Toyota Production System
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Lecture 34
Techniques to reduce Lead Time

Welcome friends. In our last session, we were discussing about lead time and we discussed that lead time is very important for developing the competitiveness. We also raised a question that when we are talking of a pull system, so in pull system, when things are prepared, when orders are prepared after getting the customer requirement, then obviously there will be larger lead time.

We discussed the example of Dell company that how they changed their model that was very unique, because they were giving very individually designed machines to the customers. But later on, they realized that customers are more interested in getting products faster and therefore, how to generate that value. The value was not in the customization. The value was in faster delivery and therefore they changed their supply chain model from online delivery to retail outlets.

So right now, Dell products are available in the online format as well as in the retail format. Therefore, what I am trying to say that lead time is a very important consideration and many organizations, those who are not able to adopt this concept of lead philosophy, this concept of pull-based manufacturing, their major concept is how to minimize the lead time. Without going into the detail of this concept, they will always have a superficial knowledge.

And that superficial knowledge will be a major barrier. It is a major challenge for adoption of lean thinking, because you will always feel that my customer will become dissatisfied. I am not able to fulfill the customer's requirement immediately, so customer will go to some other place where he or she will get products immediately. So I should also keep inventories ready, but I forget at that time where I keep inventories ready, this increases my cost of inventory.

This created waste of inventory in my organization and at the same time, my entire operations become bulky and I will not be able to change. I will not be able to have that kind of flexibility, the agility, which is required in the present environment. So therefore the pull based manufacturing, the concept of lead manufacturing helps us in achieving this particular aspect that you can become agile organization. You can change your working style.

You can change your processes, so that you can bring new products at a faster rate and that all is also requiring that you should not take unnecessarily long time to deliver your products. So on one hand, we are targeting that we should not create more inventories. We should not produce products in anticipation, but at the same time, we should do something, so that we can minimize the lead time. So in this particular session, we are going to focus on this aspect that what are those techniques.

What are those ways in which we can reduce our lead time, so that is the focus of this particular session that what are the techniques to reduce lead time? Now let us see what are those techniques available to us and what is the purpose of lead time analysis.

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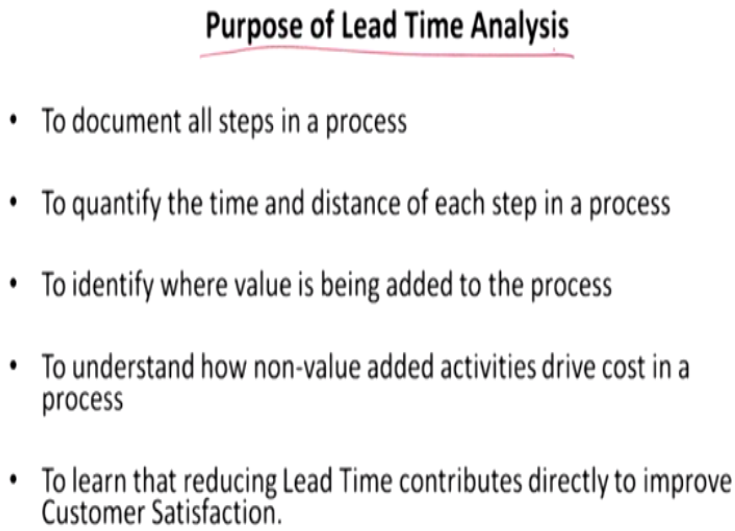

So the first thing is, which we are carrying from our previous session that what is the purpose of lead time analysis. Now first is, the first purpose is to document all steps in a process. So documentation is very important. Those who are aware about ISO certification, those ISO

requirements are only about documentation. The idea is that when you document something, it will help you to improve.

When you do not document, you do not have any kind of written evidence, then it is very difficult to improve in the abstract environment. So for having some kind of tangible improvement, you first need to start from the documentation. So the one important purpose of lead time analysis is that it creates documentation of all the steps, which are involved in your process of transforming input into output.

So that is the first important thing. The second important thing is to quantify the time and distance of each step in a process, but if you are moving from one work station to another work station, work station 1 to another work station, how much time and how much distance you are moving. So with this, you will be able to determine that how much total distance you are moving in your entire assembly line and obviously our effort will be to minimize that total distance you are moving.

How much total time you are putting in this movement from one station to another station, one point to another point from origin to finish, how much total time you are putting in the movement only. So we want to minimize the distance and once you minimize the distance, it will correspondingly minimize your time to travel, so that is another very important aspect that lead time analysis will help you in doing so.

So you need to have the quantitative majors of time and distance. The third is to identify where value is being added to the process. Now when we are moving from 1 to 2, 2 to 3, 3 to 4, maybe the third is some kind of intermediate warehouse, where your products are waiting for further processing. Further processing will take place at the fourth place, but third is an intermediate warehouse because there is a long queue in front of fourth work station.

