Economics, Management and Entrepreneurship
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Lecture – 39
Product Service Strategies and Plant Layout

Good morning, welcome to the 39th lecture on economics, management and entrepreneurship. In our last lecture, we had discussed plant location factors and how to decide among alternatives to locate a plant with a particular location, we had indicated then that the next logical topic to be covered is facilities layout or plant layout but today, we shall first discuss product service strategies that an enterprise should follow.

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Before discussing the topic on plant location thus today 2 topics will be covered; the first topic is product service strategies and then it will be followed by plant layout. So, today's topic to start with is product service strategies basically, there can be at the 2 extremes; a custom products or services or standardized products or services. When we say custom products, we mean the customer decides the specifications of the products or services that he or she desires to acquire.

And the enterprise therefore, has to keep its facilities ready to produce that product or service and deliver it to the customer. A particular customers product or specification would be different from another customer. Therefore, such custom products or services are really very challenging for the enterprise whereas, if it is a standardized products or standard product then the operations are very well known to the enterprise.

And therefore it can plan its facilities, it can acquire facilities and it can arrange the facilities in a pre-decided manner such that the product can be made to even stock, so that when a customer demands it such a standard product can be delivered to the customer with very little time at very little time. So, this is the 2 extremes of the products, we call them custom products or services and standard products or services.

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Usually, products that are consumed are standard products whereas, products that are demanded by the producer; producer goods such as machine tools are custom products. Custom products examples could be a ship or an aircraft in which case, the customer says that this is the requirement, this is the specification or even small jobs with specifications specified by the customer.

The emphasis is therefore on uniqueness and they are the difficulties arise because of unique demand on delivery time, quality and the enterprise must be flexible enough to address different specifications of products desired by different customers.

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Standard products are ideal, very little difference between products normally, variety among the product designs is very little and certain services are also possible to get in standard forms; insurance procedures, motor vehicle registration, even fast food services can be standardized.

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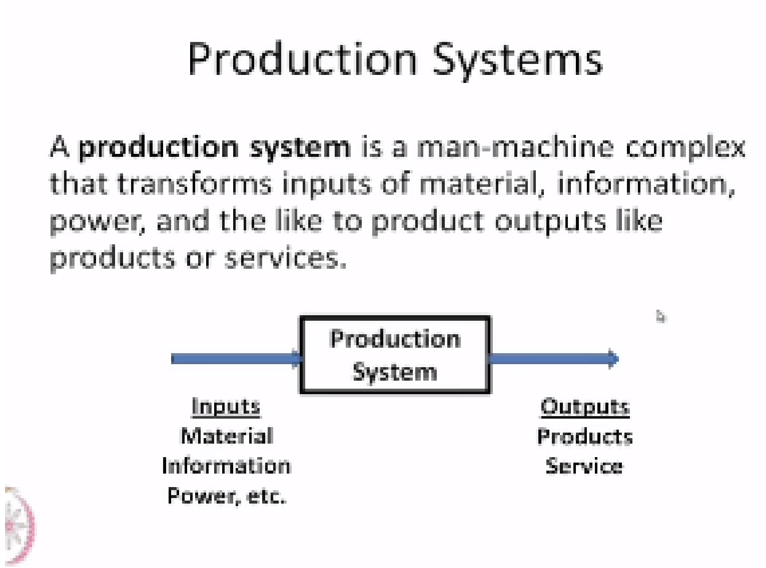

Now, normally we use a word or a term production system basically, it is a man machine complex that transforms input of material, information, power and it produces outputs such as products or services in a manufacturing environment or in the context of manufacturing system, we call it a production system.

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Now, an enterprise could be product focused or it could be a process focused, now highly standardized products or services are usually product focused and because the products or services are standardized, the production system is in continuous use and normally, the production is in high volume and one can engage specialized machines to do specific specialized operations.

And since a product is standard, its operations are known and therefore the machines are the individual processing units can be arranged in a sequence or in a line and this enables the company to go for high level of mechanization and automation and normally a marketing strategy is to produce to stock.

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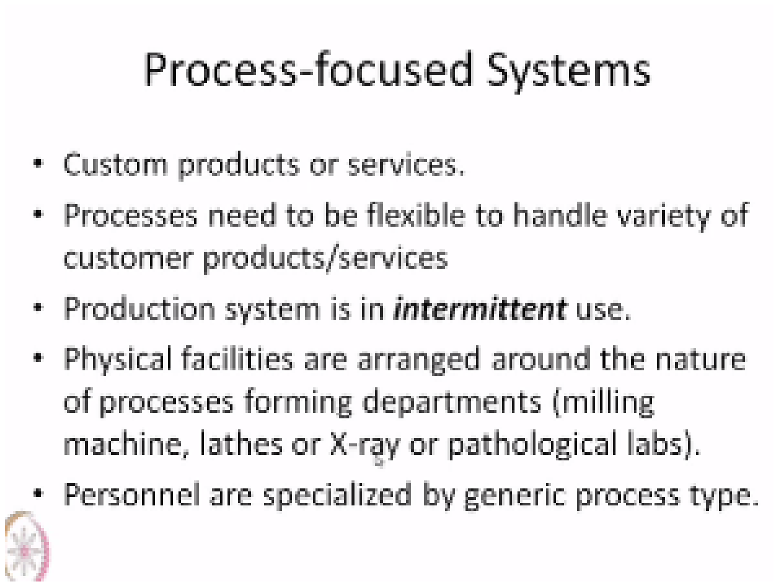

Whereas, in a in a process focused system, custom products or services they are; each one is of a different type therefore, the enterprise must have processes that are so flexible that it can handle a variety of customer products or services and production system is not always in continuous use, it is an intermittent use that means certain facilities may even idle for a while and the physical facilities are normally arranged around the nature of processes.

And therefore they form a department such as milling machine could form a department, lathes could form a department or even in service organizations such as hospitals; X rays could form X ray machines could be in one department and all pathological labs, pathological experiments, tests can be carried out in a lab; pathological lab, therefore the personnel are specialized by generic process types.

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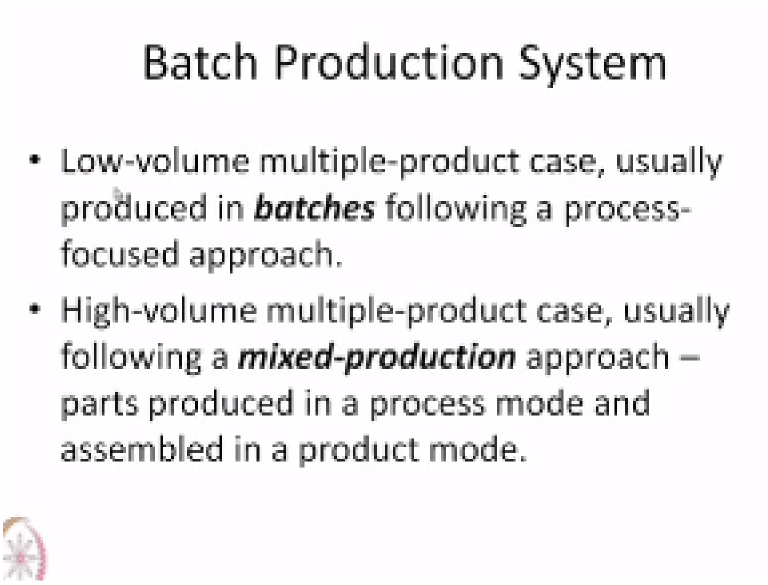

Say for example, somebody is good at milling in a milling machine department, in an X ray somebody must be very specialized in taking X ray etc. Now, normally the actual situation could be different, it may not be; it may be a low volume multiple product case. The company will be dealing with similar products of different specifications say, different brands or different volumes, so it is a low volume multiple product case.

