Toyota Production System
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Lecture 35
Value Stream Mapping

So welcome friends. This is going to be the last session of week 7. In our this week, we were mainly focusing about lead time, we were focusing about lean culture and in the last session, we were discussing about that value stream mapping is going to help us in achieving the lead time analysis. We devoted 2 full sessions on issues related to lead time.

That how lead time can provide you competitiveness, customers are looking that you should provide them products of good quality at low cost and at the same time faster deliveries are also very important. So the issues related to lead time reduction are concerned with primarily with faster deliveries, but we last time discussed that time is money. So if you are able to reduce lead time, it is also going to save you lot of money.

It is going to give you the advantage of low cost and therefore the additional competitiveness will be developed and for that purpose, we in our last session focused on some of the visual tools where we will divide our activities in value added activities and non-value added activities and for doing that analysis, this value stream mapping is a very handy tool. We can do value stream mapping for any process, anything which you are doing.

You get up in the morning, and from that time to the time you go back to bed in the night, you can make a value stream mapping for your entire day's activity and then on your own, you will understand that how much time in a day you are using for some kind of value added activities and how much time you are wasting for non-value added activities. Once you do this value stream mapping for yourself, there may be a tremendous increase in your output.

You may be a totally different personality and therefore we say that you may be a very good doctor, but how you can become a more organized efficient doctor, you need to do your value

stream mapping for that purpose. So just knowing something is not enough, but how to do things in a more efficient manner, that is more important and involving those efficiency elements is the basic purpose of value stream mapping.

So in this session, we are going to focus on this value stream mapping aspect of our Toyota Production System.

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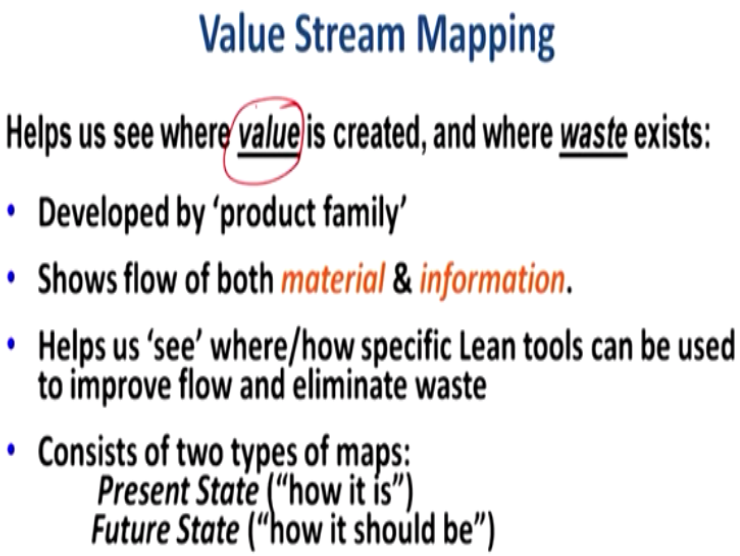

Now when we talk of this value stream mapping, so it helps us where is value created because you have a system, you have various activities in your process, various events which are taking place in your process. So all those events are not value generating events. So with the help of value stream mapping, the first thing which you are going to do that it will help you in identifying and locating those events, where value is created and where waste is existing.

So value and waste, these are the 2 important output of this value stream mapping. 1 is value and waste is also important thing, because unless until you know where is the waste, how will you target it. So knowing the places of waste, knowing the events which are resulting into waste, that is also very important, then only you can target them, then only you can eliminate them. So as our values are important, non-values are also equally important.

Therefore, it is the first important output of the value stream mapping. This value stream mapping, this is if I am talking purely from the shop floor the manufacturing, it is developed by product family. Now what is a product family? We can go to the class of cellular manufacturing. In cellular manufacturing, we develop the layout, we develop our entire manufacturing activity on the basis of this product family.

And the meaning is that those parts, those products, which require almost similar type of operations these are known as product family. So in our shop floor, there are different types of processes, which can take place, but all products may not require same type of operations or all machines may not be used for all the processes. Some group of products 1, 2, 3, this group of product requires operations on machines.

These are machines, these are products. So 1, 2, 3 they require operations on machine A, D, and G. There are other group of products 4 and 5. These are requiring operations on A and C. Then there is another product 6, which require operation on A and B, so you can have 3 product families in your organization. 1 product family is 1, 2, 3, another product family is 4 and 5 and another product family is six.

