Total Quality Management - I
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Lecture - 11
Old Tools for Quality Assurance

Hello, welcome back my dear friends; a very good morning; good evening and good afternoon to all of you. This is the TQM - I course and this is lecture number 11. I am Raghunandan Sengupta from as you know from IME department IIT, Kanpur. So, as we are discussing about Kaizen and the implementation how Toyota as a company considered the concept of Kaizen and concept of total quality in its overall spheres. So, we will continue with the 7 tools of quality assurance and how they have changed accordingly as the overall progress of different technology, different services occurred in different spheres of manufacturing and for different areas of with the economy. The comprehensive statistical process control system uses 7 actual concepts are tools to reduce variability and eliminate waste.

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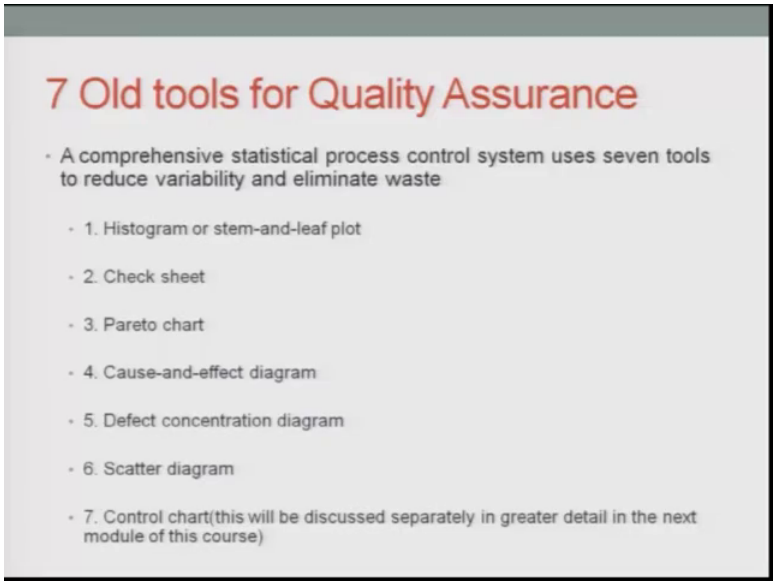

And if you remember elimination of waste reduction of variability, reduction of total cost negative cost, I am considering, trying to basically implement the concept of quality are the different important bullet points for the three stages of quality if you remember the examples which I just mentioned as a examples for Motorola G and all these things.

So, one is a histogram or the stem and leaf plot and how they are implemented and utilized as statistical process control tools I will come to that. They you have the checklist as a check sheet. Then you have the concept of Pareto charts and on the concepts of Pareto analysis, how they can be utilized. Then you have the cause effect diagram, the trying to analyze the actual result based on what are the effects which are happened earlier. You also consider the defect concentration diagrams and how they can be reduced. You consider the scatter diagram, control charts; this will be discussed separately in greater details later on.

So, I will come to the control charts of x bar charts r part charts p charts and all those things.

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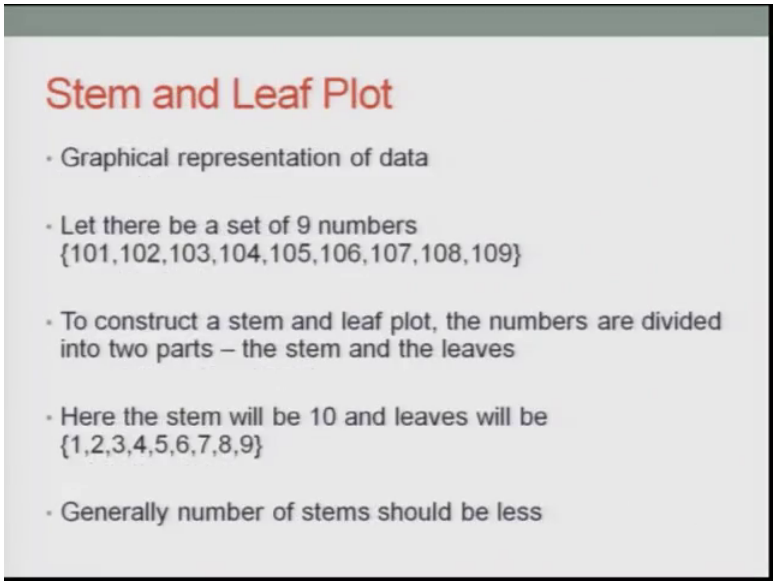

So, stem and leaf diagrams are basically graphical representation of the data in numbers on in graphs. So, let there be a set of a 9 numbers. So, the nine numbers are basically starting from 101, 2, 3, 4, 5, 6, and so on henceforth. So, trance construct a basic stem and leaf which basically, if you see the stem and leaf for of a plant or a tree the main branch has different type of stems and leaves coming out. So, basically the overall emphasis if you see the numbers one zero are common for all the nine numbers.