And they are produced in batches rather than in mass for example, a company that produces refrigerator may produce refrigerator of different capacities, it may have 5 different brands of refrigerators therefore, each it can produce in batch. Say for example, a capacity C1, it produces 100 in one batch, it may be followed by refrigerators of capacity C2 of 200 in number, thus the production machines must be geared up or must be set up to produce 100 refrigerators of capacity C1 to start with.

And then the set up must be changed to produce refrigerators of capacity C2, now this is normally the case when there are multiple products of similar nature and there of low volume. Now, sometimes we have high volume multiple product case, in such a case normally what is happen; parts are produced in a process mode that means, parts are produced in different departments whereas, they are assembled in a product mode that means in a line fashion.

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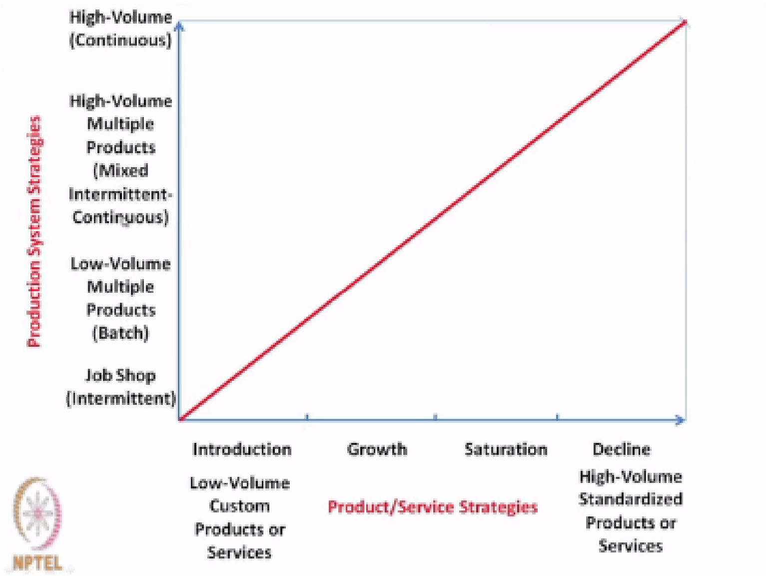

Now, in a company therefore, this strategy; the enterprise should take would depend on 2 things; one, the product lifecycle stage, at which stage of the product life cycle, the product is now operating, normally if it is at the introduction phase, then it is a low volume and probably it is a custom product or services. Whereas, if it is on the saturation on the; or decline phase probably it is high volume but standard products.

Therefore, product service strategies would depend on the stage in which the product is passing through in its life cycle then also the strategies will depend on the whether it is multiple products low volume or high volume single product. If it is custom products, each specification of the job or order is different, then that shop is known as a job orders shop or job shop. Each job is different; it follows a process strategy.

Whereas, if it is a single product but very high volume, it is a product focused enterprise where every operation, every machine or equipment is utilized continuously, between these 2 extremes as we have already mentioned, there is a batch processing low volume multiple products or mixed processing in which high volume multiple products cases are there. Now, the enterprise will naturally have to decide where to operate.

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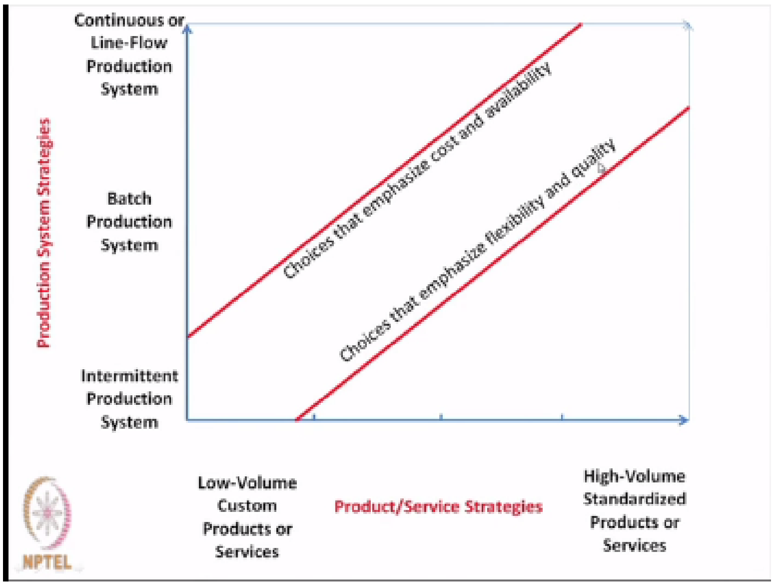

And this is the preferred path, actually the path is not such a straight line path, there is a band of choices. The band varies from here that emphasize flexibility and quality that is low volume custom products, 2 choices that emphasize low cost and high availability that is mass production or continuous production. So, the company can operate here, here, here, here and here in this band.

So, basically here we said that a company has the choice of deciding the products depending on this stage in which the products are passing and the volume or volume of demand and the nature of demand from the customers, so it has a choice of deciding whether to go for intermittent production or continuous production and in between these 2 extremes, we have batch production or mixed production strategy.

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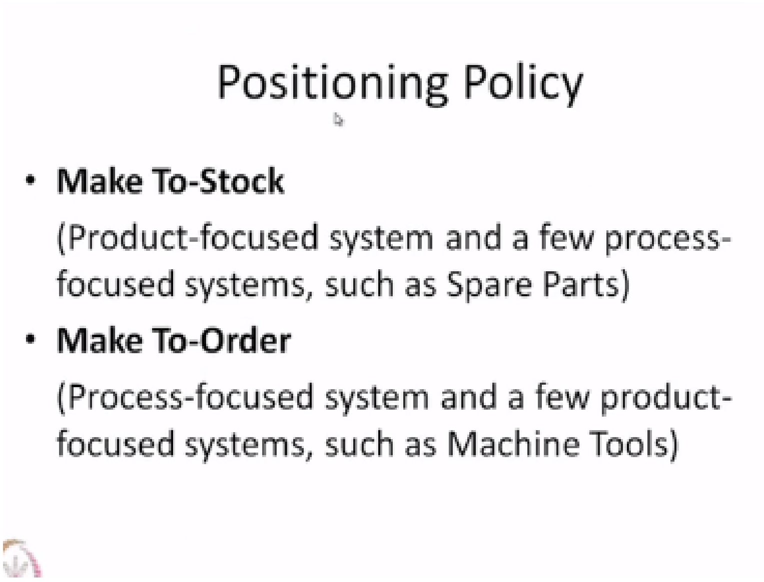

Now, the company can decide where to position itself, whether to go for product focused system and then the strategy could be to make to stock. Sometimes, even a process focused system producing spare parts may in fact, go for a make to stock policy because spare parts are something without which a machine would remain idle therefore, whenever a machine is idle, the owner of the machine would like to get the spare part as soon as possible.

