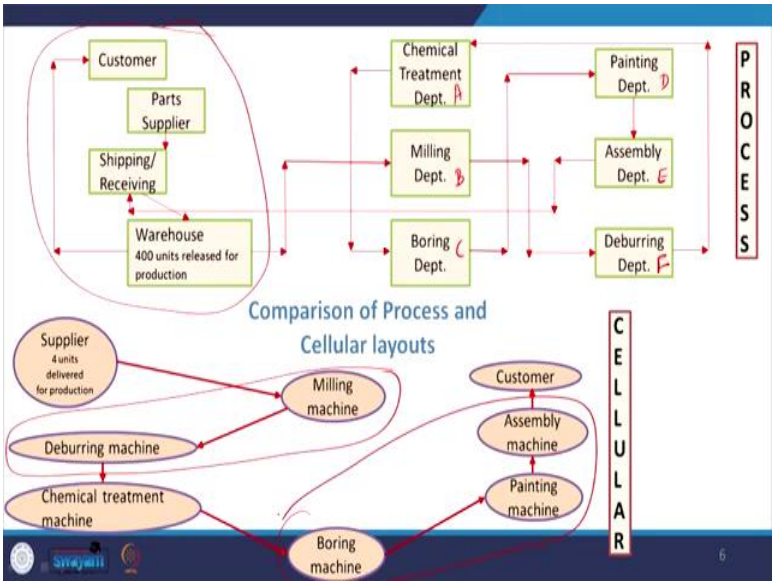

So, here you can have a very systematic comparison between your process and cellular layout. So, in this particular case if you see that there are different types of, this is the warehousing and that particular area where supply is coming. Now, here you have various processes, chemical treatment, milling, so you can name them as A, B, C, D, E, F.

Now, you are seeing that multiple arrows are there from movement of parts, from one section to another section, one department to another department, multiple movements are there because multiple customers are there and customers are requiring different types of parts. So, you see the part supplier, from here our journey is starting, you are receiving the supply then you are putting them into the warehouse and then these parts are going to milling and then from milling it is going to deburring section and then it is going to some other section then to other section.

Now, it may depend that what type of operations you require, these sections may be the part of your movement or may not be the part of your movement, so this is a kind of a process layout with, where the movement, these arrows will change as per the requirement of customer's order or customer's specification.

In the case of cellular layout, what we are doing that we will make the system in the form of cells. And here you see that different cells are there and these cells are like, you have the milling machine then deburring machine, chemical treatment, boring machine and then painting assembling section.

Now, what we are doing that now these criss-crossing of arrows not happening in case of cellular layout. So, when criss-crossing is not happening, it gives you a feel of product layout. Now, what is to be done that this may become, 1 cell, this may become 1 cell that right from the supplier, milling to deburring that is part of **one** (impor), 1 cell.

Then you may have a separate section for chemical treatment which may not be combined with any other section. And then all these 3 things can be the part of 1 cell. So, you have divided the entire operation into different cells and that will give you the flexibility of using. Maybe in some case, chemical treatment is not required, so you can directly move from cell 1 to cell 3. In other case, if chemical treatment is required, you can go from cell 1 to cell 2 to cell 3.

Now, the flexibility is also there and at the same time you have the advantage of economies of scale, your cost of production will go down. So, that is why these cellular layouts are very important thing and nowadays most of the organisations particularly organisations looking to have more competitiveness from their manufacturing go for adoption of cellular layouts.

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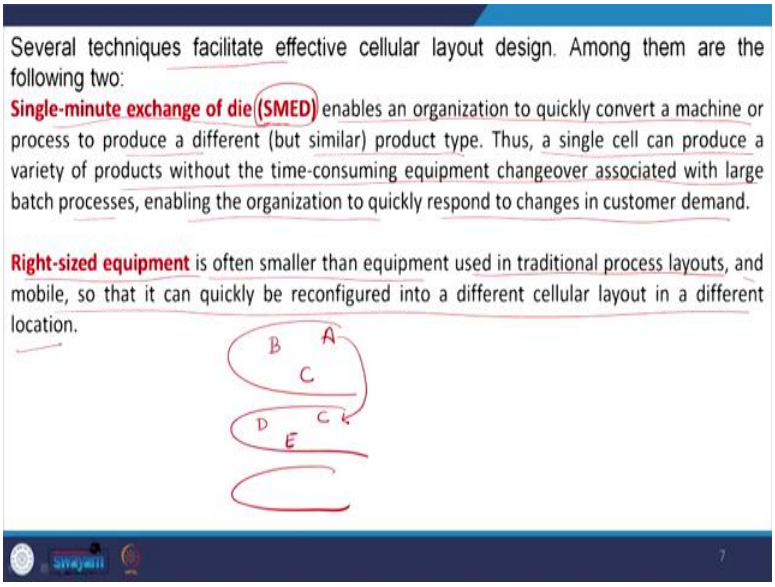