So, we will consider them as the main stem and the leaves would be basically the adjoining numbers after 10 which basically makes the sequence of the series are numbers. So, it will be to construct a stem and leaf, the numbers are divided into two

parts the stem and the leaf and hence the stem would be 10 and the leaf will be 1, 2, 3, 4 till 9. In case say for example, it was 11, 12, 13, 14 till 19 so obviously we will have the stem and leaf accordingly. It could have been say for example, numbers are 10 01, 10 02 till 10 09, so in that case the stem would be 100 and the leaf would be again as mentioned here 1, 2, 3, 4 till 9.

So, generally in the number of stem should be less and obviously the leaf would be the corresponding task or numbers based on which you are trying to work. So, this nag table which is 3.1 and all these things have been taken.

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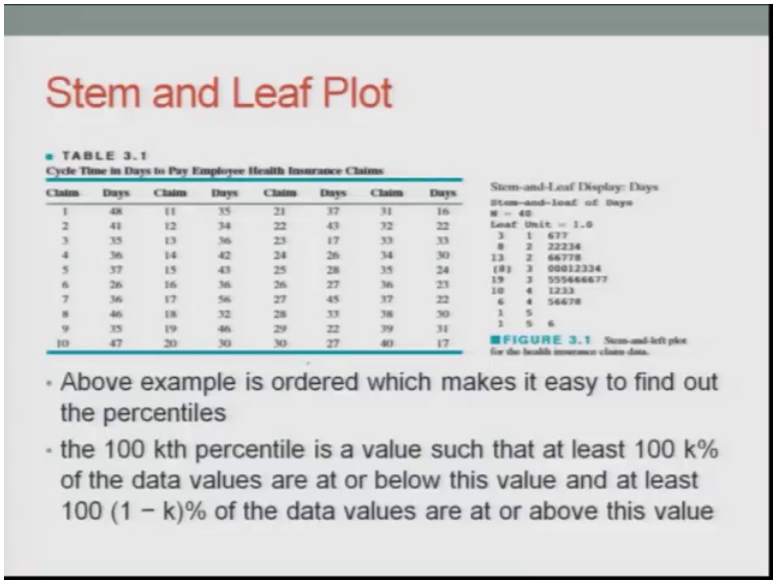

If you remember I mentioned time again when we were discussing are taken from the Montgomery's book of Statistical Process Control and the concepts there in. So, here in table 3.1 we consider the cycle timing on in days to pay employee health insurance claims. So, the claims are if they are one, days claims are given accordingly.

So, claims 1 till say for example 40 are given and all that dates are given, days are given based on which the claims can be settled. So, if you do the stem and leaf display. So, the days are the stem and the leaves are number of days are there in the overall things. So, you have a leaf unit of 1. So, if it is say for example, leaf of 3 unit is 1 and based on that you have the numbers which are given in in figure 3.1. So, that will give you how the idea of the stem and leaf is done. Above example is ordered which makes easy to find out the percentile.

So, here if you remember the claim are given from 1 to 40. So, if they are jumbled; obviously, we have to make sequence of how the claims are being done based with on the number of days. So, the 100 100kth percentile is a value such that at least 100 or k percent of the data values are at or below the value and at least 100 1 minus k percentage of those values would be basically be at or above the value. So, basically if you are considering 50 percent, 50 percent will basically have half of the of the data, half of the probability if you remember the probability part I mentioned quite in detail when we are considering the CDF and the PDF for the normal distribution.

So, there 50 percent which is the mean or the median or the mode for normal description it will imply that 50 percent of data is on to the left on the mean, on the mean on the mode and the rest 50 would be on right hand side, so if you looking from your side. So obviously, different distributions are as they are they are used would have different medians and different mean values also. But the uniqueness or the on the specialty of normal distribution is because the mean median mode are the same values.

