

**Production and Operation Management**  
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**Lecture 48**  
**Facility Layout-I (Introduction)**

Welcome friends, so far we have discussed many topics in this course of Operations Management, started with forecasting, inventory, material requirement planning and then took long time to cover the quality management. Now, we are going to discuss another very important aspect in the operations management and that is about the development of our facilities.

Now, if I know the supply chain management facilities can be of different types, facility means the place where we are doing some value addition activity, the place where we are doing some value addition activity. So, facilities can be either you have a manufacturing facility or you have a warehousing facility or you have a retail facility where you are finally selling the product to the customer. So, different types of facilities are there as per the value addition process. Now, organizing those facilities, so that whatever, because in a facility the most important resource is the space.

The space available in that facility is the most important resource and utilizing that space for the maximum benefit of the organization is a very important aspect of operations management. So, in this particular session and next one or two more sessions, we are going to discuss the management of space where we are doing the value addition process. Now, with respect to this particular aspect of space management in the facilities, we call it as a facility layout.

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**STRATEGIC RESOURCE ORGANIZATION: FACILITIES LAYOUT**

Layout refers to the configuration of departments, work centers, and equipment, with particular emphasis on movement of work (customers or materials) through the system.

As in other areas of system design, layout decisions are important for three basic reasons:

- (1) They require substantial investments of money and effort.
- (2) They involve long-term commitments, which makes mistakes difficult to overcome.
- (3) They have a significant impact on the cost and efficiency of operations.

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Now, when we are talking of facility layout, so this is becoming a very important strategic decision for the organization that how you are doing the management of this space. So, now important decision we are taking for developing the layout, where to put which particular machine, where to hold the raw material, where to hold the finished goods, where to keep air conditioning, where to keep the water cooler, where to keep the facilities for general public, all these are the important decisions which not only require the proper utilization of resources, but at the same time it also requires sufficient understanding of the safety issues in your plant.

So, layout design is on one side the effective utilization of the space and on the other side it requires the knowledge of safety aspects. Now, layout refers to the configuration of departments work centres, equipments with particular emphasis on movement of work that is customers or materials through the system.

So, where you are keeping different things. So, like a very simple example is our own house, where you have a particular area which is known as bedroom, a particular area which is known as kitchen, a particular area which is known as living room, a particular area which is known as guest room. So, these are the different areas in your house.

So, a basic area is there and that you have divided into different units or different kind of nomenclatures are given on the basis of activities you are performing in that particular area. Same thing we do in the organizations, where we configure them into departments, work centres

and where to stock the material, the rough material, the raw material, then the semi processed material that is known as WIP, then the finished material which is ready to dispatch to the market, so all these things you have to have proper allocation of space and that is the meaning of layout.

So, as in other areas of system design, layout decisions are important for three basic reasons. Let us see what are these, one is they requires substantial investment of money and effort, you can easily understand that once your house is constructed it is almost impossible that you change the location of your kitchen from x to y place, you change the location of your living room from A to B place.

Once whatever you have made that will remain forever unless until you thought of a major investment in your house by reconstructing it. So, it is a very heavy investment of money and effort in developing a particular layout. You cannot change layout on a regular basis. However, I will also like to caution you at this moment that there are places where you have flexible layouts particularly, if you go to some service organizations in those organizations, you may have some kind of flexibility also.

You visit a shopping mall and sometime you see that there is a particular side where readymade garments are put and there is another side where you have food items, grocery item, you visit that store after three months four months then there may be some change where earlier the readymade garments were there now there are some you can say cosmetic products which are placed.

So, that type of changes keep happening now a days because customer also love changes and similarly you go to airports in airports also, you will find the regular changes in their layouts. So, though in our manufacturing set ups, you will not find the regular changes in the layout but in service cases, there are possibilities of changes of layout. Because they are now working on more flexible systems of arrangement of these spaces, but it is a very very substantially cost intensive activity.

The second thing is they involve long term commitment, which makes mistakes difficult to overcome. Again we can take this simple example of our house, whatever you have done wrong at the time of making the design of your house. Whatever is wrongly done by the architect in

initial mapping of your house that difficulty that mistake is very very costly and it takes huge amount of investment or you may live all through your life with that mistake.