Therefore, although the spare parts demand is not continuous, the manufacturer of the spare parts would like to keep an inventory of spare parts in its stock, so that the customers demand is met immediately. So, even a process focused system, whose output is spare parts may go for a policy of make to stock and if it is a process focused system in which the custom orders are normally obtained and it is intermitted in nature.

It is usually make to order, you produce only when there is an order however, there are situations where if in a product focused system such as that which manufactures machine tools following a particular sequence of operation may even not produce a machine tool because it is very expensive to make one unless, there is an order. So, it can follow a policy of make to order.

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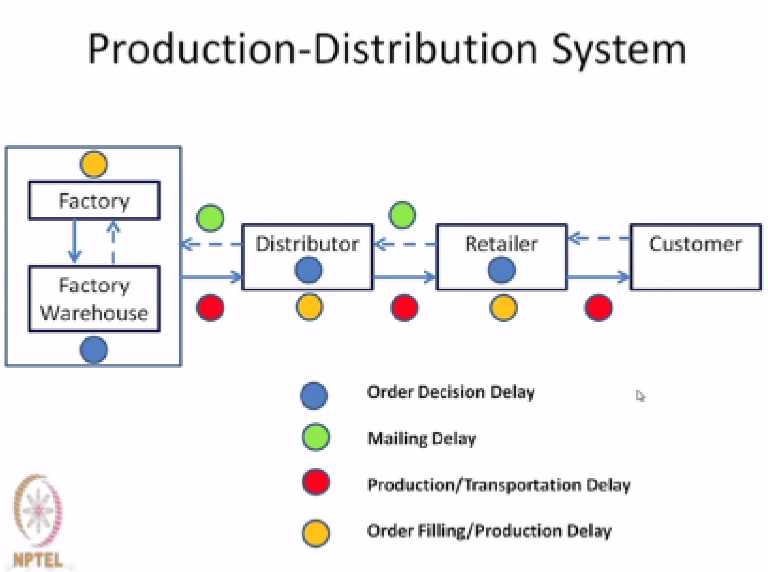

Now, before we close this topic, we would like to discuss a few things about how from the customer order reaches the enterprise or the factory. On the right hand side is the customer and on the left side is a factory and it is warehouse, this dotted line shows the flow of orders and the firm line shows the flow of material. Customer places the order at the retail for its goods, retailer fills the order, so this is order filling delay.

There is some delay in filling the order and then it supplies to the customer, there is a transportation delay here, this delay could be of the order of one day to one week. This delay depends on the inventory that is available with the retailer, if the customer demand for the product; if the product that the customer demands is available in the inventory of retailer, the delay in supplying it is not much here, the delay could only be in the transportation.

But if it is not available then it places an order for replacement to the distributor that there may be a small amount of delay here, which is what I am saying is order decision delay; some delay and then there is a mailing delay here, if it is sent by normal post today, the mailing delay could be much less because of electronic mailing system but there is a delay in deciding when to replenish the stock.

And the distributor once again passes through the same thing depending on its inventory position, there is a delay in making the supplier and there is a transportation delay from the distributor to the retailer and then the distributors stock falls and it decides to replenish it that is the decision delay to replenish the stock, you place an order there is a mailing delay, then it goes to the factory warehouse.

Factory warehouse once again supplies the material, if it is having and then when factory warehouse is inventory is less, it places an order with the factory; the factory production rate and then the factory produces it, so this is the production delay and factory supplies it to the factory warehouse, factory warehouse supplies it to the distributor, distributor to retailer and finally retailer to the customer.

So, this is the way in which the production distribution system works, so up till now, we said that a company depending on the stage in which the product is passing through its life cycle and the nature of the demand low volume or high volume and custom products are standard products, it can position itself to decide whether it should be product focused or process focused and whether it should go for make to stock or make to order.

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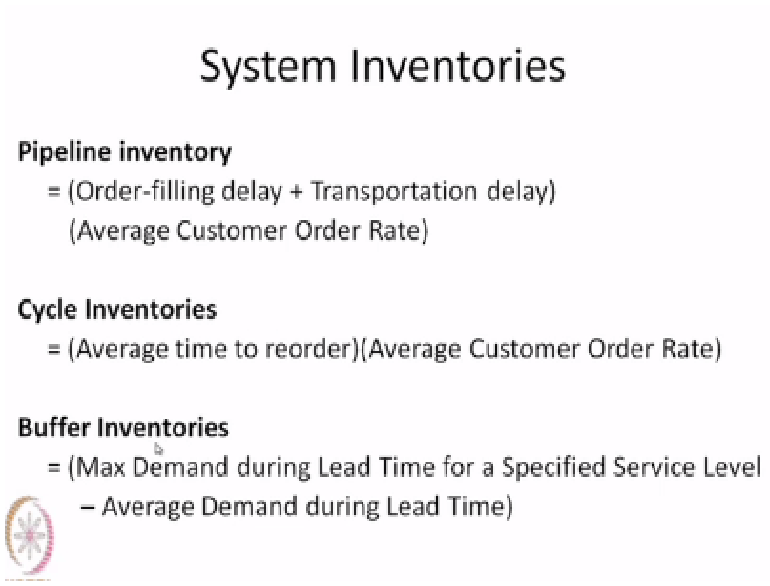

With this background, we now see the aspects of plant location, so before we do that we just would like to say that in this production distribution system; in this supply chain of course, this is this supplied to the customer, the outbound supply. Here, there are certain inventories that are piling up; one is called the pipeline inventory, this form in fact a pipeline, the whole of it is a pipeline, there is a transportation delays.

So, there are some items that are held up in transportation, there are some items that are held up also in the order filling delay and the average customer order rate when it is multiplied that is called the pipeline inventory. There are 2 types of inventories also apart from pipeline inventory that is called cycle inventory and buffer inventory. Cycle inventory is the inventory that a particular unit has before it orders for replenishment.

So, it is the average time to reorder into average customer order rate and apart from the cycle inventory, the unit also holds certain buffer inventory which is basically to guard against the risk of stock out that depends on the maximum demand during lead time minus the average demand during the lead time. These aspects of cycle inventory and buffer inventory we shall discuss in detail when we come to inventory control topic.

So, for the time being we are going to the discussion on the plant location layout factors, like plant location, plant layout is almost a onetime decision and it influences the particularly, the cost of transporting parts, sub-assemblies, components etc., inside the factory, so plant layout basically says where the machines should be located, so naturally the location of the machines inside the factory subfloor would depend on the most likely operation sequence.