So you cannot keep all those places, so you have created a separate warehouse where you are keeping these double WIPs. So if your products are at third stage, that means no value is being added. When they are at the second, some machining is taking place, at fourth some finishing is

taking place, so these things are value adding things. But when a product is just waiting for its turn to be processed, that is non-value adding activity.

So you need to identify where value is being added. So those processes, those steps where value is being added. Then, next is to understand how non-value added activities drive cost in a process. When something is sitting idle, that is involving your money. So you are paying for that storage space. There are some chances of some wear and tear, then you have also blocked your capital in that WIP.

So all are different ways in which this non-value added activity of waiting is costing you. So you need to understand that how these non-value added activities are costing you, because unless until you understand these things, like for an example, we take a very different case. We teach in our regular classes also, some time students do not come to the class and they are sitting idle either in their hostels or in canteens.

Now somebody will say that sitting in hostel or sitting in canteen from my point of view is a non-value adding activity, but you will only have the importance, you will only understand the gravity of that non-value adding activity when you can give some kind of monitory equivalence for that non-value adding activity. That if you are not coming to a class, you are losing this much of rupees.

If your total fee for MBA course is 10 lakh rupees, so one lecture may cost you 5000 rupees and if you are not coming to a class, you are losing. You are unnecessarily paying that 5k and once this figure by just missing a lecture of 2 hours, I am losing 5000 rupees, it will create a kind of waves. It will create some kind of impulse in the student, so automatically that non-value added activity will get some kind of focus and it will be eliminated by its own efforts.

So you need to understand that how non-value added activities drive cost in the process. It will be a very important thing, without associating cost to non-value added activities, you will not be able to create kind of momentum, which is required, so that is also a very important purpose of

lead time analysis. The other purpose of lead time analysis is to learn that reducing lead time contributes directly to improve customer satisfaction.

Because customers want faster deliveries, customers want on-time deliveries. So if you are able to reduce lead time, you are going to help in improving the customer satisfaction and many a times, we have discussed that we are living in the marketing era. So customer satisfaction is the most important aspect of any business, so therefore by learning the art that how can I reduce lead time, you will be directly helping in improving the customer satisfaction and that is nothing but TQM.

So lead time issue may come from the purchase department. Lead time issue may be handled at the operation department. Lead time issue can be handled at the maintenance department, but the benefit of it will go to marketing department who are dealing directly with the customer, so you can see that how all the functions of the organization are helping in improving the customer satisfaction. So these are the important purpose of lead time analysis.

And therefore, now you can understand, you can appreciate why should we go for lead time analysis.

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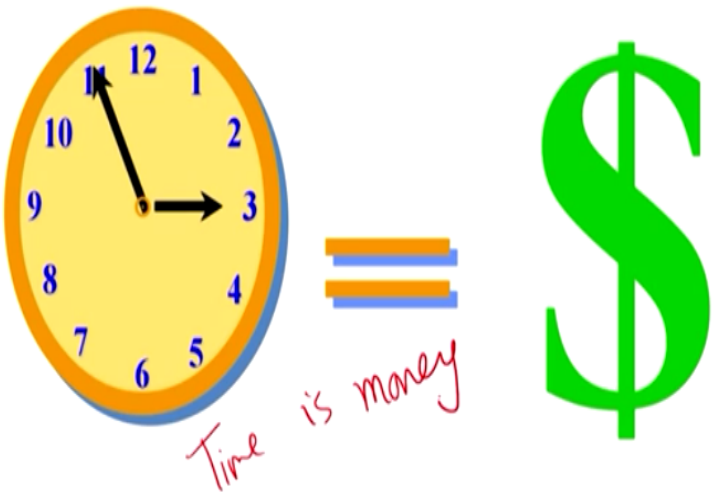

As this figure rightly says that time is money. So if you are able to save time, you will earn more money. If you are not able to save time, you are losing money. You are incurring more cost. So this is that simple representation that how time is equivalent to money. It is not only true for the organization, but for personal life also. If you do not focus appropriately at the right time for right things, you lose many things.

So later on we realize that if we could have done that thing at that time, we would have been at a different situation, but time flies like anything. So, therefore this particular slide is only to emphasize the importance of time and it is on the simplistic ground time can be equivalent to money power.