So, many a times the mistakes are very difficult to overcome in case of layout particularly again, I am talking of permanently out in manufacturing setups. So, if some mistake has happened at the time of designing, so you have to live with that mistake. The third important thing because of which layout decisions are important that they have a significant impact on the cost and efficiency of the operation. If you have not designed the layout properly, then maybe it will incur into the extra movement. It may incur into the extra uses of space.

It may incur into the extra uses of energy. So, all these things will impact your cost and efficiency. Your cost will go down and efficiency, cost will go up and efficiency will go down. So, which is not desirable. So, for these three reasons, it is very important that you focus on the layout decisions, very carefully.

Whenever we are developing a new facility layout decisions are not a routine decisions, whenever we are developing a new facility at that particular time layout decisions become very important and we need to give substantial involvement of top management in development of the layout decisions.

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**OBJECTIVES**

The **basic objective** of layout design is **to facilitate a smooth flow of work, material, and information** through the system.

Supporting objectives generally involve the following:

1. To facilitate attainment of **product or service quality**. ✓
2. To use workers and space efficiently. ✓
3. To avoid bottlenecks. ✓
4. To minimize **material handling costs**. ✓
5. To eliminate unnecessary movements of workers or materials. ✓
6. To minimize production time or customer service time. ✓
7. To design for safety. ✓

Handwritten annotations include: 'Manpower' above objective 2; 'Bottleneck' above objective 3; a flow diagram with nodes labeled '2 parts/min', '1 part/min', and '3 parts/min', and arrows indicating flow; '2/3 (6-7)' near the flow diagram; 'JIT Kan' in a box near objective 5; and 'R/H Store (gas cylinder) + Furniture' near objective 7.

Now, what are the important objectives of the layout decisions? We have seen that why layout decisions are very important. But now we will discuss that, what are the important objectives of

layout decision to facilitate a smooth flow of work, material and information through the system. So, for the smooth flow of work, material information, and we can also add one more thing is smooth flow of manpower. There are two types of things in one case manpower maybe static that work is coming to their place. But in some cases it is possible that work is static and manpower is moving.

So, we also need to include that also that it is a smooth flow of work, material, information, manpower throughout the system. Now, what are the supporting objectives to this to facilitate attainment of product or service quality? We have enough discussions in our earlier sessions about this product and service quality. So, we want to achieve a good quality of service which is as per the expectations of the customer. Particularly layout design with respect to service quality are very very important.

Because, why it is imported because customer is part of service creation. So, now in that layout customer is also need to move like that, customer is also consuming that layout and every time a new customer will be there. For an example, when you are going to a hospital, so you are not going hospitals frequently, doctor is going to hospital daily. Nursing staff is going to hospital daily, but you are a occasional visitor to hospital. Now, how the layout is designed of that hospital, so that a non frequent visitor to a particular place is also able to use that space properly or is not lost in that particular space. So, that is the meaning of service quality.

Product quality is with respect to efficiency or the appearance, it should not be disturbed. It should not be getting damaged because of your layout. So, that is the issues related to product quality. The second important supporting objective is to use workers and space efficiently. If layout is not properly designed it is quite possible that your workers may feel fatigued very early.

So, proper layout give them enough space, so that they are able to work for longer hours without any kind of stress. So, that is the second important thing, to avoid bottlenecks so that smooth flow of material can take place from one machine to another machine, from work work centre to another work centre.

So, to avoid bottlenecks good kind of layout design is important, to bottlenecks means, if these are the three machines. Now, this machine is producing 2 parts per minute. This is producing 1

part per minute. This is producing 3 parts per minute. Now, if the flow is like this. So, this machine is my bottleneck.

Because you have a very low capacity of this machine to produce output. And therefore, this third machine will always be looking for jobs because this machine is giving only one part, one product, one unit in a minute. This machine will produce three products in a minute, in a minute, so for two third of its time. It will remain idle.

So, you will not be able to use this particular system efficiently and this is the bottleneck. By proper arrangement you should be avoiding these kind of bottlenecks. So, it means in place of one machine you can install two machines, so that you can at least now you can use this up to 2 by 3 or 67 percent. Otherwise you have very less utilization of this third machine.