And in a product focused approach, the operation sequence is fixed and therefore, the problem there of plant layout is different from a process focused system in which the products are different and therefore, the sequence of operation is also different from one product to another. Let us see these complexities of plant layout in detail.

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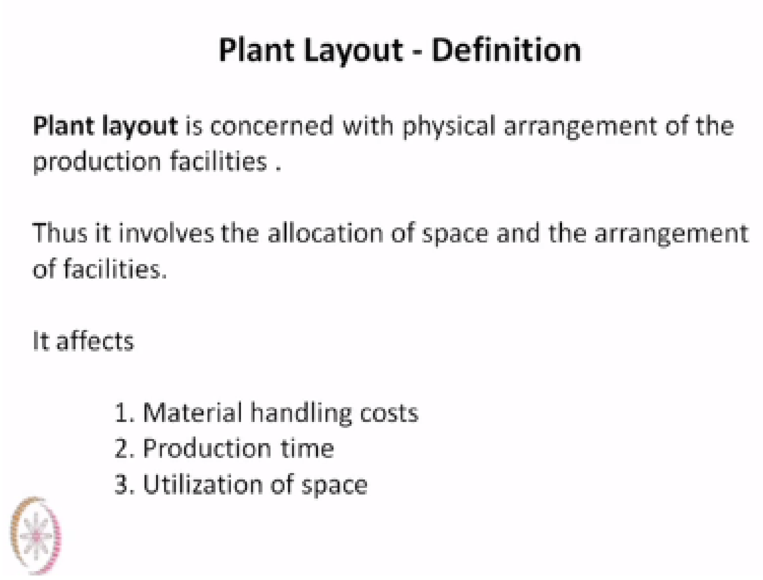

Plant layout; a small definition is that it is concerned with physical arrangement of the production facilities, thus it involves allocation of space and the arrangement of facilities and it influences material handling costs and it also influences time to produce and the extent to which the space is utilized.

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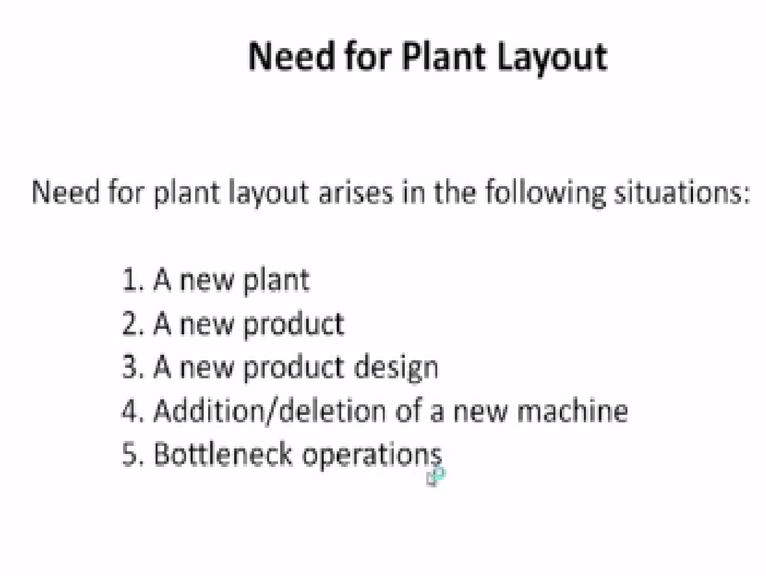

Plant layout needs arise, when an enterprise goes for a new plant or it produces a new product or the design of the product undergoes a drastic change or because of the volume of production going up a new machine is to be installed or a new machine more capacity and a more efficient machine is being installed instead of the old machine which is to be taken out or there can be certain machines that are creating bottlenecks.

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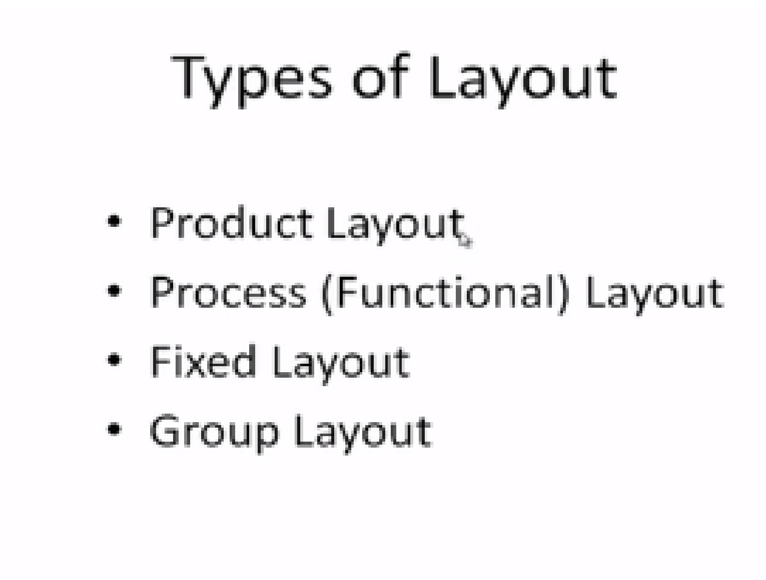

And they are calling for; they call for a new machine or a new way of handling things, a new way of production, these are the reasons why plant layout is needed. There are different types of layout, we have grouped here 4, we have already given idea about what a product focused system is and that calls for a product layout and a process focus system goes for a process layout.

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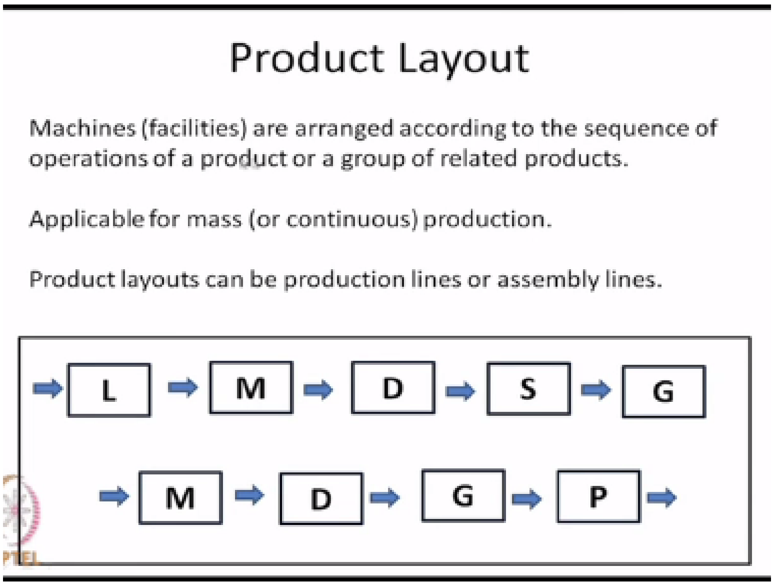

Apart from these 2, there are 2 other layouts; fixed layout and group layout, let us see what they mean. In a product layout, the machines are arranged according to the sequence of operations of a product or a group of related products that means the sequence of operation is fixed, even if the product is one or a group of products they must have the same sequence of operation. If the operation sequence is known, then the machines are arranged according to the sequence.