So these are the different product families, because 1, 2, 3 require operations on similar type of machines 4 and 5 require operation on similar type of machine and 6 requires operation on one group of machines. So based on their requirement of operations, you call it a product family. So this is developed by product family concept. Another important thing, it is not only showing you the flow of WIP, flow of material from raw material to various stages of process.

But it is also showing you the flow of information. So the flow of information and the flow of material both these flows are included in your value stream mapping. So that is also important thing. Then it helps us see where and how a specific lean tools can be used to improve flow and to eliminate waste. When you have a detailed idea about value and waste, it can help you that which type of lean tool whether 5s is used.

If you are taking too much of time in identifying the particular tool or raw material to be used for the next stage, 5s can be used. If you are repeatedly doing some king of mistake and/or you can say repeatedly some kind of defect is generated, then you will do a 5y analysis. So depending upon what type of problem is there, what type of situation is there, what type of waste is being generated, accordingly you will have a choice of lean tool.

So we have already discussed different types of lean tools in our previous sessions, so which type of lean tool is required that is depending upon the type of waste. So because value stream mapping will give you the idea of waste where it is being generated, what type of waste is generated, what is the quantity of that waste and based on all these input, you will have the choice of selection of a particular lean tool.

The important thing is that where are you right now. So that is your present status. So how it is, what is your current state, how much time you are taking, how much waste you are generating, what is the percentage of value added time out of the total time you are taking in making that product and then what should be the ideal stage. The future stage means the ideal stage if you eliminate the entire waste out of your system, then what will be the future state.

So you have 2 you can say comparative statements, 1 is this is your current state and then you make another diagram where no waste is there, only value added activities are there and in that also we have discussed in our previous session that we try to squeeze our value added activities also. So that value added activities also consume minimum amount of resources, maybe material, maybe time, maybe money, so they should also be more efficient.

So how with minimum input, you generate maximum value, that is the ultimate purpose of this value stream mapping. So it is not just elimination of waste, but waste elimination is one part and how with minimum resource input, you can generate more value that is also very important. So you need to have the ideal space, the benchmark state that how it should. So present and future are also the output of your value stream mapping.

So this is, you can say primary understanding that what value stream mapping is going to do us, how are we going to prepare it and what should be the output of a value stream mapping. Now when we are talking that it has two components, one is the present state value stream map and then you see we have a future state value stream map, so these are the 2 maps which we create in the value stream mapping.

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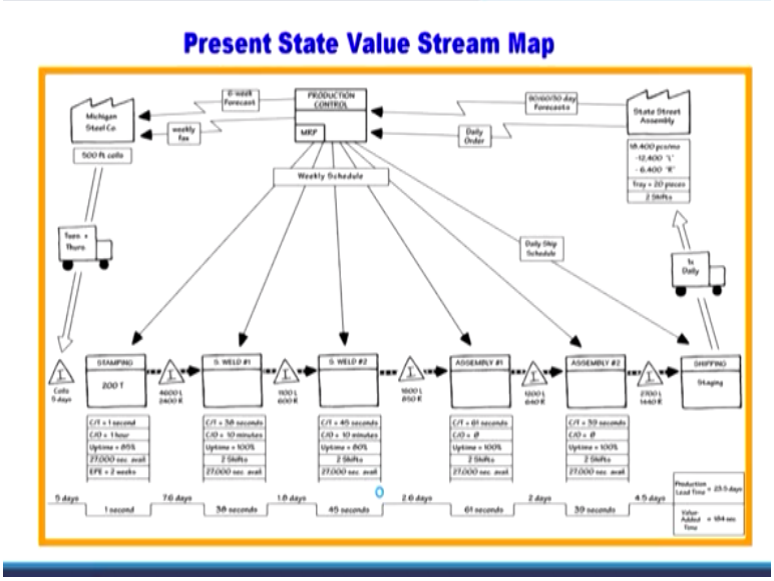

Let us first see this present status of value stream map, in which you can see that lot of time is taking there and out of this entire process, starting from this particular point, this is the start and here you are going out of that, these points are representing some kind of value added activities and these are NVS, non-value added activities. So when you are making the total of all these time, which is being taken in the present status, it is taking 23.5 days.

