Manufacturing System Technology - II
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Lecture – 12

Hello and welcome to the Manufacturing Systems Technology part two - module 12. We were doing process FMEA; and in context of it, which we are we have identified some failure modes and try to actually do counter measures, so that this modes get eliminated. So, we did the first mode which was about inserting or adding you know positive depth stop layer with the limits which we actually do the dispensing of the spray, and there we found out that there is a reduction in the risk priority number from two hundred and eighty to seventy.

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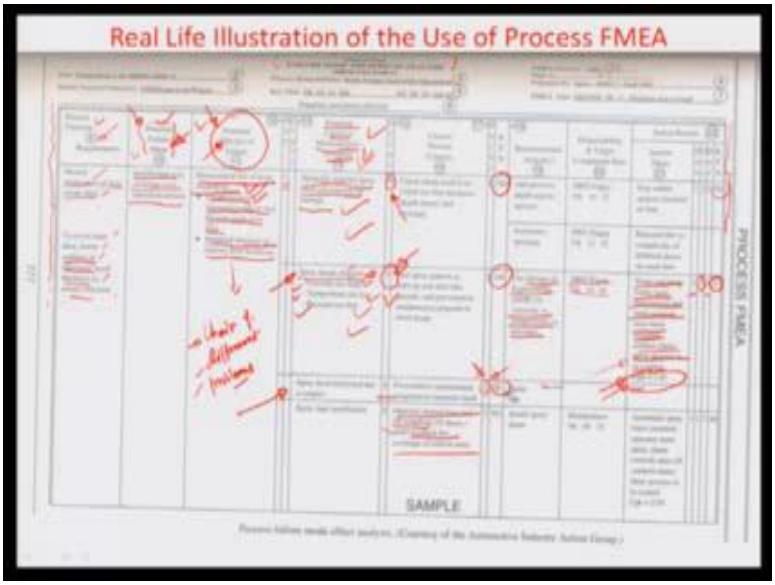

The other is basically the spray head clogged; here the spray head slogged problem which is the number two problem which was having a RPN of 105 was really about that the viscosity was too high or temperature was too low or the pressure was too low. So, there was no such pattern has to what would be the ideal temperature, viscosity and pressure at which the wax flow could happen in an uninterrupted manner and then it could prevent the stop you know prevent the clogging of the nozzles or the sort of entrances to the nozzles etcetera. So, here the assembly engineering decided or the process engineering decided to use DOE or design of experiments scheme where you

could optimize the various parameters related to the temperature, velocity and pressure and there was optimization carried out based on viscosity versus temperature versus pressure here, and some solution was provided as to what would be the ideal ranges of these different values and so manufacturing engineering again was given a target of implementing this by a certain date which they did.

So, the temperature and pressure limits were determined and limit controls now were installed for example, there would be a thermocouple inserted inside the bottle of the wax which would be fed into the pumps, so that you know the moment the temperature goes above of a certain limit the pumping would start, so that is some kind of a fool proofing switching which has been established between the bottle of the wax fed into the system and the pumping unit. So, it can be set at the particular temperature range in question and then also some controls have been inserted on the pressure at which the dispensing can happen. So, there is a pressure gauge which is going to give you the operating pressure of the liquid wax or the molted wax within the circuit and that is also going to in a way control the spraying process. So, unless and until the pressure is attained or unless and until certain said value of temperature which has been arrived at from the DOE- design of experiments have been attained the wax will not even flow into the system.

So obviously, after that the control charge which I will talk about in details following this particular module they were plotted and CBK value was of 1.85 was shown in the process and I will actually in detail illustrated how control charge can be plotted and calculated CBK for you later modules. But then this was a very good optimization experiment suggested by the assembly engineer and the manufacturing engineer implemented. Now let us look at what is the RPN because of the implementation of the same, so obviously the severity and the detect ability does not change because the process of checking is still the spray pattern test which was there earlier or may be preventive maintenance schedules which were earlier for preventing this problem, but then you know the occurrence has reduced really from 50 percent value earlier as you can see here all the way to about 10 percent. So, the occurrence of this defect is reduced because of the counter measure subsequently the RPN has come down from 105 has shown in this particular you know column 17, column 18 to 21.