They are naturally applicable for continuous production and product layouts can be both in production lines or assembly lines that means, parts are made and then assembled that is normally called an assembly line and while producing production takes place, it may be done in a sequential manner, it is a production line. Now, this is an example of a product that passes through these different machines.

Lathe, milling machine, drilling machine, shipping machine, grinder, then milling machine again, drilling, grinding and then finally packaging. So, this is the sequence of operation and therefore machines are laid out in this fashion.

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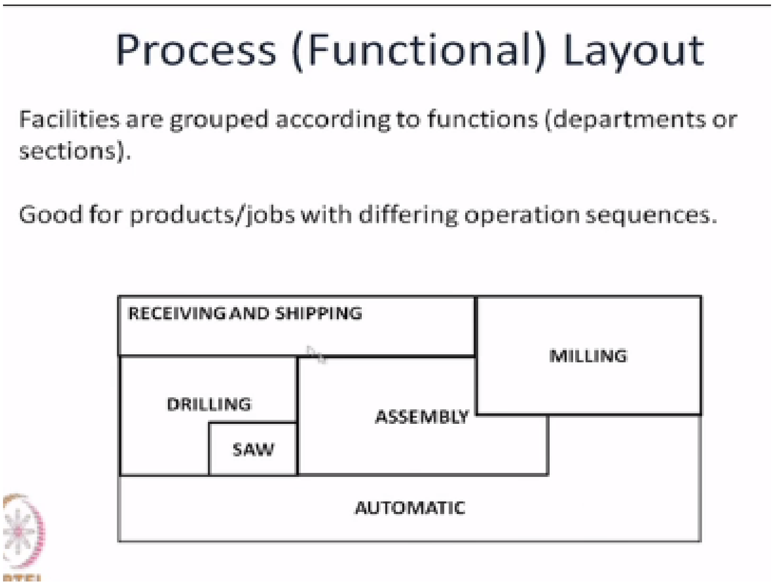

In a process layout, which is also known as a functional layout, facilities are grouped according to functions that means, departments or sections are formed. They are good for products that differ in their operation sequences meaning custom products in which the specifications are different, the designs are different and the operation sequences are also different. Here is an example; the milling machine is all milling machines are put together in one place.

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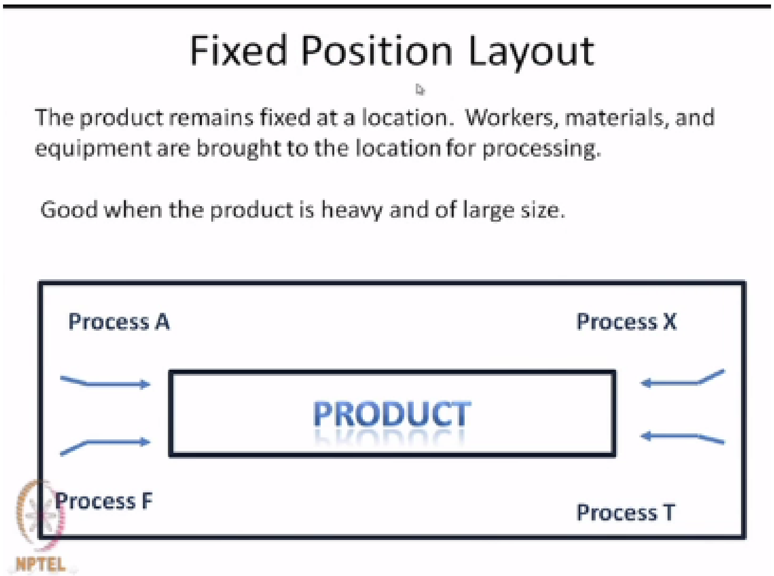

All sawing machines, all drilling machines, all automatic machines are separately placed and a department for receiving and shipping. Fixed position layout normally very heavy and large size products such as a seat or an aircraft, they are very large and very heavy. So, normally they are put in one place and different processes serve the production need for the product, so this is a fixed position layout.

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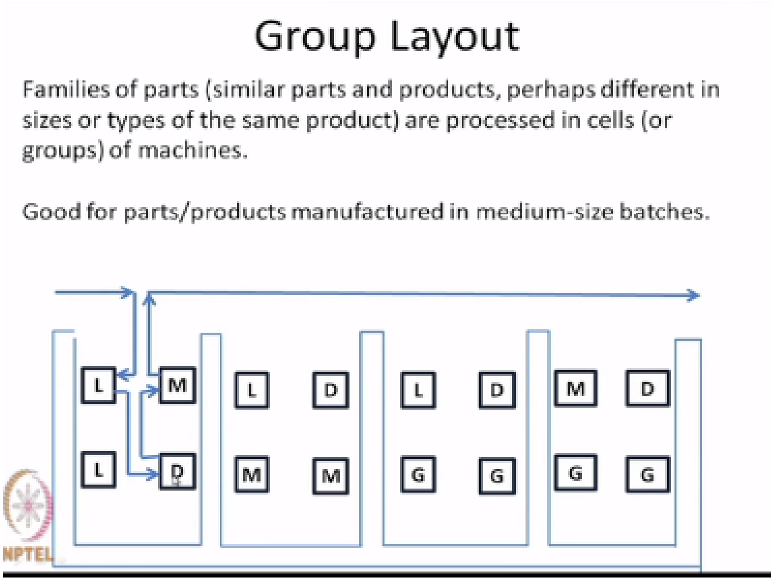

Workers, materials and equipment are all brought to the location for processing the product. A fourth layout is called a group layout in which families of parts are processed in cells of machines, parts that are similar perhaps different in sizes or types of the same product and they are processed in cells or groups of machines. Now, you see L; lathe milling machine, another lathe and drilling machine, they are put in this cell or group.

So, the product that comes here goes to this lathe and then to the drilling machine then to the milling machine then goes away, so this may not require another operation or use of another lathe but a second product of the same type may require to go through still another lathe and go out, a second product may go through the second cell, lathe milling machine and another milling machine and a drilling machine and then goes out.

So, this is called a group layout because the operations required are similar in nature, products of those type come here, a product of another type comes here and the third type comes here, the fourth type comes there.

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Comparison of Product and Process Layout

Characteristic	Product Layout	Process Layout
Machine utilization		☑
Flexibility		☑
Availability in case of machine breakdown		☑
Use of individual incentive scheme		☑
Low material handling cost	☑	
Low in-process inventories	☑	
Simplified production control	☑	
Less space required	☑	

Now, we can compare between the product layout and process layout, these 2 are the predominantly the layouts that are used in practice. In a product layout the material handling cost is low, in process inventory is low, production control is simplified, less space is required and in a process layout, the machine utilization is high, the flexibility must be high, there must be another machine available, when it is breaking down.