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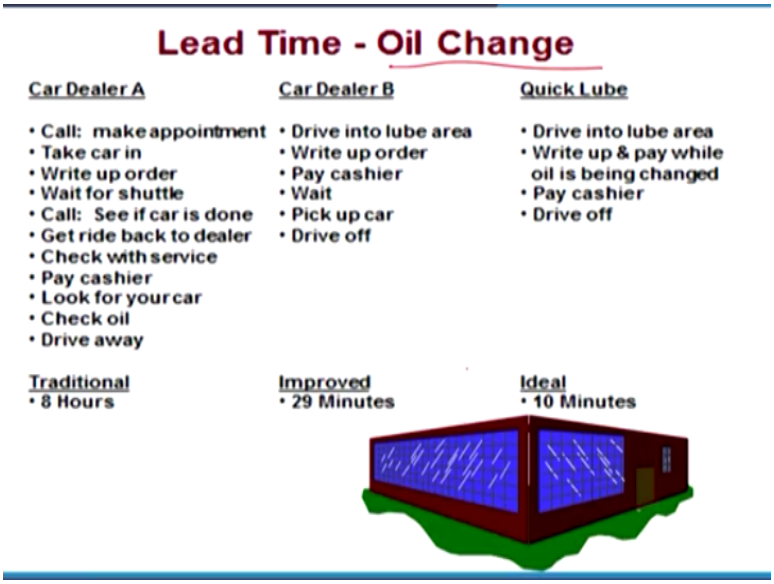

Now with that example, we try to understand that how lead time in a case of oil change, that is being done and in case of a traditional system, this oil change is taking 8 hours. In an improved system, where a car dealer B is there, it is taking 29 minutes and in a most ideal situation, the same thing can be done in 10 minutes. So you can see that how much improvement we are able to do that 8 hours mean almost your full day is involved in changing the oil.

Why, in a very improved situation where you are able to follow the strategies of lead time reduction, we are able to do this in just 10 minutes. So how different processes are happening, you see that how many processes we are able to continuously reduce. So by reducing, if you read

this, that make appointment, take car in, write up order, wait for your shuttle, call and see if car is done, get right back to dealer, check with service, pay cashier, look for your car, check oil, drive away.

Now these are the various activities which are involved in changing the oil. Now you can understand by doing this lead time analysis that all these activities in this process are not the value adding activities. There are various non-value adding activities, but those one value adding activity are taking majority of your time and here in quick loops, we have reduced, we have eliminated almost all those non-value adding activities.

So actually, there is only 10 minutes' time which is being taken for the oil change. So that is how if in this particular case of car dealer A, you need to leave the car, go back and come again for collecting your car, because you are not going to wait there for 8 hours, but in this case of quick loops, you can go, just sit, and have a cup of coffee and you can drive back your car with changed oil.

So the tremendous amount of customer satisfaction has been increased by this simple example, you can say and you see that you have just that various activities are now happening in parallel. So you are able to reduce the time because in a real case, things were happening in sequential mode and therefore it is such a long time, so it looks like a magic, but from 8 hours, we can reduce it to 10 minutes and that is a possibility. This is from the live case studies.

So that is how the lead time reduction can increase the tremendous amount of satisfaction for the customers.

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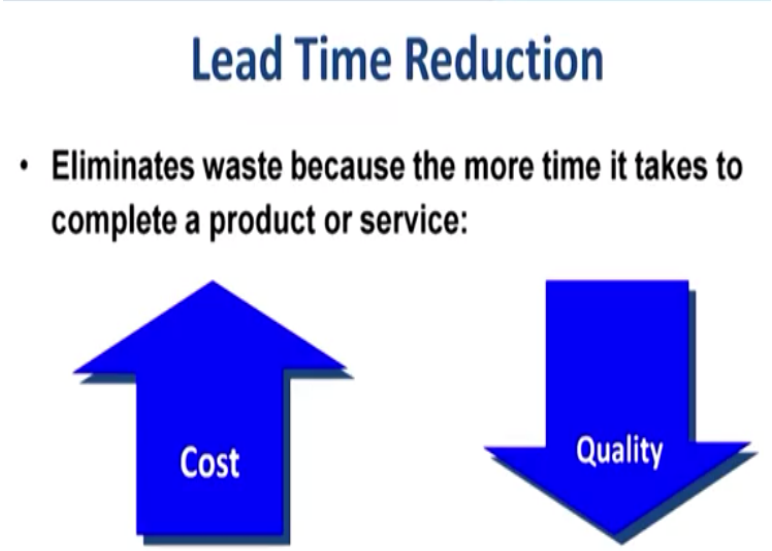

Then, you see by eliminate, because excessive that since more time you are keeping a product in the system that according to Toyota Production System is a waste. So lead time reduction is actually the waste reduction, because when we are talking of lead time, in our previous session, we discussed that maybe up to 70% of the time is contributed because of waiting, transportation, change over, etc. The actual processing time is just 30%.