That is the total time production lead time of this particular product from start to finish, the shipping and out of that, the interesting thing is that the value added time, these seconds, 1 second 38 seconds, 45 seconds, 51 seconds and 39 seconds, the value added time is just 184 seconds. Your total delivery time is 23.5 days and out of that the value added time is just 184 seconds. So can you imagine how much waste you have generated, how much waste?

It is just around 3 minutes' time in which you can produce this product, but you are delivering this product in 23 days. So if you are able to eliminate all that waste, it is more like product is

available off the shelf. The customer may not even understand whether the product was readily available or it came after my order. If you can eliminate all that waste of so many hours, so many days, if you are only able to produce product in 3 minutes' time, the customer will be excited like anything.

He will be delighted, so that is what happening because you see everywhere you are putting lot of time in movement and in waiting. Everywhere you have some kind of weekly production schedule and because of weekly production schedule, you have so many these Is everywhere. So everywhere wherever it is reaching to some machine, or it is reaching to some kind of fabrication activity, it is reaching to some kind of assembly shop, there is a queue.

And there is lot of waiting time before any kind of machine and as a result of that, this product is taking so much of time right from the day of receiving the order when a coil is received from this Michigan steel company to finally the product is being shipped to the customer. So it is such an interesting thing that 3 minutes' work is actually being done in 23 days. Now we will go back to the analysis of that present work also.

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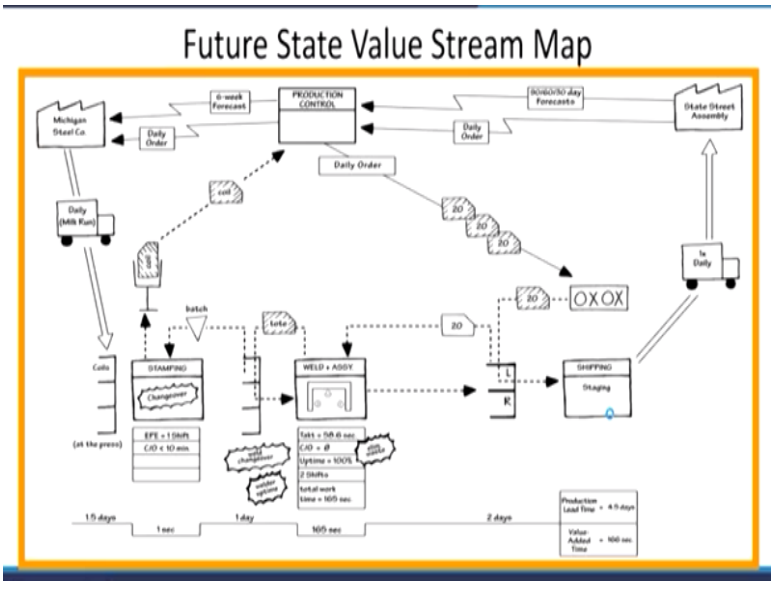

But now you see, in our future state, we are because there are certain limitations, you cannot do that elimination of waste 100%. So there will always be some scope of improvement, but to some extent you can do that and this diagram explains you that particular phenomena that from

23.5 days, we are able to come to 4.5 days. So you have reduced this 19 days' period. How dramatically you have improved your performance.

It is again looking like magic. In our previous session, we discussed that how that oil change was done in a traditional workshop in 8 hours, and in that new system it was possible in just 10 minutes. So that type of magic is possible, that is a magic that is possible if we follow the proper scientific way of doing the things. So from 23.5 days, we are now able to reduce this lead time to 4.5 days and obviously it is not 100% only the value added activities.

There are still certain non-value added activities, but as a part of ideal situation, you may still improve this particular situation and earlier, this value added time was taking 184 seconds. So we have excused some value added activities also, wherever possible we have reduced the time taken by value added activities also, so therefore this 184 seconds is reduced to 166 seconds. So not only you are targeting, not only you are targeting your waste activities, you may target your value added activities also.

And you will see that 184 became 166, so reduction in value added activities will not be very much because already these things are adding value, but some reduction is possible. Now you can see this diagram that how we are able to reduce this time, because you are doing many things parallel and when you are doing many things parallel, you see earlier what has happened by changing your process, we were doing many processes, 45, 61, 39 and 38.