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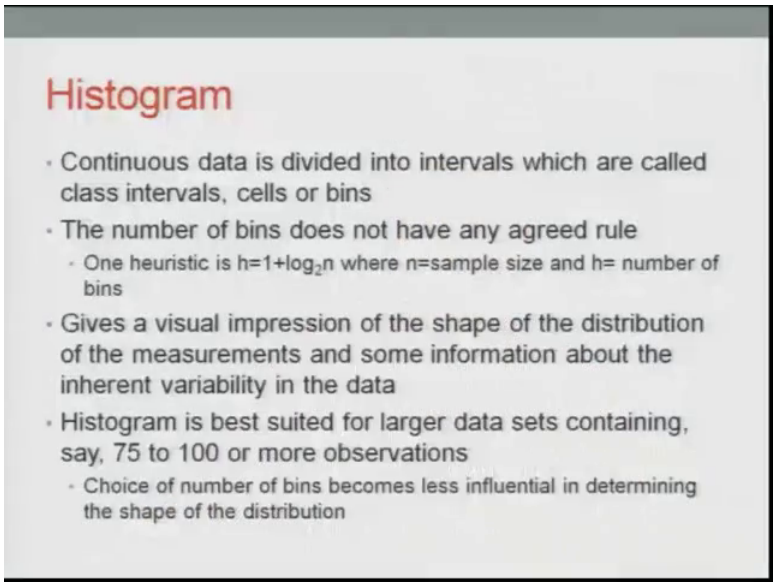

So in in histogram the concept is, they are continuous data, is divided into intervals which are called the class interval cells are bins and obviously the class, class intervals are done in such a way they are of equal; no, I will not use the word dispersion; they are of equal breath.

So, if you are trying basically find out the number of students who have, see for example number of have say family members between see for example, 2 to 4, then another would be for example, from 5 to 7. So obviously, in the bins or the intervals are 2 in number. So, you will basically find out number of people who are there with that family numbers and note down and add up the whole value to find out the total number of the frequency.

The number of bins does not have any agreed rules, but any check taken be one of the heuristic is basically as given here where the number of bins is h is equal to 1 plus log to base Nepeden to the binary base 2 n, with n is the sample size and h is the number of bins which you want to basically have.

So obviously, they without going to the rules which would basically depend on what is your experience and based on which you are trying to basically divide the data into bins and try to understand what type of different type of distributions would be used and what analysis we can do from the data such that it will give you some idea about the from the quality perspective. If you remember this is not to do with statistics, but more to do with the concept of quality and how you can implement the different type of statistical quality tools in order to improve quality. Given a visual impression of the shape the distribution on the of the measures, so you gives you quite a lot of informations and some information about the inherent variability in the data can also be found out for the histogram.

So, the histogram if you look at the middle value and they are equally dispersed on right or the left; obviously, you will you will be able to say that the total amount of dispersion is equal balanced both on to the left or the right or a mean value. But now when I am talking about variability, remember that variability, or the word which we try to utilize in statistical terms is variance or standard deviation, they are based on the concept what is the dispersion based on fact that how big or how small they are from the mean value. So, variability can be considered at different points with respect to median, with respect to mode and all those all those concepts can be utilized. But we will stick to the concept of variability based on the mean concept only.

Histogram is best suited for large data set considering say for example, 75, 100 and 105, 110 data points. So, the choice of the number of bins becomes less influential in determining the shape of the distribution. So, larger the data sizes you will be able to

appreciate that they will slowly turn out to be normal distribution. So, this is the concept of so called central limit theorem which I am just mentioning it will be taken up later on as required.