So when I am talking of lead time reduction, we are trying to target that 70% time, which is a waste time. So if you are able to eliminate waste, you are able to reduce the lead time and by reducing the lead time, you will improve the quality and your cost will go down. So that is how this is going to have dual advantage for your organization. Now by the help of graphic tools, we can see that how lead time reduction is taking place. This slide gives you that idea. That how graphic tools can be used for developing your lead time analysis.

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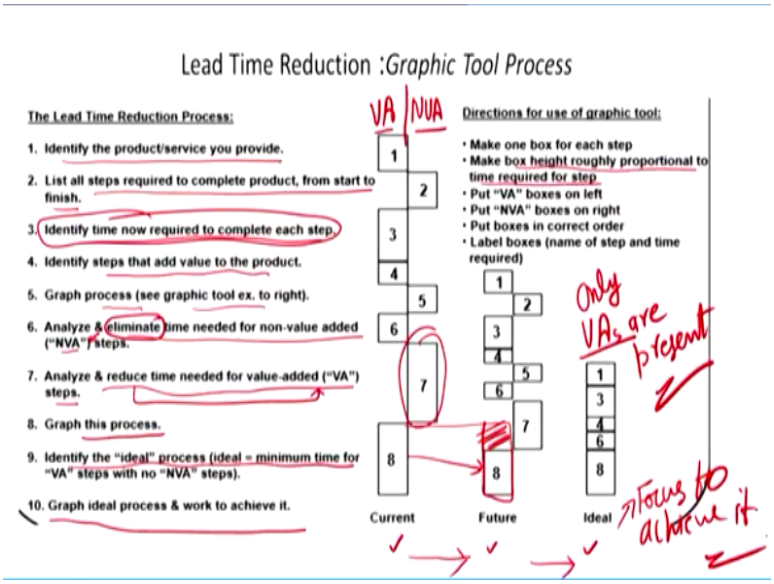

Now in this lead time process, these are the 10 steps and you see that how these 10 steps are being carried. So identify the product service you provide, list all steps required to complete product from start to finish, identify time now required to complete each step that how much time and for that purpose, you can go to the class of industrial engineering that what is the most optimistic time, pessimistic time, and likely time.

And on the basis of these 3 time estimates, you can determine that how much time is required for one particular activity in your entire process. So you can go to that class of project management or you can go to the class of basic operations management to understand or even during the class of industrial engineering that how we determined the time to complete each step or activity in the process. Identify steps that add value to the product.

Graph process like this is the graph which are the current state, the future state and the ideal state, so that you are able to reduce the lead time. So here we will just see, analyse and eliminate time needed for non-value added activities, NVA, non-value added activities. Analyse and reduce time needed for value added steps. So because in your entire process only two type of things are there, value added things and non-value added things.

So you see we need to eliminate non-value and reduce time required for value added. So we are going to target both the things, non-value added activities as well as value added activities. For

non-value added activities, we are going to eliminate them and for value added activities, we are trying to squeeze, we are trying to make them more efficient that with less time, how you can complete those things.

Because these are necessary, these are required for conversion, so we cannot eliminate them, but we can think that how to make them more efficient and how can we reduce the time required by those value added activities. Then, graph the process because you have graphed the original process and now you will graph the new process. Identify the ideal process. Now ideal means the minimum time for value added steps with no value added activities.

So you have the original, then you are going to eliminate something, some non-value added activities and you are having only value added activities. Now you want to go to a third stage where no non-value added activity is there, only value added activities are there and how much you can squeeze, those value added activities, that becomes your ideal. So therefore you see in this particular case, there are 8 steps, 1, 2, 3, 4, 5, 6, 7, 8.

Now out of 8 and finally the 10th step is graph ideal process and try to achieve it. Now you see that for each step, you are making one box, like there are 8 steps, so 8 boxes are there, 1, 2, 3, 4, 5, 6, 7, 8. Make box height roughly proportional to time required for a step. So like you see that box 4 is much smaller, box 7 is much larger, box 8 is also big enough. So it means that 4 takes very small amount of time, 7 and 8 are taking bit longer time.

Third is also a bit larger. So depending upon the size of box, you understand that whether this is, how much time it has been taken. Now very interestingly, the boxes which are on left, these are value added activities. These boxes are for value added activities and the boxes which are on right, these are non-value added activities, NVS. So the purpose of display is this only that just by glancing it, you understand that what are the value added activities, what are non-value added activities.

Which value added activity or which non-value added activity is taking more time and we know this that resources, which take maximum things, those activities which take maximum resources

should be targeted first. So like in this particular case, just by seeing the first figure, you understand that 7 is that particular non-value added activity, which is taking longest time in NVS. Three activities are there, which are under NVA, second, fifth and seventh.

But 7th is taking maximum amount of time, so when we are going for the improvement activity, we should first target the 7th, because wherever you have the maximum consumption of resource, you can save maximum amount of resource from there only. So therefore the 7th become the first target and then you make this second diagram that in future, 1, 2, 3, 4, 5, 6, 7, 8, because you are doing two things simultaneously.