So, in the first problem which was identified the RPN was reduced from 280 to 70; and the second problem, it comes from 105 to 21. So, both the counter measures which have

been implemented so efficacy and they show that there is a reduction in the occurrence because of those counter measures. And this way a correct documentation of the process plan has been prepared and now you have to follow these standards which have been obtained or the check points which have been obtained the various levels like the automation spool proofing or even the DOE based analysis of the temperature, pressure ranges. And then also control limit switches which would ensure that this would happen and so always there would be a low occurrence based on such a complete illustration.

So, essentially a FMEA is nothing but organized approach of problem solving by identifying what are the many causes which are there, and trying to eliminate with counter measures some of the causes which are the most occurring once, so that is essentially what FMEA is nothing beyond. So, we leave the spray head deformed problem due to impact because of the low RPN it already has. So, it is not really of critical importance towards at this particular level its 28 RPN. The other which is very, very important is spray time insufficient because as you know the RPN was very high of 392 earlier and we would like to reduce this. So, basically here the whole you know process engineers who were there suggested that you install a spray timers. So, unless and until this whole time cycle of spraying of the wax is proceeded there is no way that the dispensing can stop.

So, therefore, the operator has to actually now not only rotates the nozzle handle in the complex profile that has been shown in the door lower all the way, but it has to be smoothed up with the total timing of the spray, so that obviously, if at one place the spray is more and other is less the there would be a beading in the place where the spray is more. And that can be detected in the subsequent stages when they are going to check for the critical coverage of the doors by looking at ten doors per shift and lots sampling. So, they are also going to investigate what is the depth of the wax lining which has been laid in and beading or any area which is insufficiently covered would come up in such a check points. So, therefore, the spray timer was a very important aspect which was inserted in the system that, unless and until the wax is completely covered unless and until the total time the wax is supposed to be covered for executes, the dispensing will not stop. So, therefore, the operator has to keep the gun inside the door for that particular time and nothing beyond.

So obviously, when the operator knows that it has to because either wise if he just pulls out the gun, the dispensing will still be continuing and it will spread on the different

members of the car body like the lets say the door in our or even to some extent the station that he is standing etcetera. And he will avoid this unpleasantness. So, it is a spool proofing on the timing that he is spending to doing the wax spraying that is number-one. Number-two is that; obviously, because of the correct lot sampling in terms of the depth of wax etcetera and the measurements there in if he even dispenses it for the same amount of time duration, but only at one place within the door that is also going to caught up some kind of spool proofing.

So, here the maintenance engineering was given this initiative to install the spray timer; obviously, it was in a machine that this timing was given because from one cycle to another, the PLC or the programmer logic controller in the machine would have to be given a timing clause, so that the cycle does not end before the timing ends. And this automatic spray timer was installed by the certain target date which was given and the operator starts the spray and timer controls shut off. So, then a control charge was processed or plotted again and it was showing a CPK value of 2.05 which is reasonably good. And so therefore, what was observed again in the terms of occurrence that the 80 percent occurrence which was happening earlier because of this one step was about 10 percent now and the RPN obviously, reduced because of that forty nine from three hundred eighty ninety two.

So, in a way what you have done is you identified the three top causes and you have taken counter measures to the three top causes and with the RPN sequence, you are trying to see the RPN is getting reduced. So, is it there the is there complete effectivity or efficacy of the control that has been introduced or the new process modification that has been introduced which will not allow the particular reason the cause of the failure to happen, so that the overall failure goes down because of that. So, that it is also known has the defect tree analysis sometime that is how FMEA process works you probably now quite aware of how FMEA can be carried out.

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So, now, we will just go to the next section which is sort of important here which talks about how do you improve product quality during the production phase. So obviously, quality can be designed into a product as you seen earlier Taguchi robust design approach and then the product needs to be manufactured and so therefore, control of the quality of the product during the manufacturing process is also very, very essential. So, there may be some assignable causes which may occur and they were seemingly at random beginning, but then there is certain pattern of this causes which would go over a long time duration which would lead to the change in the manufacturing quality of the product etcetera. And these assignable causes if allowed to continue for a long time eventually lead to the shift of the process to be out of bounce of the limits which the process is designed for, and there has to be some kind of contraction which is taken at that level, so that it comes back to normal see and within the control guidelines which have been given for the process the product flows. And so therefore, it is very, very important to reduce what you call the variability of a production process, so that the output quality is always going to be good quality. And then it can obviously, eliminate cost, it can eliminate wastes because of this complete you know control of the manufacturing process.