Then the to minimize material handling cost, if you have system that it is going from here to here and then here to here and then again here to here and then again here to here. So, it will unnecessarily increase the transportation cost and we need to have that kind of system. So, that our material handling cost is as low as possible. So, that is another important reason. We discussed in our earlier slide that if you have poor layout, it will increase the cost and it will reduce the efficiency.

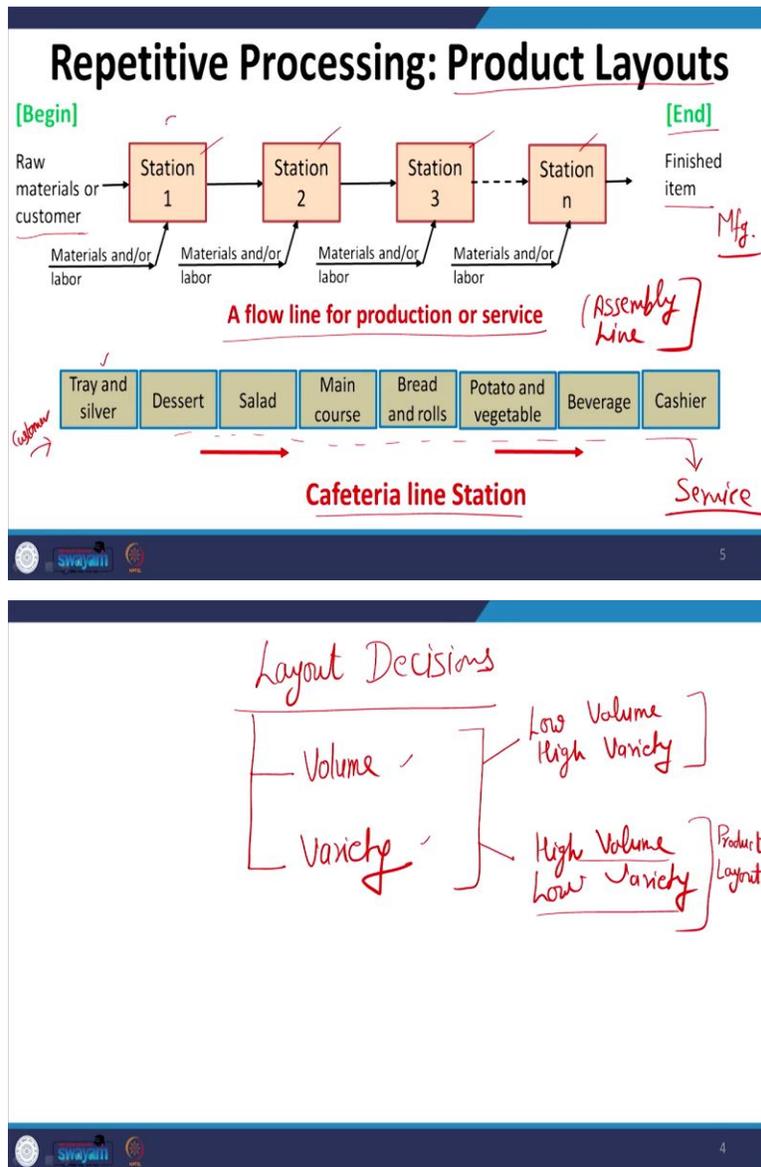
One of the reason of increasing the cost is material handling issues. If layout is not properly designed your material handling cost is going to increase. So, it is a very important objective of any layout that how can we minimize the material handling cost. Then to eliminate unnecessary movement of workers or materials, because your layout is not properly designed so many times it is possible that workers or materials need to move unnecessary.

If you go to the classes of JIT or lean manufacturing in that also we particularly focus to avoid the unnecessary moment of workers or materials, unnecessary movement of workers will create extra fatigue. They will be more stressed and as a result their efficiency will go down and chances of errors will also increase that may result into poor quality.

So, it is a you can say multiplying effect of unnecessary movements, cost is obviously going to increase but there are other issues also which will surface out. Then to minimize production time or customer service time if you have less material handling, if you have minimum material handling requirements, so you will be able to produce products with lesser production time.

So, your throughput will increase if you have a good system of layout and to design for safety as I said that safety is also very important in an organization. So, if you have a raw material store where let us say you have stocked some gas cylinders. So, obviously you will not have any you can say furnace close to that. Because if furnace is close to that, it is quite possible that some accident may happen. So, you will see that how to design your layout so that you can fulfil the requirement of safety also.