You can see the size that from this 8 to this 8. Earlier, it was of this much size, now you are able to have only this much size, this is not there. The meaning is that you are not only targeting your NVS, but you are also targeting your value added activities. You are thinking that how to shorten their duration, how to reduce the time used by those value added activities. So there is a considerable squeezing of all the value added as well as non-value added activities time.

And then, we will go to this ideal situation from the future situation, where you see that no NVA is there, only one straight line is there and that straight line is having only value added activities. Only value added activities, 1 is there, but 2 is not here, 3 and 4 are here, but 5 is not here, 6 is here, but 7 is not here and then 8 is there. So you have 1, 3, 4, 6, 8 only value added activities, only VS are present.

So this is a very interesting graphic tool, which can help you in reducing your lead time. You have divided the entire process into various activities, then you display them in the form of this graphic tool on one side you have value added activities, on other side you have non-value added activities. You make their size according to resources consumed by them and then you are trying to create a future situation and an ideal situation and now focus on to achieve this.

That is our target that how should we achieve this ideal situation where we can have the minimum time, so you can see that initially the diagram was so big, but now the diagram has considerably reduced and we already know that it is representing the time. So our total time has

been reduced by less than 50%. So if originally it is taking 60 minutes to complete a particular job, now I think it is taking around 20 minutes or 25 minutes to complete the job.

So that is how this power of lead time reduction is there and you can go for that. So here if I go in step by step discussion of various stages of this lead time reduction process.

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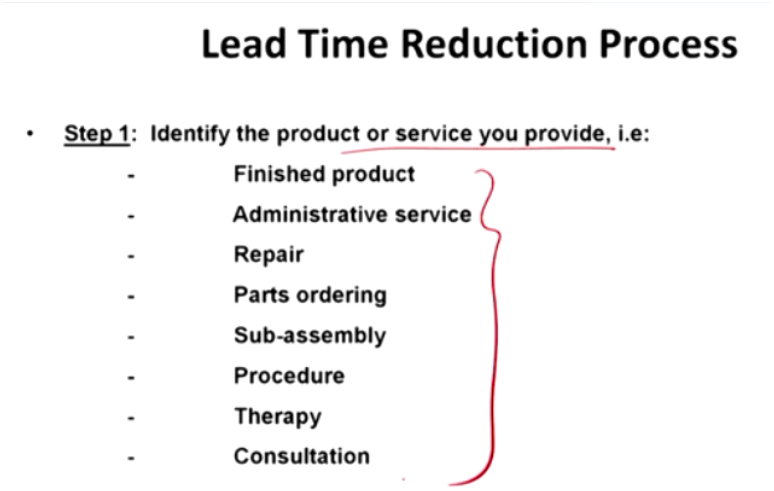

The step #1 is identify the product or service you provide. So already these are different types of services, etc., list is there that from finished products to intermediate things to MRO where you have the maintenance repair activities and maybe you can have some kind of service activities. So this is an example of service. This is an example of service. This is example of MRO and therefore, whatever type of activity you are performing.

Why we are discussing that, this lead time reduction can be done for internal or external customers. So when I am doing it for internal customer, so let us say repair work, so some tool get some kind of issue and you have to repair the tool, so that tool is required by some machine in my plant. So the internal customer is important and if I am not able to maintain, if I am not able to address the issue of that tool, so it means the waiting time of that machine will increase.

And the machine will remain idle, because I am not able to respond quickly to the demand of my internal customer. So it is not necessary that all the time I focus on external customer. Internal customers are equal; therefore, this particular listing is discussed here.

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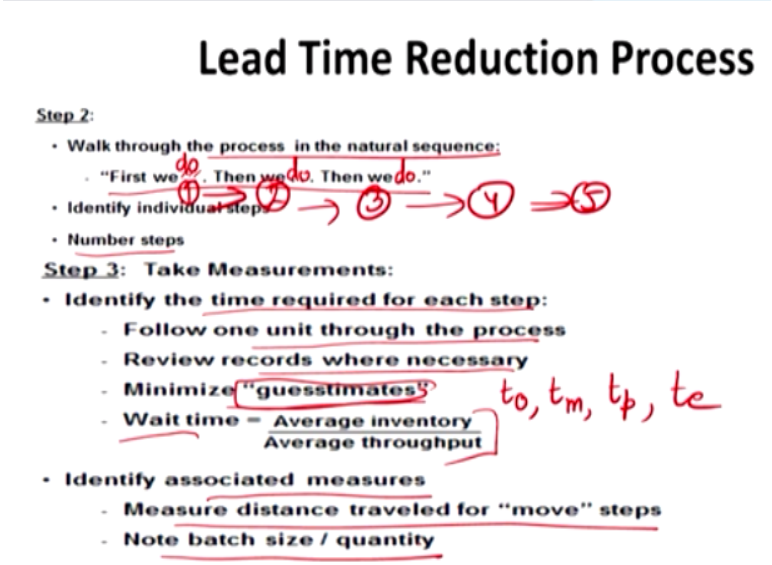