These different processes we were doing, but after another. So in between, for all these processes, we were spending enough time for these non-value added activities. Now in the new situation, we have combined all these different processes and if you remember our discussions of previous class, when we were discussing about the reduction in lead time strategies, one was the idea of combination of various value added activities.

So this shows you the combination of various value added activities that we have combined all those value added activities into a single activity of 165 seconds. So here the intermediate waiting time is eliminated, because now all value added activities you are doing are a machining

center. So therefore, if we go for modern system of machining, where we have the machining center, so the time for movement from one particular machine to another particular machine, that can be minimized.

And various activities can be done simultaneously and therefore those organizations, which are using CNC and C machines, their productivity level is much higher than the productivity level of our conventional lathe machines, conventional engine machines, etc., because you are able to do many things simultaneously without any change over, etc. So that is how we can achieve a future state of value stream map.

Since now this background is clear in our mind that what is the present value stream map and what is the future value stream map, with this we can have a detailed analysis of our current state mapping and future state mapping.

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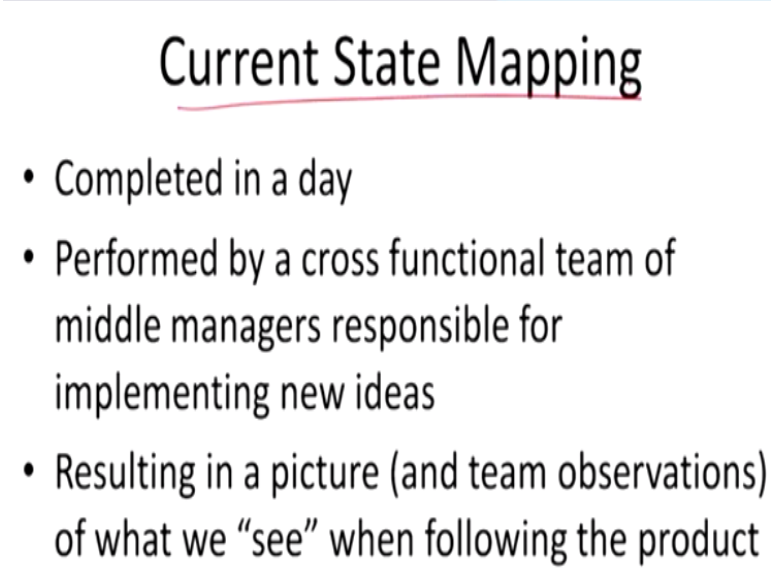

Now in this current state mapping, you have completed the task in days performed by a cross functional team of middle managers responsible for implementing new ideas and resulting in a picture and team observations of what we see when following the product. So how the product is moving? You see the most important thing in this particular discussion is that we follow the movement of product and just now we will see that we will follow the movement of value addition in our future state mapping.

So from this idea of following the product, we will have a different outlook for future state mapping and therefore in the future state mapping,

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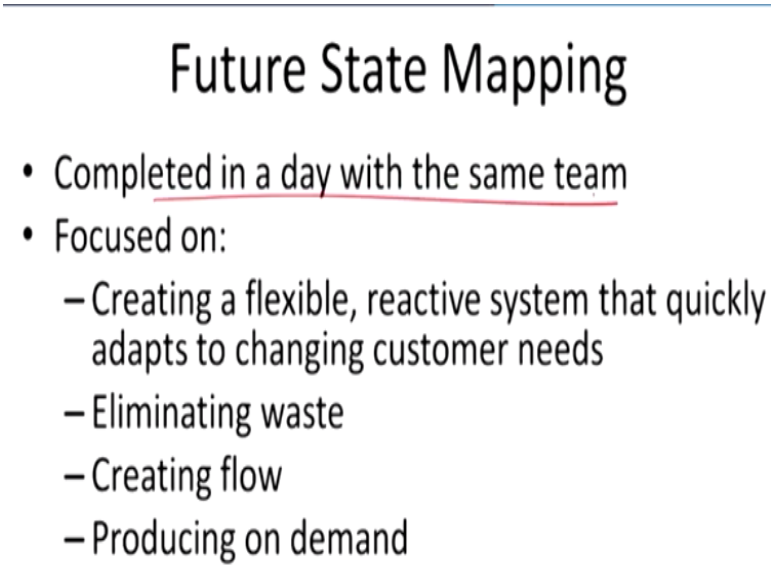

Again we will say that same team will be there and there is no need to change the team. Now our focus has moved from that product based approach to creating a flexible reactive system that quickly adapts to changing customer needs. So our focus is not one product. Our focus is on developing a flexible and reactive system. So the orientation has changed. Orientation has changed to elimination of waste in the processes.