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Now, we see that the layout decisions are broadly based on two very important issues and these issues are, these are the two important issues on which our layout decisions are based volume

and variety. Now, with respect to volume and variety you have various combinations, one is low volume high variety, and another is high volume and low variety and these two make us two important type of layout categories.

And based on that let us first see that this is product layout, in the product layout you have a system in which continuously you are producing products and this particular system is followed for high volume and low variety. Because your machines are put in a system, where they are repeatedly producing the same type of job. So, there are different machines 1, 2, 3 and up to n and your raw material is entering at this station and it is being processed from 1 to 2, 2 to 3, and then finally to the nth station and then the finished parts are produced through this sequence of operations.

So, it is a like any example you see particularly in the automobiles, when we have the assembly line. You will see this type of example where from one side you start putting some kind of components and then intermediate assemblies are there and finally the last station produces the finished goods or the final engine you can say.

We have one example of cafeteria and you see that how different activities are being done in this sequence that tray, desert, salad, main course, bread and rolls, potato vegetables, beverage, cashier. So, all these things are arranged in a sequence and a customer is starts from here. So, customer comes and he first takes the plate, then moves to in this particular sequence and finally cashier is sitting at the other side and cashier is taking the cash of or the payment for the consumption of food items by this customer.

So, this is either in case of a manufacturing. This is manufacturing, this is service. You have the repetitive processes where you find the use of product layouts. Now, the product layout because here the variety is very limited. We use normally all these machines which we are using at different stations are special purpose machines. These are special purpose machines, which are capable of producing only a particular type of product only a particular kind of operation these machines can do.

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### Advantages and Disadvantages of Product layouts

The main advantages of product layouts are-

1. A high rate of output.
2. Low unit cost due to high volume. *E. of Scale*
3. Labor specialization, which reduces training costs and time, and results in a wide span of supervision.
4. Low material-handling cost per unit. Material handling is simplified because units follow the same sequence of operations. Material handling is often automated.
5. A high utilization of labor and equipment.
6. The establishment of routing and scheduling in the initial design of the system. These activities do not require much attention once the system is operating.
7. Fairly routine accounting, purchasing, and inventory control. ✓

The primary disadvantages of product layouts include the following:

1. The intensive division of labor usually creates dull, repetitive jobs that provide little opportunity for advancement and may lead to morale problems and to repetitive stress injuries.
2. Poorly skilled workers may exhibit little interest in maintaining equipment or in the quality of output.
3. The system is fairly inflexible in response to changes in the volume of output or changes in product or process design.
4. The system is highly susceptible to shutdowns caused by equipment breakdowns or excessive absenteeism because workstations are highly interdependent.
5. Preventive maintenance, the capacity for quick repairs, and spare-parts inventories are necessary expenses.
6. Incentive plans tied to individual output are impractical since they would cause variations among outputs of individual workers, which would adversely affect the smooth flow of work through the system.

And there are multiple advantages and limitations of this product layout. So, let us quickly go through those advantages and limitations of product layout. Because you have a very limited variety and you are using special purpose machines. So, very high rate of output is obviously possible. Low unit cost due to high volume.

You enjoy economies of scale. Repeatedly you are doing the same thing. So, cost of production per unit goes down tremendously. Your labour specialization because each workers is continuously doing the same kind of work. So, you attend a very high level of labour specialization and this reduces the training cost and time and results in a wide span of supervision. You do not require a supervisor for each workstation because your labour the one who is doing the work at the station is already in a (( ))(23:09).

So, for 2, 3, 4 stations, you can have only one supervisor. So, your cost of supervision is also less in this particular case. Low material handling cost per unit, material handling is simplified because units follow the same sequence of operation. So, continuously same sequence of operation is there from 1 to 2, 2 to 3, 3 to 4 and 4 to n. So, that way your cost of material handling also less.

A high utilization of labour and equipment because you have developed your line in such a way that almost all these stations all these work centres are giving output at similar rate more or less similar rate. So, you have very high utilization of equipment and labour. We try that there should

not be any unnecessary queue in front of a particular machine and there should not be a situation of starvation in front of any machine.