Now, some of the important terms we like to mention which are used to facilitate effective cellular layout design and one of them is single-minute exchange of die which is very

commonly known as SMED that is single-minute exchange of die. And this is actually how fast you can replace your dies so that your setup time can be minimized.

So, it enables an organization to quickly convert a machine or process to produce a variety of product types. Thus, a single cell can produce a variety of products without the time consuming equipment changeover associated with large batch processes, enabling the organization to quickly respond to changes in customer demand.

So, because like you are making bulbs, you are making toys, you are making furniture items, so you require different variants of furniture. Now, in that particular case, if you have the facilities of SMED in your organization that will enable you to quickly respond to varied needs because you will be ready with various kind of changeovers and complete die will not required to be changed.

Then another important term is RSE that is right-sized equipment that is often smaller than equipment used in traditional process layout and mobile so that it can quickly be reconfigured into a different cellular layout in a different location. Sometime it is possible, like we discussed these three cells and here we had three machines A, B, C, in another we had C, D, E. It is quite possible because of flexibility which you want to build into your system that we want to shift this machine A from cell 1 to cell 2.

Now, when we are willing to shift machine A from cell 1 to cell 2, if machine is not of right size, it will not be fitting into the cell 2, it will create a problem, so we want to have smaller and those machines which can be moveable, so that if I move them from one cell to another cell, it can easily adjust, it can easily fit into those cells.

If you use traditional heavy oversized machines, it will be very difficult because that place you require customized fixtures, customized system for those machines, so we do not want that kind of bigger machines in our cellular systems, in this particular system we want a smaller machines.

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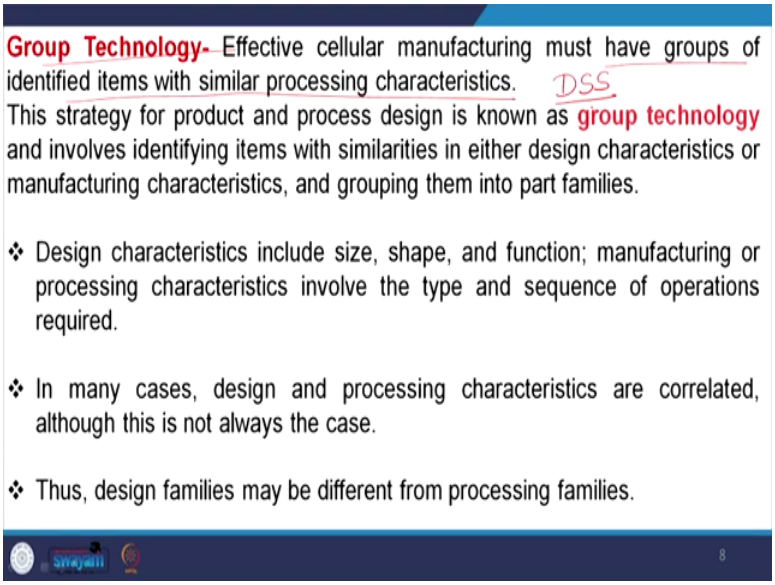

Then the group technologies are also there which are very much similar to cellular layout and the effective cellular layout must have groups of identified items with similar processing characteristics, so that we have already discussed that these are our part families which are requiring similar kind of processing requirements and on the basis of that we develop different types of decision support systems.

To identify that how can you put different products into similar kinds of processing requirements, so because if you go to an automobile company where thousands of components are manufactured, so it becomes very difficult manually to develop the right part families. So, we have good number of DSS and in our ERP systems nowadays we are able to identify combination of those products which require similar processing, so on the basis of that the group technology is very much, you can say important part of cellular layouts.