That how my processes are, so I am again not focusing on product, that product is looking good or not, but what process I am following in making this product, that is more important. For an example, there may be a lot of issues. We have two years MBA. We have 4 years B.Tech. Then we have various other courses of different durations. Now I propose that we can do value stream mapping of these courses also that if a course is taking two years' time.

If a course is taking 4 years' time, so how much value are we adding in that 2 years' time and 4 years' time. You will realize that by value stream mapping, you may at least save 6 months to 9 months' duration of these courses. In just 2 years' period maybe you can find that we can deliver

almost similar content in 1 and half years. So actually you can be more competitive if you offer similar level of delivery to your students in one semester less time.

Therefore, students would like to come to your institution because they get same knowledge, same degree in less time and obviously less time means less money. So the value stream mapping of academic courses will also help you in improving the competitiveness of your courses. Similarly, this value stream mapping will create more flexible, more demand driven systems in the organization and this will eliminate the waste.

It will create that continuous flow, which is one very important aspect of Toyota Production System and you will not be creating inventory. You will be producing on demand. Whenever there is a demand, you will only produce for that. So this is the pull system, which we are continuously talking that with the help of lead manufacturing, with the help of this kind of value stream mapping concepts, we will be able to achieve the objective of pull based manufacturing.

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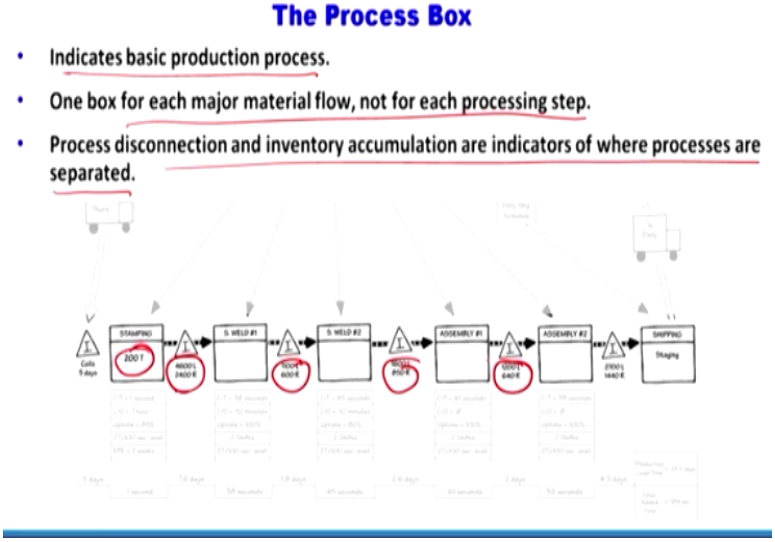

Now during this entire process, that is what is happening? Now you see the various process boxes are there and here you have the transportation. So these Is are representing transportation that from one production process to another production process, you are moving. Now there are production processes, one works for each major material flow, not for each processing step. So wherever there is a major material flow, you are representing that into.

And process disconnection and inventory accumulation are indicators of where processes are separated. So wherever you are writing these things, it means some kind of inventory accumulation, and some kind of discontinuity is there and by removing those discontinuities, bringing those discontinuities in a more synchronized cohesive manner, you will eliminate the waste.

So this is the various process box which was there in our map and now you can understand that stumping is a process. So stumping is done for 200 tonnes. Now when you are moving this I is representing that you are moving this stemmed coils to the welding section and then in the welding section, it is taking some time and that data is available here. That in 2 shifts you have total 27,000 seconds available. The up time is 100%.

It is available all the time, which are available and the welding is being done. Then, again it is having some kind of movement from this welding section to another welding section. So 2 types of welding are required, maybe one internal welding, one outer welding. So we do not have the much detail of the process, but there are 2 welding available, but here you see the uptime here it is 100% and now uptime has reduced to 80% in the second welding.

So here comes the role of your maintenance department that how we can increase this uptime. If you can increase the uptime, that means this 45 second, which is being taken, you see whenever some process is taking place, like stumping 1 second, on welding first 38 second, so all these things wherever you have some kind of production process, these are value added activities wherever there is some process happening.