The establishment of routing and scheduling in the initial design of the system is required and once you have this initial system design it continuously go. So, the transient stages are not there and therefore you do not lose any quality during the transient phase. And in this particular case we have fairly regular or routine system of accounting, purchasing and inventory control.

So, efforts required in all these activities are also very less. Some of the limitations are also there that in this particular case, we have intensive division of labour and a particular labour who is at machine number 1 is always doing the same kind of job. So, it is quite possible that repeated job gives them less opportunity of advancements and may lead to some kind of moral problems.

So, very there is a continuous research going on, whether we should have more specialization or a broad based activities. So, there are people who say that high level of specialization is desirable, some people say that wide span of activities are desirable. Because job enrichment is also very much necessary. So, that is a limitation that it does not provide enough opportunity of job enrichment.

Then poorly skilled workers may exhibit little interest in maintaining equipment or in the quality of output. Because if you have to do a particular task where your superior skills are required. So, in that case the poor skilled workers may not be suitable for your organization. Sometime organizations do not think of too much training of their employees and they may go with low skilled employees to save the cost, but that is not possible in this particular case because you have to perform your jobs with superior skills.

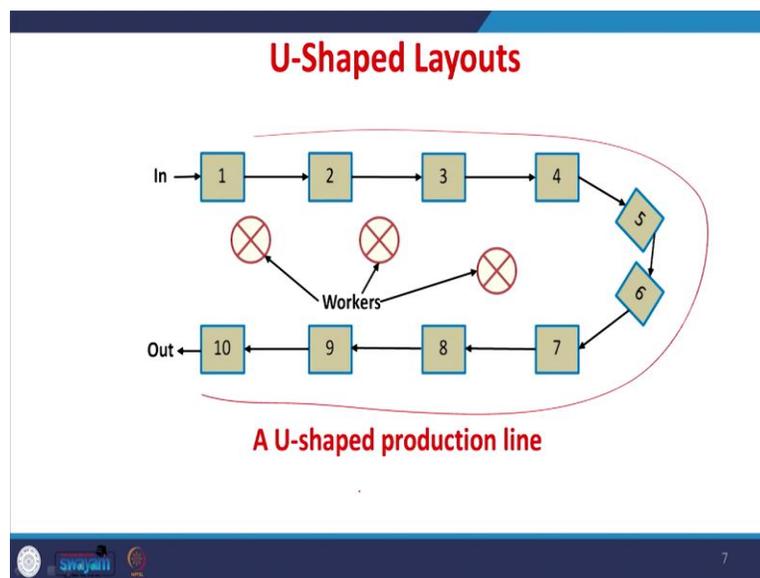
Then because of special purpose machines this system is inflexible. You cannot produce many varieties, so you have that limitation of limited flexibility in this particular case. The system is highly susceptible to shut down caused by equipment breakdown. Because all these machines are arranged one after another in a very tight schedule.

So, therefore, if one machine gives one problem the effect of that, the impact of that is going to come on your entire assembly line, on your entire plant. So, one machine's problem will create that kind of impact which is known as systemic impact that is going to affect the closer of or the partial shutdown of your plant.

The preventive maintenance the capacity for quick repairs and spare part inventories are necessary expenses. Because you cannot afford to have a breakdown and therefore preventive maintenance you have to follow. So, that all the time your plant is properly running. Then how you are able to do quick repairs and for that purpose maintaining good quality of spare parts inventory all these require additional expenses.

Then incentive plans tied to individual output are impractical. If you want to say that I want to award my those labour who are hardworking labours. But that is very difficult to identify in this type of layout system because individual's role in productivity development cannot be identified so well. So, that is also becoming a kind of limitation for motivating the individuals.

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So, this is another variation of that product layout where it is a U-shaped layout. Here we are using the workers at different stations. So, that you can give more enrichment to the worker only 3 workers are there and these 3 workers are actually controlling 10 workstations because the layout is arranged in a U-shape and if this layout in place of this U-shape, if you put it into a straight line, then it is not possible to have 3 workers controlling 10 workstations. But now, you see that we have this kind of arrangement. So, these 3 workers can easily control the 10 different locations. So, this is the kind of variations which are possible in our product layout.