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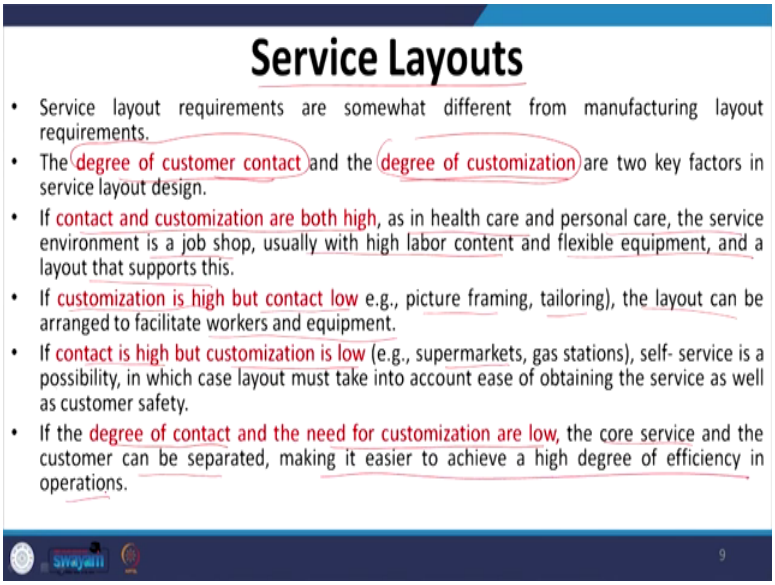

Then another very important category of layout which we want to discuss that is service layout. Service layouts are very important part of layout discussions because here the role is entirely different. In all other layouts, only the workers are within the plant, workers are within the warehouse, but in service layouts, customers are also part of that layout, customers are continuously involved in the layout.

So, here the degree of customer contact and degree of customization, these are the two very important factors which are absent in our other manufacturing layouts. And if contact and customization are both high like in case of hospitals, personal care, the service environment is like a job shop environment and usually with high labour content and flexible equipment and that a layout that supports this kind of system we need to design.

As we see that in hospitals, so patient is continuously part of that layout. Wherever patient is there, only that particular area means something for hospital. If patient is not there, there is no meaning of hospital. So, you need to design your layout in such a manner that whether this is providing sufficient contact to the patient and doctor and whether you are able to provide unique requirement of different patients. So, these are the important issue that how much is the degree of customer contact and how much degree of customization is needed.

The other category is if customization is high, but contact is low. Like in case of picture framing, tailoring, etcetera, so here the requirement of each customer is unique. When you are going to a tailor, so you all want uniquely designed products for yourself, but your point of contact is only to the front desk, the one who is dealing with the customer. What is

happening inside back office, you are not so much concerned. So, the layout can be arranged to facilitate workers and equipments. Then inside facility is like our manufacturing layouts.

The contact, if if contact is high, but customization is low like in case of supermarkets, so your contact is high, you are continuously involved in moving the various aisles of the market, but the customization is low, supermarket design, the supermarket layout is fixed for all types of customers, so that is another type of system.

Then another type of system is if degree of contact and the need of customization, both are low. When the degree of customization and contact both are low like the core service and the customer can be separated making it easier to achieve a high degree of efficiency in the operations.

For an example, whenever you have a system where you are distributing the registration form for the admission in a college, so in that kind of thing you do not want customization and degree of contact is also very low, there is a front office from where you are getting the forms for the admission, for the registration process. So here your operation, here your layout can be designed to provide very high degree of efficiency in the operation.

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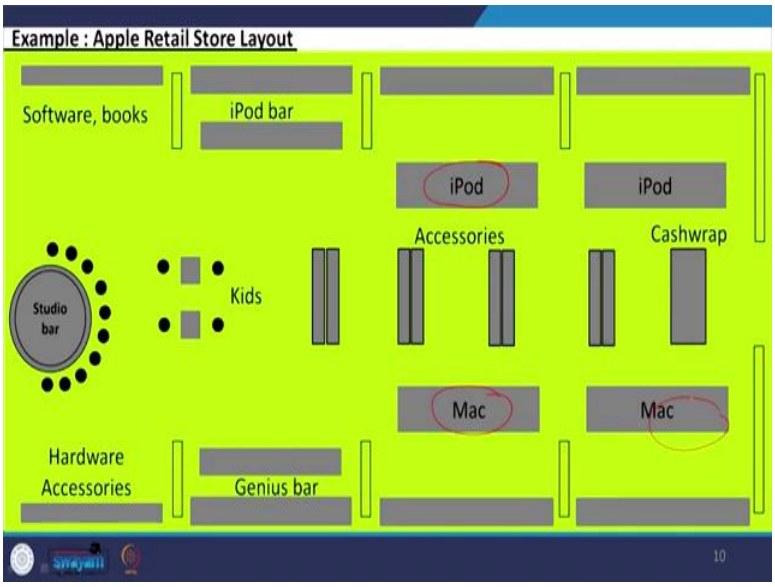