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Product Analysis

Assembly (Gozinto) Chart

- Shows flow of material and relationship of parts

Operation Process (OP) Chart

- Gives a summary of all required operations and inspections.
- It is a general plan of manufacture

Because all machines are in one place and one should go for individual incentive scheme. Now, normally before one decides the way the machines are to be laid out, a product analysis is required. Normally, graphical presentations are done, one at the assembly level and the other is at the each operation level accordingly, it is called assembly chart or Gozinto chart; Gozinto basically goes into; goes into; goes into, it shows how flow of material and relationships of parts.

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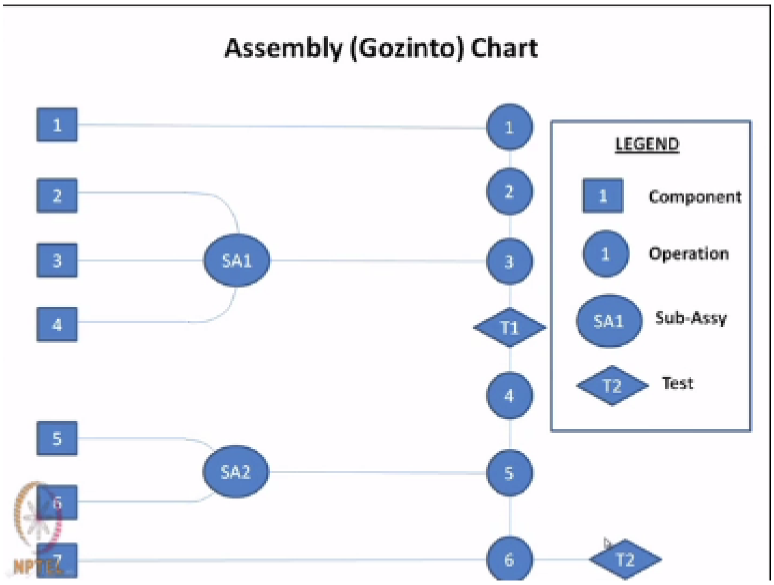

And operation process chart is basically a graphical representation of the operations that take place when a process a part is produced. Let us give an example of Gozinto chart, this is also known as an assembly chart. This involves are for the components, so this is a component, so they are all bought from outside and these are the operations of course, I have not written down the names of the operations but one should write the names of the operations.

So, these 3 parts together for sub assembly, this part or component goes through 2 operations, sub assembly and these parts after operations go through another operation and then it is tested. So, this symbol is for testing, this symbol is for sub assembly and the circles for operation like this and other sub assembly is here out of 2 bought out components, this and after testing and another operation, this goes to another operation and then this part and this through this operation and finally the testing is done.

You can now understand why it is called a Gozinto chart, these components go into this process, these goes into the sub assembly and then into the process and finally to the assembly, so this is a broad view of how component and sub-assemblies go through different operations to produce the final assembly, they go into chart.

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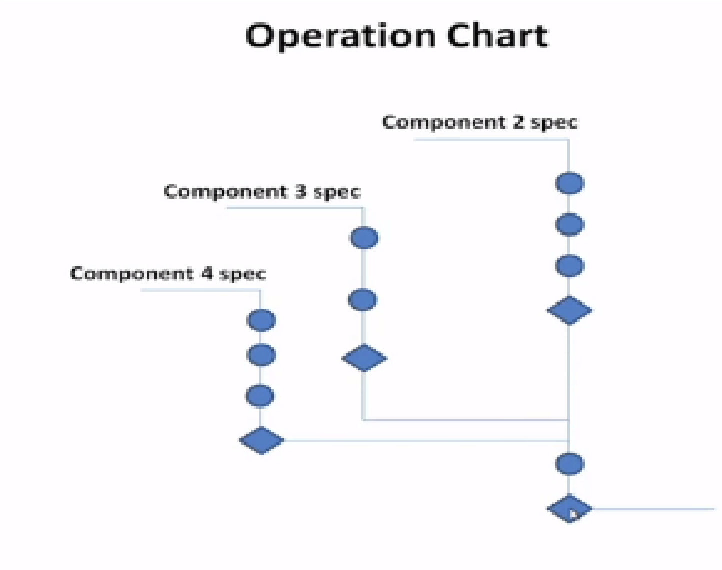

Now, in this let us consider how these 3 components are go into the sub assembly one, this is shown here. Sub assembly is made here and the 3 components are this; component 2, 3 and 4; component 2 passes through 3 operations and a testing, component 3 passes through 2 operations and a testing, component 4; 3 operations and a testing and then all of them pass through another operation and then a testing.

Before they form a sub assembly 1, so you can see that it is further broken down into individual operations, this is how an operation level analysis is done. So, you can see that we are following a top down approach in which the first the assembly level details are found out through the Gozinto chart and then we make an operation level analysis that means, you break down the sub assembly into different parts.

And find out how the different components pass through different operations and then they are assembled into sub assembly. So, operation chart can be very big but I have only shown only for sub assembly one.

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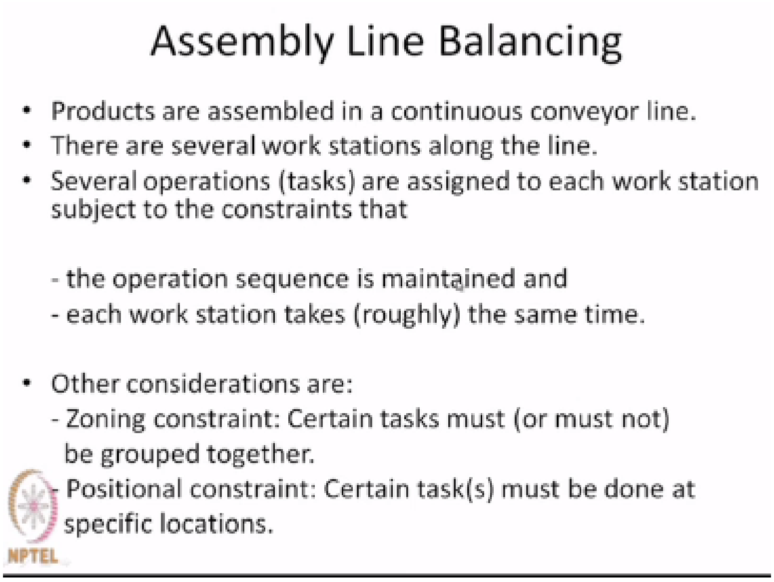

Normally, in a product focused system, the proper layout is a product layout or a line layout, so there the problem is whether the line is balanced, you can know that every operation takes a time that is that can be different from the operation, which is next to it. So, unless the 2 operations are equal in nature, if every operation is given to one machine then it is possible that there is a mismatch of the time and therefore a machine may even idle.

Because the operation in its previous machine is not yet complete, now this idle time is the problem in a line layout therefore, in a line layout it is required to make the design of the line in such a fashion that the delay is the minimum particularly, in assembly there is a possibility of bunching certain operations into a particular station and the station times should not be very different from one another, this is called the assembly line balancing problem.