Then, the second step in this process is walk through the process in the natural sequence. So what sequence you are following. In that original order without doing any kind of improvement, what is the natural sequence, you need to develop a kind of map. So first we do this, then we do this, then we do this, so these fill-in the blank, first we do, then we do, then we do, so like this we develop a complete hierarchy structure that how these things are done.

Then you will number these steps, that this is step #1, this is step #2, this is step #3, this is step #4, this is step #5, so step 3 take measurements, identify the time required for each step, follow one unit through the process, review records wherever necessary, minimize guesstimates, so means do not just do your guess work, you need to do estimates, not guesstimates, so that is why this term is being used that we need to have proper estimates.

And therefore I suggested that we need to have that what is the most optimistic time, what is the most likely time and what is the most pessimistic time and then you will have a proper estimate of time that estimated time for completing this particular activity is TE. So using that particular concept, we need to estimate time for each activity involved in our process and then you can use this calculation of waiting time, the average inventory and average throughput.

Then identify associated measures like measures distance, travel for, move steps, note batch size, quantities, etc. So how much is the distance products are traveling. Sometime it may look that

this is a small shop area and how much a product will move, but because of various zig-zag motions, because of your layout problems, because of your scheduling problems, sometime within a very small plant, products travel 100s of kilometer because of their zig-zag movements.

So we do not realize unless until you actually quantify the entire process, entire route and therefore it is important to have these kind of measures also.

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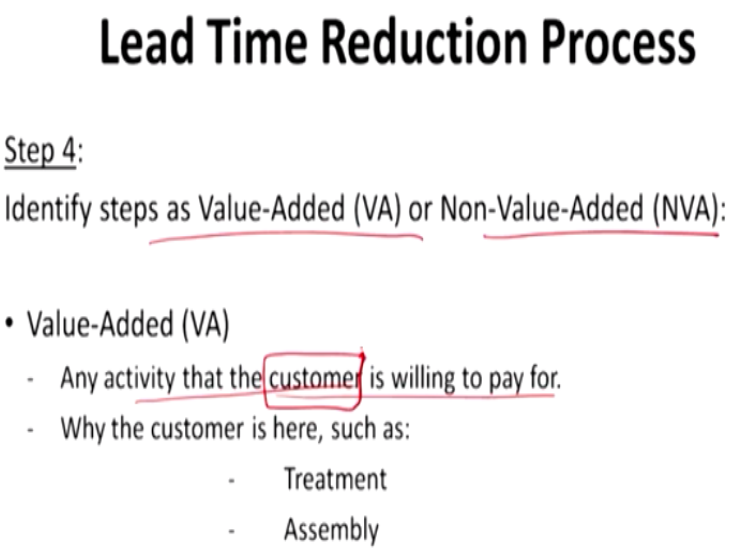

Then the step #4 is identify steps as value added and non-value added. So value added as we already know, the customer is willing to pay for. The simple answer, because it is a very important thing, people do not understand that what is value and people give different versions to give the meaning for value. So going from the spiritual discussions to the discussions based on quality management, we have large variations in understanding of value.

So I just want to contribute to this discussion by saying this particular line that any activity for which customer is willing to pay that is a value activity, may not be value from my point of view, but if my customer is ready to pay for that thing that is a value. So ultimately it has to be seen from customer's point of view. That is going to decide and why the customer is here, such as treatment, assembly, maintenance, order, complaints, etc., that also decides the value. That for what purpose customer is coming to you. Then, continuing the same step.

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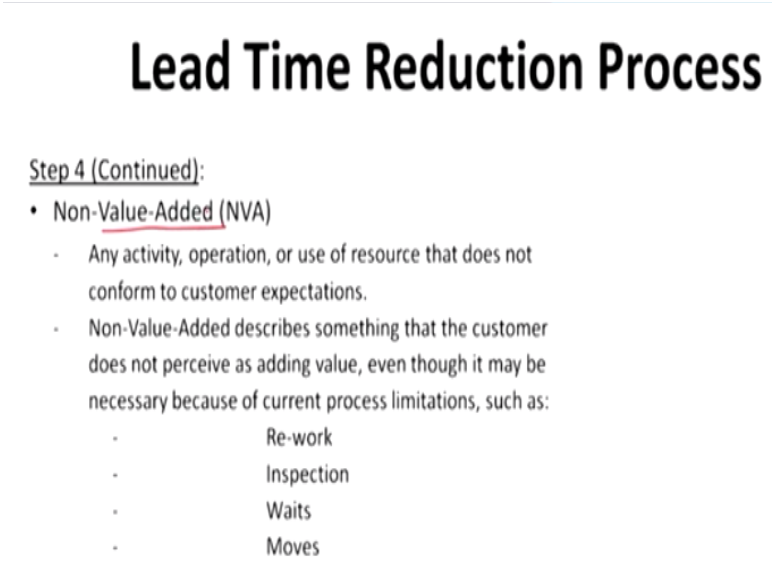