And when the process is not happening, it is simply the transportation from one space to another space, like if I represent with this way. So these are non-value added activities where you are just transporting products or WIPs, we say, from one space to another space, then you take it to first assembly section and it takes 61 seconds for getting it assembled. Then, you take it to second assembly section where it is taking 39 seconds.

And then finally you are taking it to shipping area, where it takes some kind of loading on this vehicle and then it goes to out of your factory. So that is how this entire process is taking place and in this case, we saw that whenever some production process, it is there, but in that also you have issues related to this stumping, because here the uptime is 85%. So there is a scope to increase the uptime at the stumping. Here the uptime is 80%.

So here also there is a scope to improve the uptime. So even in your value added activities also, there is a scope of improving the uptime and improving the uptime, you can say it can reduce the lead time and that will increase the output rate. So that is one thing. Another thing which we have not included in this because that is traditionally not seen, but in our latest discussions, we also need to include that particular aspect.

That what is the output particularly with respect to quality. How much rejection these production processes are producing. So depending upon that also you can find that whether these outputs, which are being generated by these production process, how much defect these are generating. So that will be the additional indicator of, because sometime it may happen that in order to do things, or a faster rate, you may generate more defect.

So that is very obvious, because sometimes we only consider time as a criteria. So it is very much likely to generate more defect. So we need to make a balance between time and our quality of output. So additional criteria of quality also need to be incorporated and then we will go to that idea, because when you are having uptime that is the availability, the quality and at what rate you are producing the output.

So the issue related to OEE can also be discussed for each of these stages. So what is the equipment efficiency, overall equipment efficiency coming for these different production processes. So that indicator can also be added into these discussion.

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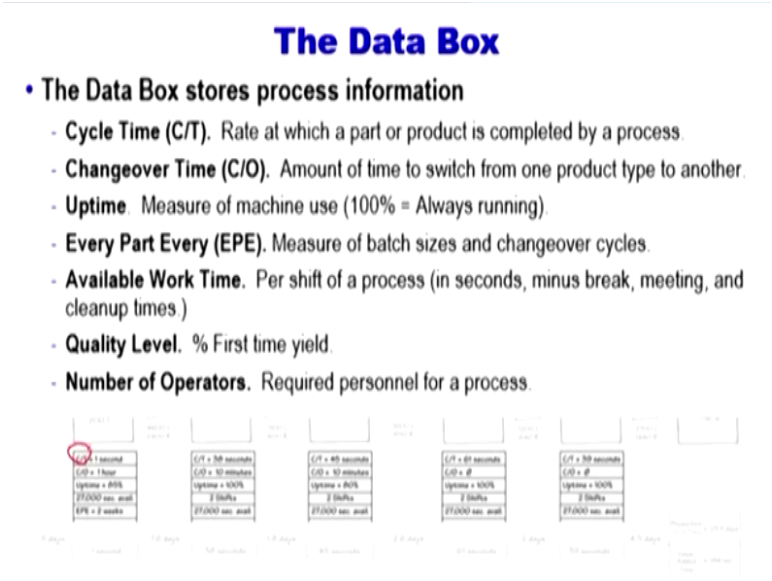

So as we have just discussed that there are various type of information, we have at the bottom of this graph and in that we have this cycle time, the important thing, rate at which a part of product is completed by a process. So as in the first slide, we discussed this is not only about material flow. This is also about the information flow. So therefore, we need to see that what type of information you are flowing.

Because if you generate too much of data, if you generate too much of information, your time is wasted in understanding that information. So you need to be very careful that what data you are producing. What data you are writing in this value stream maps, so that it can directly help you in taking some decisions. So one important information we write that is about the cycle time. That is rate at which a part of product is completed by a process.

The second information we write for the change over time. Amount of time to switch from one product type to another. So that is the second. This is the first, this is the second. The third is uptime. Measure of machine use, so means whether the machine is or whatever the machine is available whether it is running continuously or not running continuously. So this is the third important thing, that is how much is the uptime.

Then every part every, EPE that is coming in the last of this table that is measure of batch sizes and change over cycles. So what is the measure of your batch size and change over cycles, so

that is like it is mentioned two weeks here, it is mentioned only here that is the two week is the measure of batch sizes and your change over cycle. Then, available work time that how much time is available per shift of a process maybe in seconds minus break, meeting and cleanup time.