Now, here normally the products are assembled in a continuous conveyor line, there are several work stations along the line, several operations or tasks are assigned to each workstation subject to the constraints that the operation sequence is maintained and that each workstation takes roughly the same time that can be other considerations but principally these 2 considerations are important that the operation sequence must be maintained.

And the workstations must be balanced meaning, roughly they should take the same time and that each workstation can or should handle one or more than one tasks or operations, so in which way the operation should be grouped, so that these 2 are achieved. The other considerations are that there could be a zoning constraint or that certain tasks must be done at specific locations and all that they are more difficult to handle.

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Example:

Consider a 9-task (or 9-work element) assembly problem. The ***precedence relationships*** among the tasks are shown below.

Element (Task) Number	Duration	Immediate Predecessor(s)
A	5	-
B	3	A
C	4	A
D	5	B,C
E	1	D
F	4	D
G	5	D
H	4	F
I	6	E,G,H

But this is easier things to handle and we will study that, we are illustrating this with the help of an example. Consider a 9 task assembly problem, a task is also known as a work element, so this tasks are A, B, C, D, E, F, G, H, I and the duration in minutes are given here and the immediate predecessor is this or this, meaning that to carry out B, A must be completed, so A is the predecessor of B.

To carry out C, A should also be completed, only A not B, so A is its immediate predecessor, to carry out D, we need to complete both B and C, otherwise D cannot start. So, I cannot start unless E, G and H all the 3 are complete.

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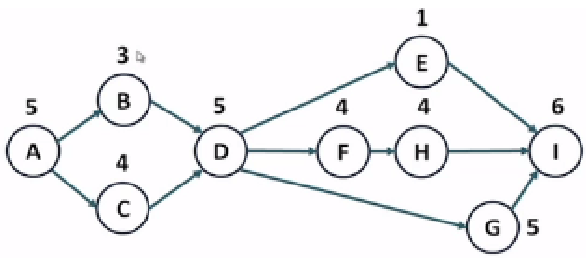

Precedence Diagram for the Tasks

Assume that the output requirement is 4 – 5 units/hour, resulting in the desired ***cycle time*** of 12 – 15 min per part.

The problem is to

- group the tasks (work elements) into different sets and
- assign each set of tasks to a work station

while satisfying the constraints mentioned earlier.

Normally, this is shown in the form of a diagram, here you see it says that once A is finished, B and C can start and when both B and C are complete, D can start, when these complete any one of these 3 can start; E, F and G but not H. H can start only after F is complete and only when E, H and G are complete, I can start and complete and these are the times that I had written down in the table here, the duration times.

Now, assume that the output requirement is between 4 to 5 units per hour; I am sorry these are all hours; 5 hours, 3 hours, 5 hours, 4 hours etc. No, these are minutes, let us say that the output requirement is 4 to 5 units per hour resulting in the desired cycle time of 12 to 15 minutes, if in one hour 4 units are made then per unit it is 15 minutes, whereas if it is 5 units, it is 12. So, if the output requirement is between 4 to 5 units, the cycle time has 12 to 15 minutes per part.

Now, the total time comes to, if we add all this comes to 37; 5 + 4, 9, 12, 17, 21, 22, 26, 32 and 37, so total 37 minutes, we are interested to group these operations or tasks or work elements into different sets and assign each set of tasks to one particular workstation such that the station time is between this.

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Total number of tasks = 9

Total task time = 37

The following possibilities are there:

No. of work stations:	2	3	4
Ideal Cycle time:	18.50 min	12.33 min	9.25 min

The problem is to group the tasks into sets such that the total task time in a set is as close to the ideal cycle time as possible.

So, the total number of task is 9, total task time is 37, if we go for 2 stations, every station can have a something like 18.50 minute but we need something between 12 to 15, if you go for 3 workstations then it is 12.33 minute and if you go for 4 work stations, it is something like 9.25 minute at 37/4; 37/3 is this, so it appears that if we go for 3 workstations, we can get the required output.

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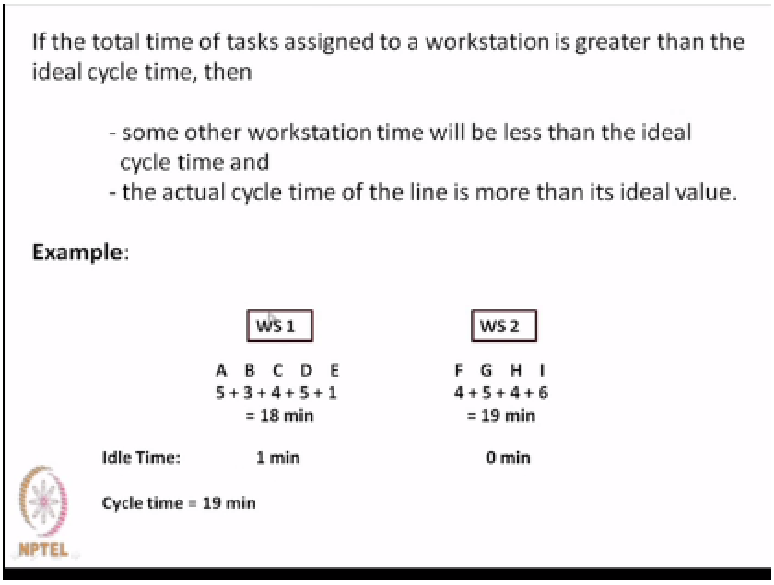

The question is how to group the operations into each of these 3 workstations, now here we have given an example, suppose that we go for 2 workstations; work station 1 and workstation 2 and suppose that we arbitrarily assign A, B, C, D and E, let us look at that yes, this one; A, B, C, D and E, these 5, we assign to work station 1 that means these tasks will be completed in work station 1, so they will take 18 minutes, A takes 5 etc.

And the remaining time work station 2 takes 19 minutes and the cycle time that means the work will be completed after 19 minutes only that is called the cycle time. The cycle time is therefore 19 minutes and the idle time of machine or work station one is 1 minute, for 1 minute it will remain idle and work station 2 will be always busy of course, we need 3 work stations and not 2.

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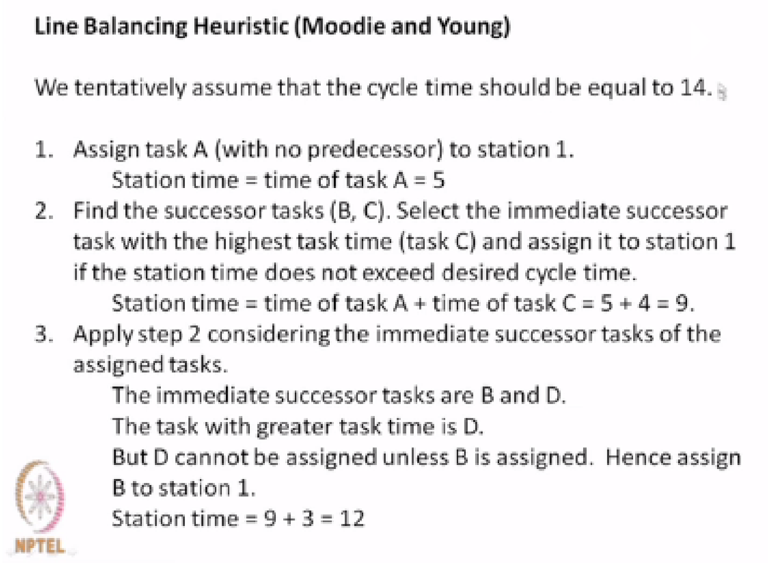

Now, we use a balancing heuristic given by Moodie and Young, it says first of all assign task A, we assume that to be equal to 14, assign task A to station one that does not have a predecessor, so first task A does not have a predecessor, so assign that to work station 1. So, this station time is 5, now finds the successor tasks B and C. Look at this diagram, after A is complete, B and C is available.