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### Nonrepetitive Processing: Process Layouts <sup>Tool</sup>

Process layouts (functional layouts) are designed to process items or provide services that involve a variety of processing requirements.

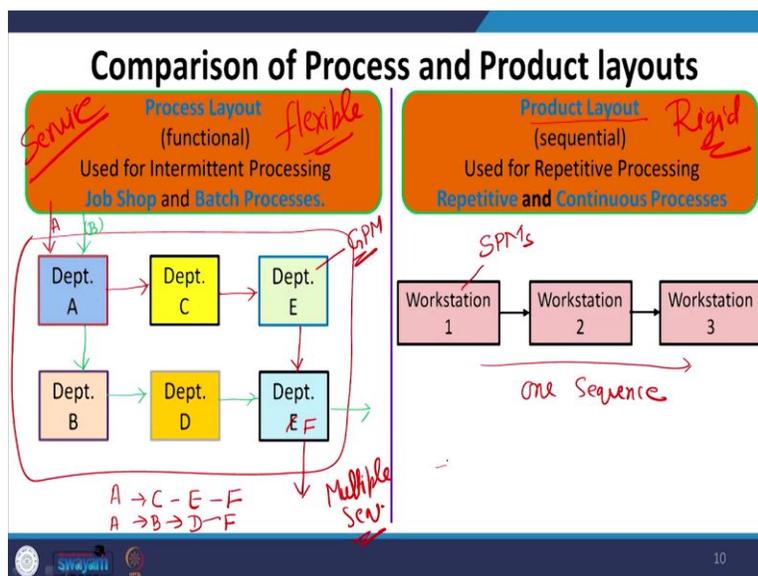
- ❖ The variety of jobs that are processed requires frequent adjustments to equipment. This causes a discontinuous work flow, which is referred to as **intermittent processing**.
- ❖ A **manufacturing example** of a process layout is the **machine shop**, which has separate departments for **milling, grinding, drilling, and so on**. Items that require those operations are frequently moved in lots or batches to the departments in a sequence that varies from job to job. Consequently, variable-path material handling equipment (forklift trucks, jeeps, tote boxes) is needed to handle the variety of routes and items.
- ❖ The use of **general-purpose equipment** provides the flexibility necessary to handle a wide range of processing requirements. Workers who operate the equipment are usually skilled or semiskilled.

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Then another important type of layout is the process layout. The process layout is non-repetitive processes. Here, the volume is low, but the variety is high. You can use this type of layout, the best example is tool room. Where you have each job, which is requiring a different kind of processing and then you have to see that what type of processings are required.

So, all the equipments, all the machines may not be required for this type of job. So, you have to have more general purpose equipments, in our product layout we have special purpose equipments, in case of process layout, we have more general purpose equipments.

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When we see the process layout and product layout. So, you will be able to understand very clearly that in case of process layout. This is a process layout you have a different types of departments located like this and a job can enter from this side, then it can go to this machine, then it can go this particular department and then this and can go out of the plant.

Then in the another case, it is quite possible that the second job is entering again from department A but then it goes to department B, and then it goes to department D and then it goes to department E and then moves out. So, this is B and then earlier was A. So, A and B are two different types of jobs and their sequences are also different for A it is A, C, E this is F and for another it is for the second it is A, B, D and F.

So, these type of multiple sequences are possible in case of process layout. But in case of a product layout you can only follow one sequence. Here you can have multiple sequence. These machines as we discussed are SPM's while these are general purpose machines. So, you have to make every time arrangements for these machines that depending upon the requirement of the job you have to select, you have to set the process parameters. You have to select the tools for these machines.

But in case of product layout we do not do these things. So, this is a more flexible kind of system. It is a flexible kind of system. It is more rigid, you cannot make new varieties on a product layout while you can try new varieties very easily on a process layout. So, if you are producing more varieties particularly in case of service, this process layout is more suitable.

And wherever our volume of production is less process layout is more suitable because it offers you lot of flexibility. When you have a more repetitive and continuous type of production in that case product layout is more suitable. So, we will do some more discussion with respect to these layouts particularly how to balance or how to design these layouts in our next class and we will see some other important type of layout designs also because these are two extreme cases. We have a combination of these two layouts also, so that all we are going to discuss in our next session, for this thank you very much.