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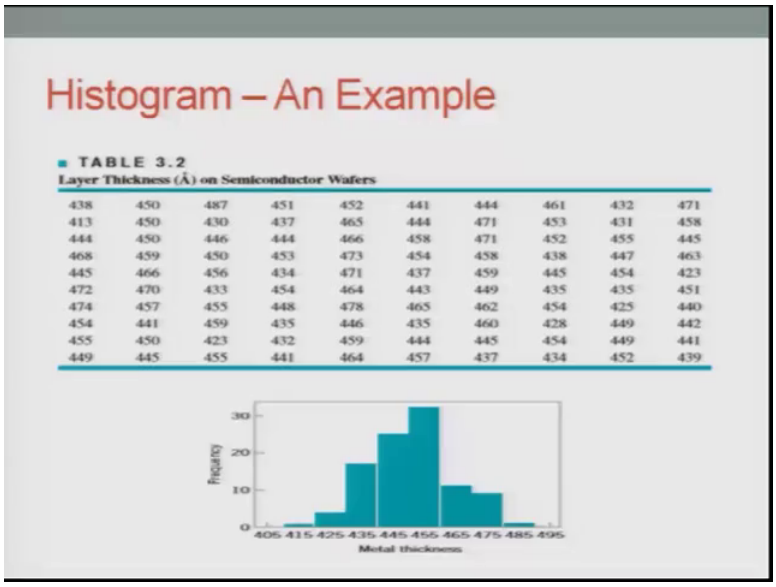

So, again the histograms an example which is taken from Montgomery; so, they are layer thicknesses and Angstrom, Angstrom is a unit of measurement; on semiconductor way first. So, the thicknesses are given here, starting from 438 forth to 439 and if you see that you have basically 3, 6, 9 and 10 columns, each of them have the amount of reading which is noted here. So, if you basically with divided into bins and draw that histogram, the histogram is given as shown here. So, along the Y axis you have basically the frequency and an along the X axis of the bins of the intervals which are basically to do with the layer thickness in Angstrom.

Now one should remember the bins or the interval which we have made can be broader or smaller depending on what in the amount of information which you want. So, finer you make more better the graph would be and it will be able to give you a lot of information what is the overall distribution of so called thickness depending on the number of reading which you have. So, it will depend more on accurate working, but it does give you lot informations from the histogram and whatever level of accuracy you want that can be increased or decreased depending on the interval length.

So, I am just considering the interval length efficiency on information can be increased for statistics point of view using different tools, but let us only concentrate on the interval aspect only. So, the check sheet would be collection of the datas, measure the overall idea which are trying to get and the information which you want to get.

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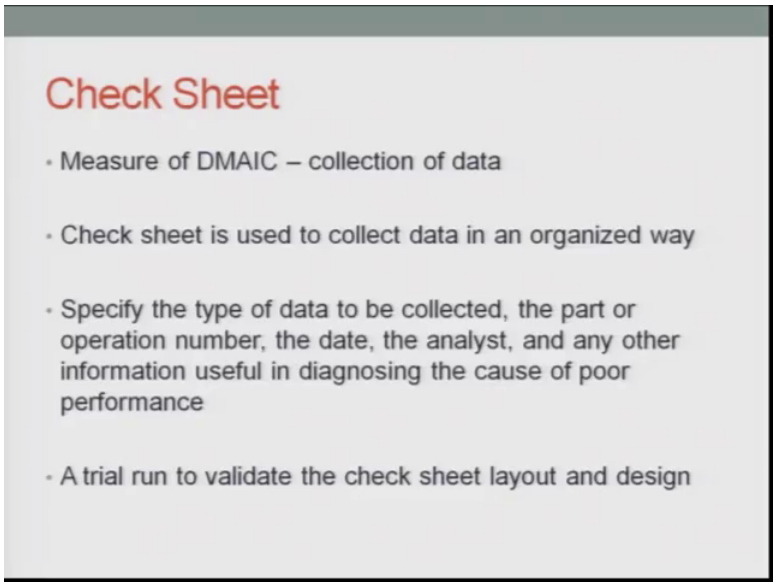

Check sheet is used to collect the data in an organized manner, specify the type of data to be collected, the part or operation number on the date; who are the analyst? Who collected the data? How many different points were collected? At what point of time they were collected and all the information is important. A trail run to validate the check sheet layout and the design can also be taken in order to accurately you find out that the data which would be utilized is how good or how bad it is. Is it spurious or is it the collection has been data has been done in the best possible manner, those have to be check.

So, a check sheet is just given here for information.