So let us say, you are working for 8 hours. So in 8 hours you have these many seconds out of that you may say let us say 30 minutes for your lunch break, then 10-10 minutes for two tea breaks, so 30+10+10 is 50 and you have another 10 minutes for some kind of meeting and discussion, so in fact you are consuming one hour in a day for all these other activities. So 1 into 60 into 60, so that much time is available per shift, so that is this fifth point.

That is 27,000 seconds are available per shift. Then the quality level as I was mentioning, that how much is the quality level. What is the rate of defect you are generating? So this is also an important item we need to be careful and number of operators that how many personals are involved in this particular operation at different stages. So it is also very important that in order to reduce your lead time, we should not increase our number of personals.

So how many people are involved, if you are reducing lead time, but you are increasing the person, so the benefit of cost will be neutralized. So you ideally should not increase the people for reducing the waste out of that purpose.

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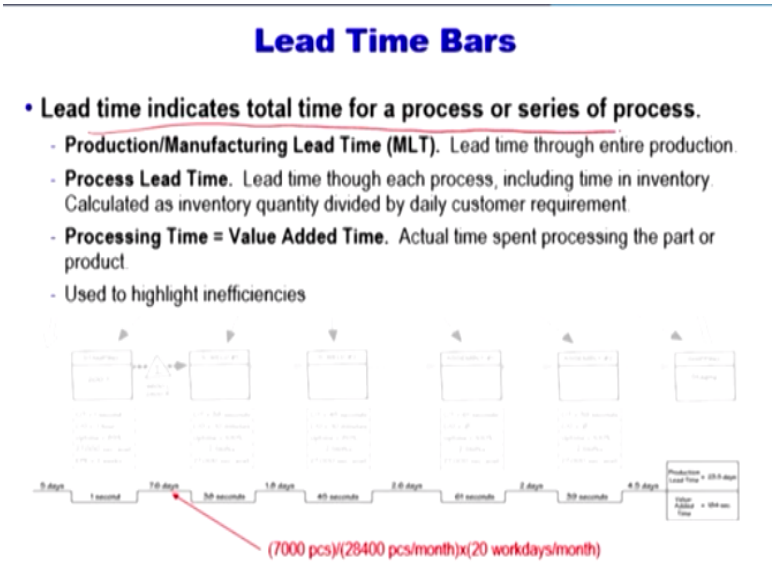

So we have just discussed that how you have calculated various things and these lead time indicates total time for a process on series of processes. So because of various activities either or processing or of transportation, you get these various lead time and the calculation is given here that 7000 pieces and how many pieces you are making per month that is 28,400 pieces and in a month you have 20 work days. So on the basis of that, this calculation has emerged. So what does this value state map features?

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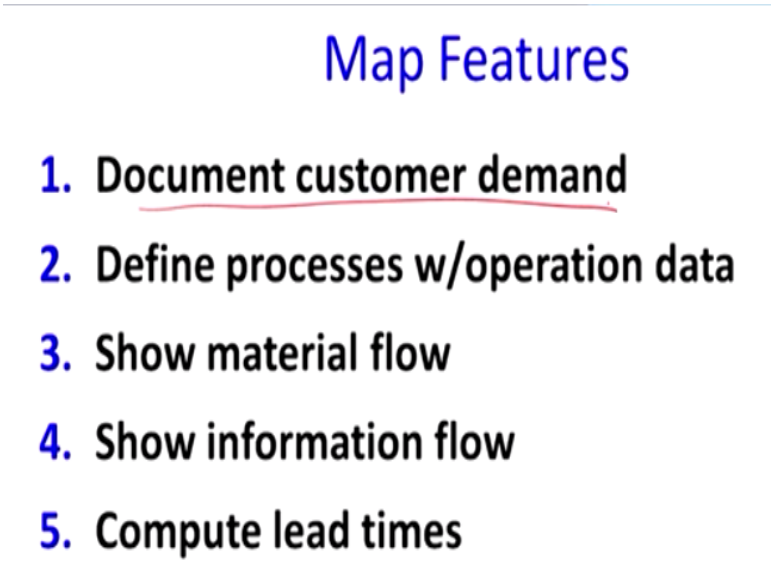

One is it documents the customer demand and on the basis of that we will see that we can calculate the TAT time. It defines processes without operation data. It shows material flow and also information flow. So both these things are there and it also helps us in computing the lead time. So we already discussed that what is lead time and how to reduce the lead time, so no need to go again in detail of that lead time.