So, you saw earlier with the FMEA analysis how you have solved a problem in the manufacturing process. Now there are many other ways and means for solving you know may be coming to reverse gear and little bit and trying to look at whether the process is a controlled one or if it is out of control then can we bring it back to control. So, there are

many real time strategies which are involved and one of them is; obviously, control charts, where you can actually see a measurable dimension of or an output or a quality characteristic coming out, and you can monitor that with some control guidelines which are actually the upper and the maximum upper and the maximum lower limit of the particular parameter that is allowed in the system. In the moment it goes outside that you start focusing on the process and control the process, so that it can come between that control guidelines.

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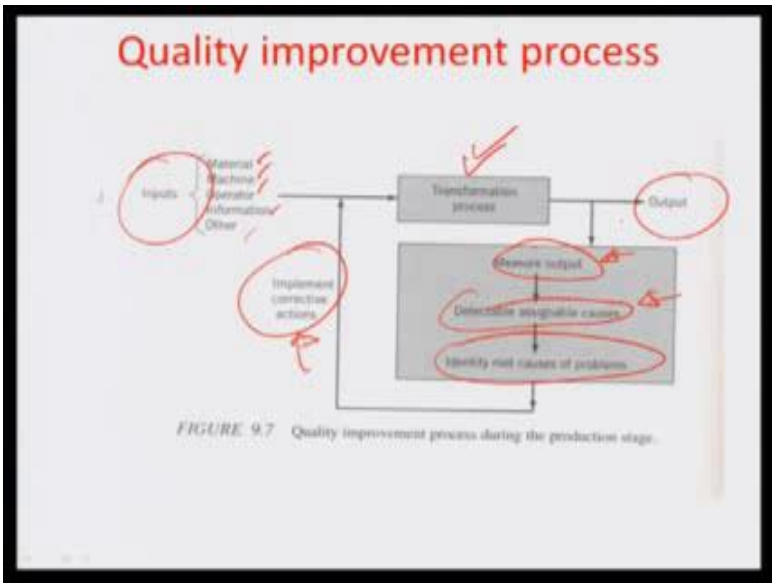

So, in a way if you look at it is schematically we have a transformation process is a manufacturing process many inputs like material, machine, operator, information others on this transformation process, obviously it gives an output. And then there are certain sampled outputs which are measured and there are detectable assignable causes which are made because of which whatever variation in the output is recorded sort of identified. And then obviously, the root causes have to be eliminated and then again whatever implementing has to be done regarding the correcting measures which identify the root causes and eliminate them has to be fed back into the transformation process, so that it now has a measured output which is within reasonable limits, so that is how the whole process of quality improvement schematically can happen within any manufacturing process and it is very important.

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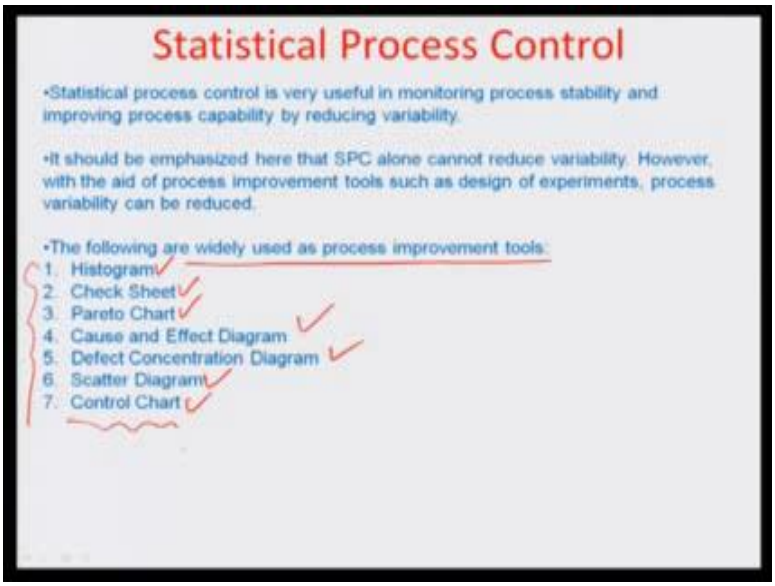

And there are many parameters which are there are many methods of study in which you can actually measure this output and report this output, so that it can give you some kind of understanding. So, there are many mainly seven different tools which are used, and I can say that this use is more how to represent statistically the measured output in a manner, so that it comes quickly to the eyes of the control management of the particular process. So, these are known as the seven tools of quality control and they are widely used as process improvement tools. So, one of them is the obviously the histogram, then we have the check sheet, the Pareto chart, the cause and effect diagram, the defect concentration diagram, scatter diagram, and finally, the control charts.