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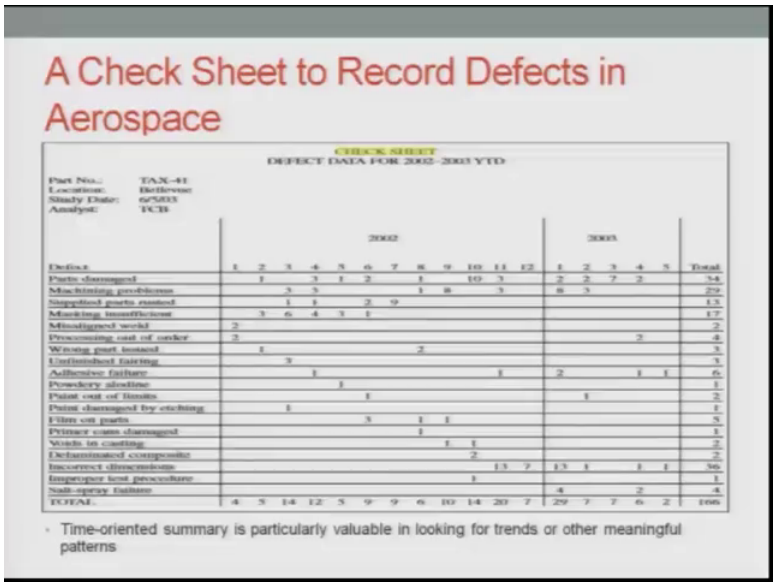

So, they are technically just I am giving a very brief background. So, the last 2 columns is basically has a 2003 data and the total amount of so called defects for the data which are for year 2002 and 3, and the middle column is basically the yearly data pertaining to 2002 and the left most column basically has the entities or what are the different type of defects, they can be supplier parts rust, are rusted misaligned and pains out of limits is there, voids in casting is there. So, all of different defects are basically marked on the left most column.

So, the time oriented summary particularly variable in looking for trends or other meaningful patterns in order to understand how the overall process is going on and whether their abrasions based on which you can take immediate actions to reduce the variability.

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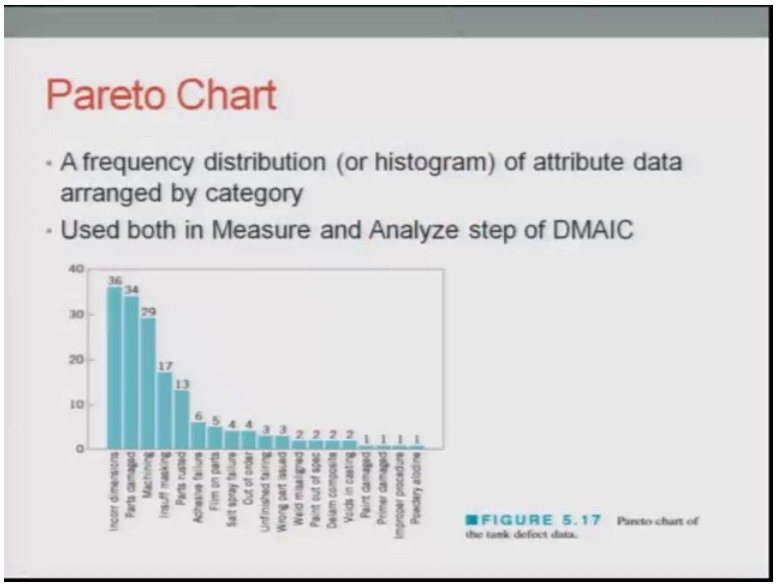

So, the Pareto chart is basically the next concept as we have discussed when you are going through the bullet point of discussion is basically, the Pareto chart is a frequency distribution or histogram or attributes data arranged by category. So, you would basically arrange them depending on what level and which areas they make, they can be clubbed, use both in measure and analysis step.

So, you have basically or, or if you remember on the leftmost column you have the all different type of defects. So, they have basically being put along the Y axis and the number of defects are basically marked along the X axis. If you see the ADC failure they are a 6 in number. If you see say for example, machining number they 20 time in number. So, you can understand that; what is overall frequency of the errors which are occurring for different defects and then you can basically understand the whole process and take corrective actions as required.