What is non-value added? Because we said that we need to identify value added and non-value added. So value added we discussed, but now what is non-value added. Any activity, operation or use of a source that does not conform to customer expectation. So those things, which are not meeting the customer requirements, which are not essential for the customer, which are not desired by the customer. All those things are non-value added.

Non-value added describes something that the customer does not perceive as adding value, even though it may be necessary because of current process limitations because of your process limitation, something may be required, but if it is not required at the customer end, then it is of no value. Maybe my organization, if I have a business company and my organization gives no importance to ethics in the business, I just want success at any cost.

That is the way I want to work. Now I am hiring students from one IIT. Now in that IIT, there are 2, 3 courses which are focusing on business ethics, environmental ethics. Now all these things, all these courses where I am teaching ethics of different types, these are non-value added activities for that organization where my product is going, because the organization does not care for those ethics.

So from the organization point of view, this is non-value, but from my point of view, from my institute's point of view, I am considering it is a value thing that I am teaching ethics to my

students, but ultimately it is not a value added thing from the customer's point of view. So all these things like rework, inspection, waiting, movements, etc. whatever is happening inside your plant with respect to these things, because of processes are non-value added activities from the customer's point of view.

So for doing a lead time analysis, we need to have this kind of sheet in our log books, we create this kind of template.

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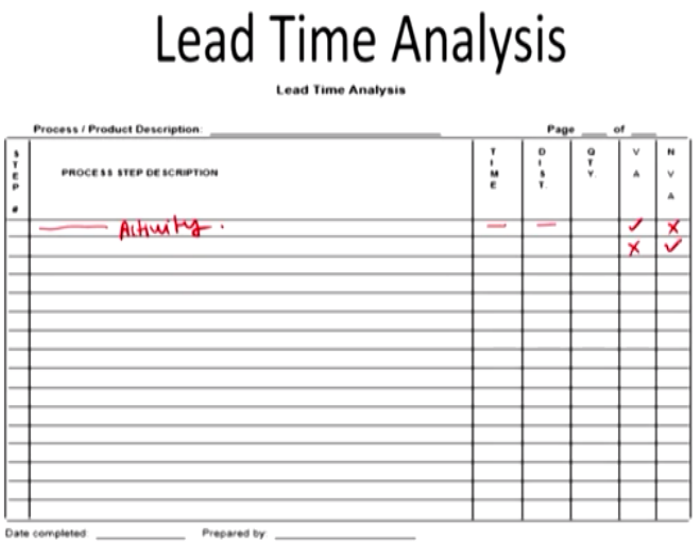

And earlier people those who are available at the shop floor, the industrial engineers, they used to do this kind of lead time analysis, so here you see this template, so you write the process name or activity, and then how much time it is taking, how much distance it is moving from one place to another place, whether it is value added or non-value added, so out of these two things, you make this kind of check.

So with the help of this document, it will help in preparing that graphical tool that what has to come on the left side of that graph and what has to come on the right side of that graph, how much should be the size of those activities that is depending on the time. So this type of sheet is required for doing the lead time analysis. Then once you have done that, we do this kind of graphical process, which we discussed that we will make the graph.

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Lead Time Reduction Process

- Step 5:
  Graph the process:
  - Make one box for each step
  - Make box height proportionate to time required for step
  - Position "VA" boxes on left
  - Position "NVA" boxes on right
  - Put boxes in correct order
  - Label boxes with:
    - Number of step
    - Activity of step
    - Time required
    - Distance traveled
    - Quantity (if applicable)

Where you will have some activities on left and some activities on right, on left you have value added activities, on right you will have non-value added activities. You will make boxes, so that you can represent that how much resources are being consumed by different activities like this. So you can actually put numbers on these boxes and you can also label them that what is the time required, distance traveled, how many quantities are moving, like that. All those things you can make in this kind of graphical display.

Then, we summarize the information that how many total value added steps, non-value added steps, the time required by each value added, non-value added step and determine the percentage of value added work that out of total time taken from start to finish how much time is taken by the value added work. So that is also being calculated. Then we eliminate non-value added activities.