So, I am going to now illustrate briefly about how these seven tools of quality control can be utilized or what they are really; and with the lot of on to this lower the last category which is the control chart category, because this is something that is a real time health monitoring of a certain process. So, it is a parametric for illustrating that and it has to be necessarily done within any transformation process to keep it in limits and bounds of whatever it has been planned for. So, therefore, let us look at the first aspect which is the histogram so obviously, histogram is about laying out the measurements in terms of measurement in the frequency.

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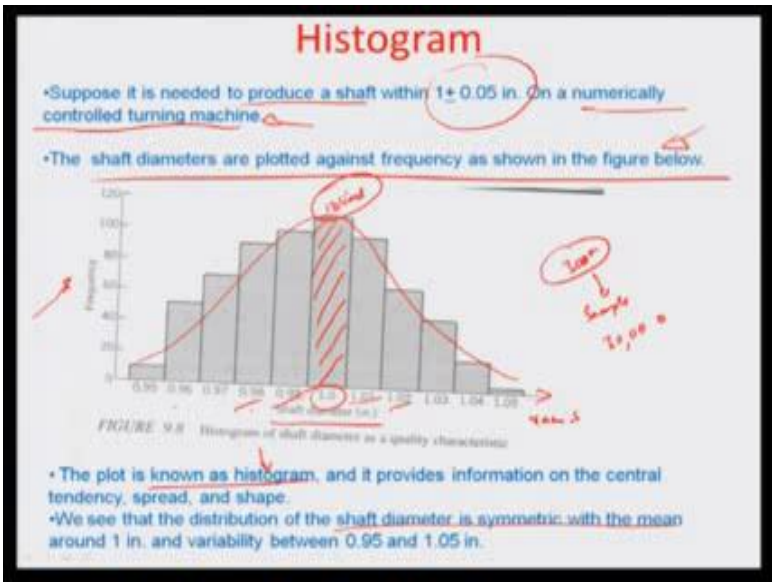

Let us say we are talking about the shaft and the machine produces the shaft within the tolerance limit of 0.995 inches and 0.95 inches and 1.05 inches and this is the numerically controlled machine that we are trying to measure the process capability off. And we are plotting the shaft diameters against the frequency for sample of may be let say about close to three or four hundred pieces and here we see that out of the measurements of three and four hundred samples out of may be 30,000 which are produced by this numerically control shaft for a period of let say two days or one and half days, you have a distribution in terms of a frequency that means, the number of occurrences with the shaft diameter. So, on the x axis here, you are plotting the shaft diameter let say you are talking about one inch diameter emanating from the process and in this whole 300 measurements - 300 plus measurements which are merely a sample representing the 30,000 pieces which have been made you find out that the shaft of diameter one inches occur something like 130 times.

So, this is the frequency and you are plotting this histogram based on that diameter and the frequency over which the diameter has repeated. Similarly you have measurements like 1.01, 0.99 etcetera and there frequency has been plotted in this particular histogram. So, this is called histogram right. So, this plot of frequency versus occurrence of the particular dimension; that means, the dimension and the occurrence it has come, number of occurrences that it has had this is basically the histogram. And you can see that it is sort of bell shaped you know distribution like this that it is representing and there are many other inferences that can be drawn by looking at this figure particularly. But we see

that the distribution of the shaft diameter is quite symmetric about the mean value that is one inches.

So, this is something that is a learning experience for us that the process is in within control that when that these specifications says 1 plus minus 0.05 the maximum number of occurrences that are having that we are having out of all the observations you know let say three hundred plus samples out of this thirty thousand observations which we are talking about. They are having a highest number of occurrences along the mean that is one inches. So, this gives you very good idea whether the process is in control or not and a glance by looking at some process or systems like this. So, we will probably close on this particular module in interest of time, but the other tools of QC like let say the defect chart or the control charts or even the scattered diagrams etcetera, we will take up in the subsequent modules.

Thank you so much.