Now if I see this diagram, this value stream map improvement versus process improvement. So there is a slight difference between value stream improvement versus process improvement.

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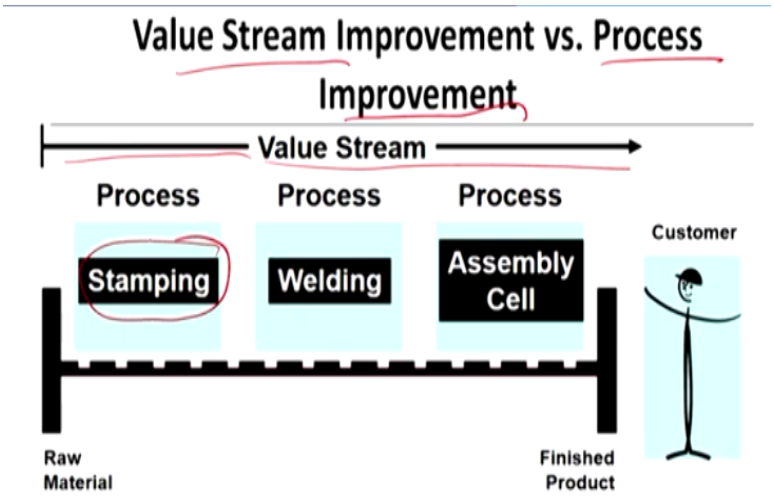

Now what is it? That value stream is actually a series of processes where just we discussed that there are 3 processes stumping, welding, and assembly. So start with stumping, that is taking only one second, then welding is there and then finally 2 cells are there where you are doing the assembly operation. So these are the various processes and total of those processes is known as your value stream.

Now in that, we have moved this raw material from this stage, from where we are receiving the coils and finally we are making the finished product. Now when we are focusing only on processes, we will not be able to focus on these aspects. So therefore it is important to focus on value stream, so that our focus is not limited only to these processes, but to those things also, which are not part of your contributing processes.

That is what we discussed value and waste, both and for that purpose, we have this very common, you can say, process map which is known as SIPOC.

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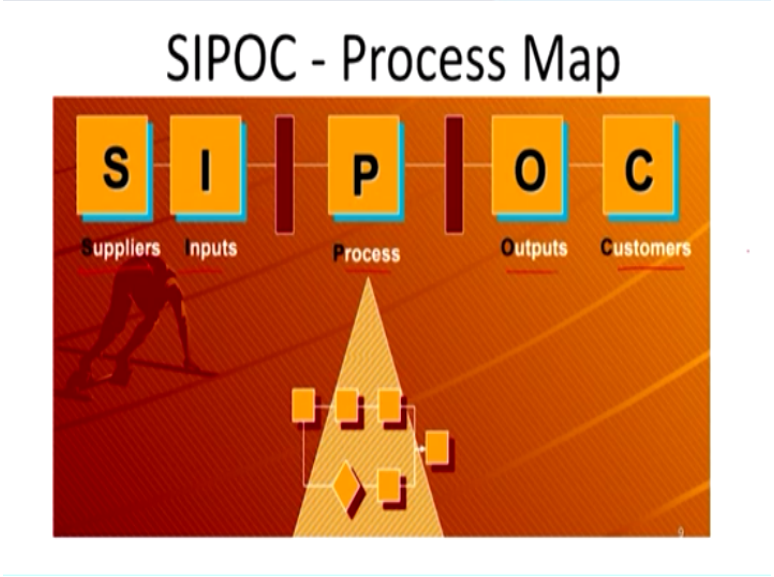

Under SIPOC, we take the 5 important considerations, the supplier, input, processes, outputs, and customers. So that is the combination of 5 things. We will discuss this SIPOC map in little bit more detail in our next session and with the help of this SIPOC map, you can actually play, you can make your value stream diagram more attractive, which is visually appealing and these are some of the symbols, the icons when we use when we are making a value stream map for showing different activities on the map.

So there are some standard icons which are used. We will discuss that also in our coming session and this is about the calculation of tact time, so since time is running up, we are not continuing with this calculation of tact time. We will take this numerical in our next session and with this, we come to end of the session. Thank you very much.