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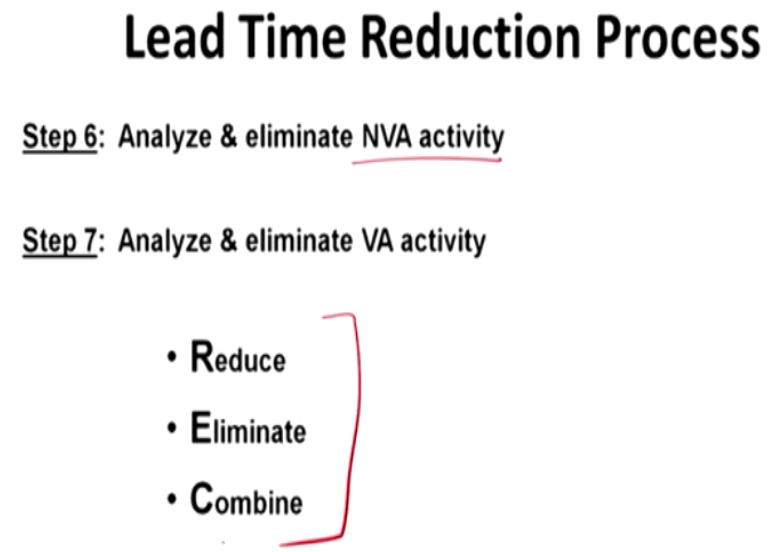

We have already discussed and by following these three combinations, we reduce, eliminate and combine, we try to actually minimize the time taken by value added activity. So how we can, it is not eliminate, rather it is how we can reduce the value added activities and then how we can eliminate some of the value added activity by combining. So a separate value added activity may not be required, but two value added activities can be merged into a single activity.

So that you can actually minimize the total time taken by the value added activity. So merging of activities are also possible and that will help us in reducing the lead time. So that is also very important.

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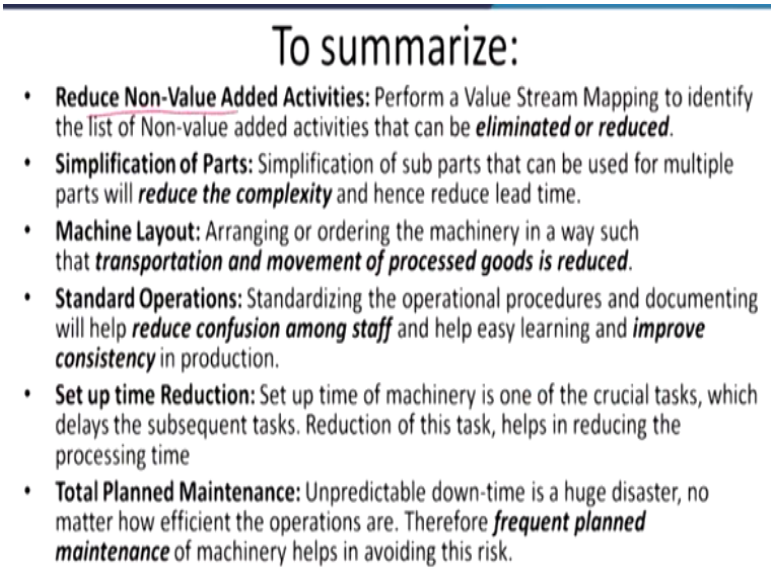

So finally we reached to this conclusion that we can eliminate the non-value added activities by doing the value stream mapping and that value stream mapping is the point of discussion of our next session. So in our next session, we are going to discuss that how to prepare this value stream mapping, then we need to go for simplification of activities, so that you can minimize the time taken by your value added activities.

You need to improve your lay out so that the time required in movement from 1 to another and therefore now the trend is to go for cellular layouts where our old layouts, either process layouts or product layouts are becoming obsolete and we are moving more and more for the cellular layouts and this will help us in minimum movement. Then standard operation, standardizing the operational procedures and documenting, the documentation importance we have already discussed.

That documenting will help minimizing the confusion, people will know what are my responsibilities, how I will be able to improve, what is the standard process, all those things. We need to have setup time reduction, so how we can go for things like SMED, single minute exchange of dice. So that you can have minimum time involved in change over or in setting up the system and then TPM, total plant maintenance.

So that because of wear and tear of tool, because of some breakdowns your machines are not idle. Your parts are not waiting for their turn to be processed. So if you have a proper planning for maintenance, you can ensure availability of your machines for most of the time, but if maintenance is not proper, so machines will not be available and that will again be leading to higher lead time and it will ultimately result to poor customer satisfaction.

So all these things are necessary for reducing the lead time and that will help us in improving our competitiveness. So with this, we come to end of this session and in our next session, we will discuss about the issue of value stream mapping. Thank you very much.