B with 3, C with 4, the heuristic says find out of this B and C, the task with the highest task time in this case, it is C4 that has four minutes, assign that also to station 1, so the station one total time becomes 5 minutes for A and 4 minutes for C making it 9 minutes. So, now that A and C are both assigned the immediate predecessors; successors are B and D, however D cannot be; between these 2, B has higher value 3 and 5; 5 is higher.

So, these could be applied; could be assigned to work station 1, however D has a predecessor B and B has not been yet assigned therefore, unless B is assigned, D cannot be assigned, hence B has to be assigned to work station 1 according to this heuristic, so that is what we have written. Although, D satisfies this criterion higher of the successor tasks, it cannot be assigned, hence assign B to station 1 and station time becomes 12.

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5. Continue to apply Step 2.

In this case, D cannot be applied to station 1, because the station time will become 12 + 5 = 17, which is greater than the desired cycle time of 15.

Assign D to station 2. Station time = 5

The immediate successor tasks are E, F, and G.
The task with the greatest task time is G (5 min).

Assign G to station 2. Station 2 time = 5 + 5 = 10

Following Step 2, we assign task F to station 2.
Station 2 time = 10 + 4 = 14

The remaining tasks are assigned to station 3. Station time = 11 min

We are interested in the cycle time between 12 and 15 and we are suggesting that it should be 14. Now, that we have assigned B, we can now think of assigning D, which is its successor but D when applied to station 1, its station time becomes 17 much in excess of 12 to 15, therefore D cannot be assigned to station 1, it should be assigned to station 2, so assign D to station 2, therefore this station time of station 2 is 5, the task time of D.

And the immediate successors of D are E, F and C, of these 3, G is having the highest task time therefore, easily G can be given to work station 2 making the station time 10. Now, we have the successors are E, F and I but I cannot start unless H is complete, therefore I is out of question, we have to think between these 2, between these 2, F is higher. So, F probably can be given to work station 2 making the value 5 + 5 + 4; 14.

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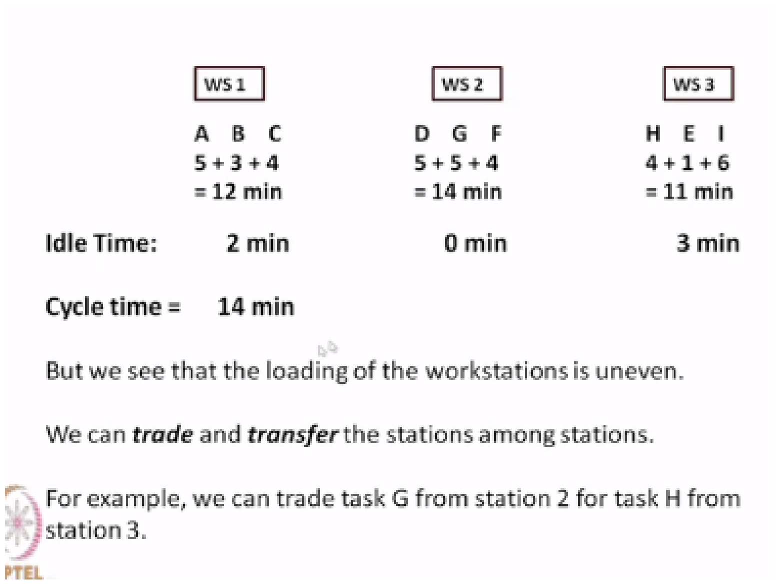

The remaining tasks are assigned to station 3, station time is 11 minute. So, now we have 3 stations and we have followed the Young and Moodie's heuristic to assign the tasks to different workstations resulting in 12 minute, 14 minute and 11 minute and the cycle time is the highest of the 3, which is 14 minute and compared to this, the idle times for work station 1 is 2 minute, work station 2; 0 minute, work station 3; 3 minutes.

Now, we see that the loading of the work stations is uneven, it is not very, very good because the difference is here 3 minutes, 2 minutes and 0 minute, now we can use our judgment to trade and transfer the station among stations. For example, G from station 2 and H of station 3 can be traded and transferred, G has got a time of 5 and H has got a time of 4 and if we look at the precedence relationship, once F is complete, G and H can be put anywhere.

So, we are putting G here and H here, so resulting in 13 minutes here and 12 minutes there, the cycle time reduces to 13 minutes therefore, the production time will improve, the idle time is now reduced to 1 minute for work station 1 and one minute of work station 3 and here of course, it is 0 minute.

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Improved Balance

Station	Task	Task time	Station time (S_k)	Idle time ($C-S_k$)
1	1	5		
	3	4		
	2	3	12	1
2	4	5		
	6	4		
	8	4	13	0
3	7	5		
	5	1		
	9	6	12	1

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Balance Delay

$$d = \frac{100(nc - \sum t_i)}{nc}$$

where,

n: number of stations
c: cycle time
t_i: time of the ith task

For this case d = 5.4 %.

It will give 4.6 parts per hour.

Normally, these unevenness, so the improved balance is I have given here, therefore we can; we normally define a term called balance delay and define it in this fashion that it is 100 * nc - summation ti/ nc, where n is the number of stations in this case 9, c is the cycle time, the cycle time we have got is 13 minutes, so 13 multiplied by 9 is n * c - total time is 37 / n * c, which is 9 * 13, this in our case comes as 5.4% and with a cycle time of 13 minutes, it will give us 4.6 parts per hour.

So, friends today what we did? We started with the broad product service strategies that an enterprise can take. As I said it depends on principally 2 things; one the stage of the life cycle and the nature of the demand, low volume or high volume or custom products or mass products depending on that the company can go for either intermitted production or continuous production or in between batch production or mass production.

We talked about 4 different types of layout, for standard products, we followed product layout or line layout, for custom products we follow process or functional layout and then there are 2 other varieties; fixed layout and group layout, towards the end of the lecture, we discussed about particularly a problem that is encountered in assembly lines known as line balancing problem.

There, the problem is how to group different operations and assign them to different workstations such that the workstation times are more or less equal, we defined a quantity called balance delay, which can be used to compare between different allocations and normally one uses different methods by using judgement known as heuristics, to decide how to group the operations or tasks and assign them to different workstations.

In our next class, we shall discuss about how to make process layout decisions and after that we shall start discussion on production planning. Thank you very much.