So, some of the, this is one diagram which is available in Apple's retail outlet. So, here you see that how they have arranged their layout, so that they can put all those important things which are to be highlighted on some height. If you go to any Apple store, so you will see that these kind of hardware accessories, etcetera are normally not shown at the front places.

The front places are shown for their important products like iPod, Macbooks, etcetera etcetera, so that customers, the product which they want to push to the customer can be highlighted. And those products which customer is coming to purchase, so those products are placed on some corners, so that your important place is not used for those things which are automatically will be sold.

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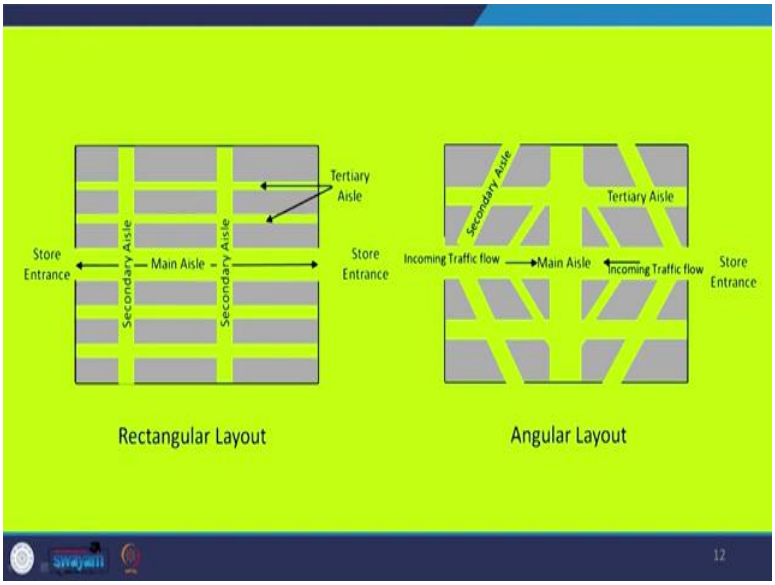

Similarly, you can see these type of arrangements when you are going to various shopping malls. Here, we have the main aisle and you have various tertiary and secondary aisles, so in this particular case all these aisles are intersecting at 90 degree. Here, in the second example, angular layout, here these tertiary and secondary aisles are some angle.

So depending upon how much space you have and what type of flow you want to maintain, so that if you want to have a flow where you are designing the flow of customer in such a manner that if a customer enters to your office or your retail outlet, he or she necessary needs to go to all the aisles then you think of what should be the width, how the movement should take place so that nobody can take a U-turn out of that.

And how much visibility you want to create for your various items which you have displayed, so on the basis of that you have these rectangular and angular systems. And in this particular case, what type of sign, symbols and what type of artifacts, etcetera you are placing, so that these are visible to the customer and customers can readily identify those particular thing. All these are the important part of this development of retail outlets. So, now you see in any retail

outlet, all these things are given enough importance so that it can be easy for customer to move around the shopping area.

And those things which are less in demand, which are not frequently purchased by the customer are normally placed at the most prominent location, so that customer can continuously see them. And those things like grocery items, pulses, salt, your personal care items, these things are placed at a location which is not so prominent, which is not easily visible, because that in any case, you are requiring, so you will search for them.

But those products which you are not naturally requiring, but company is looking to push those items into the market, so those items are normally placed at a very prominent location, so that your eyes catches those items and then you may take a decision to purchase these items.

So, with this, we have discussed enough about various types of layout decisions, layouts in manufacturing and layout in the service organization. And in our next session we will discuss 1 or 2 numerical examples for the layout design. And with this we come to end of this session. Thank you very much.