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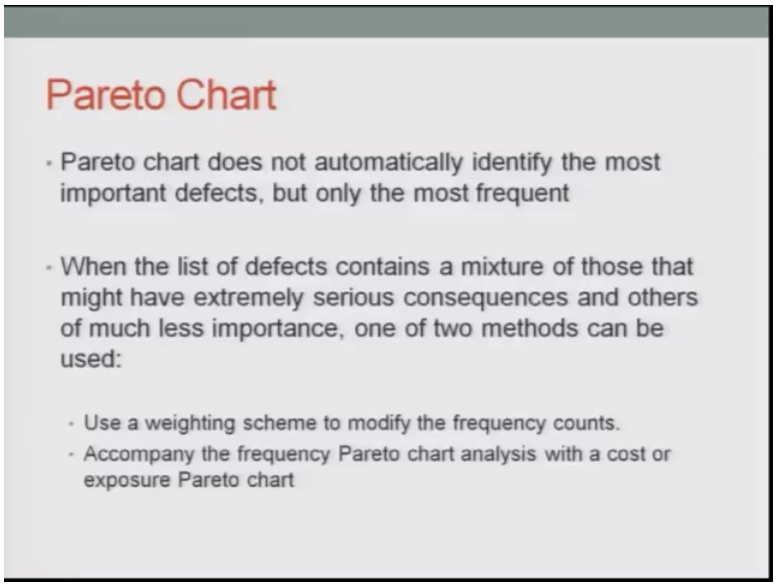

So, the Pareto charts are they do, they do not automatically identify the most important defects, but only the most frequency which are there. When the list of defects contains a mixture of those that might have extremely serious consequences and other of much less importance, one or two methods can be utilized in order to find out what is the level of such some importance which are there for the defects which can actually adversely affect the overall manufacturing process or the overall service process which you are trying to study. Using a weighting scheme to modify the frequency counts can be done. So, the more the weights are or more the frequencies are given a higher weight or later the more recent occurring's obviously you can give higher weight. But all; obviously, it will be that there is some rationale base on which you trying to give weights.

So, for the time being will consider weights can be done, but will ignore that for analysis and later see at how they can be taken up. So, Pareto charts as you can discuss the so-called leaf stem and leaf diagrams and the over analysis of the data which are there. So, it basically Pareto chart accompany, the frequency Pareto chart analysis with the cost of or exposure of the Pareto charts and what are the, what are implement implications from the cost perspective.

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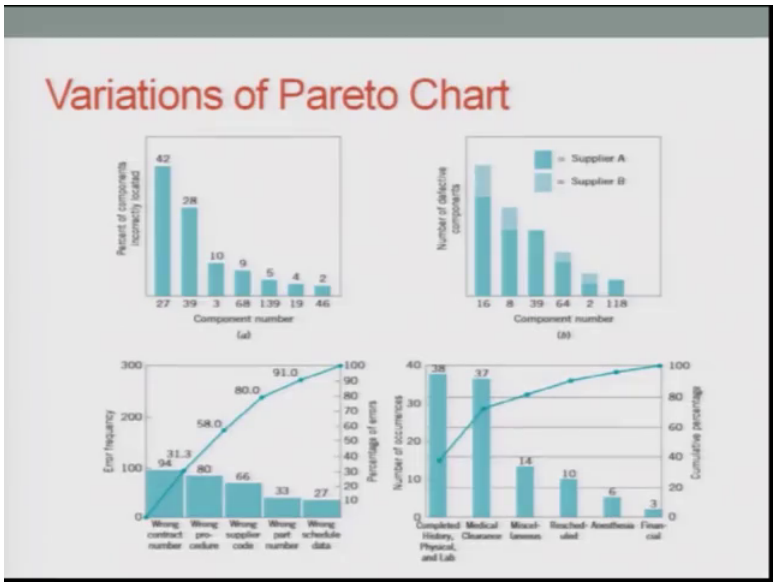

So, the variations of the Pareto charts are given. So, component numbers are given and on the Y axis basically find out the percentage of components in accurately located. Then in the other diagrams again you have the components and all the wrong things which been done like the rust part, the paint being be not there, casting being not done properly, welding being not done properly. So, all these are technically marked a long the X axis.

And the error frequency on the number of occurrences depending and how you want find out numbers, it can be frequency it related frequency, percentage of occurrences, so and all these things and marked along the Y axis. So, if you find out. So, in in the second diagram you have again the component on the Y axis you have the number of defective components. In the next 2 diagrams which have graphs where I am pointing my finger; you have the wrong, so called wrong numbers are there on the X axis. And on the Y axis you have the error frequency and so on and so forth for the fourth diagram also.

So, the next idea which is very heavily used in statistical process control, total quality management, ideas how to implement them is basically cost and effect diagram. Once a problem has been identified, we have look for possible sources of the problem.

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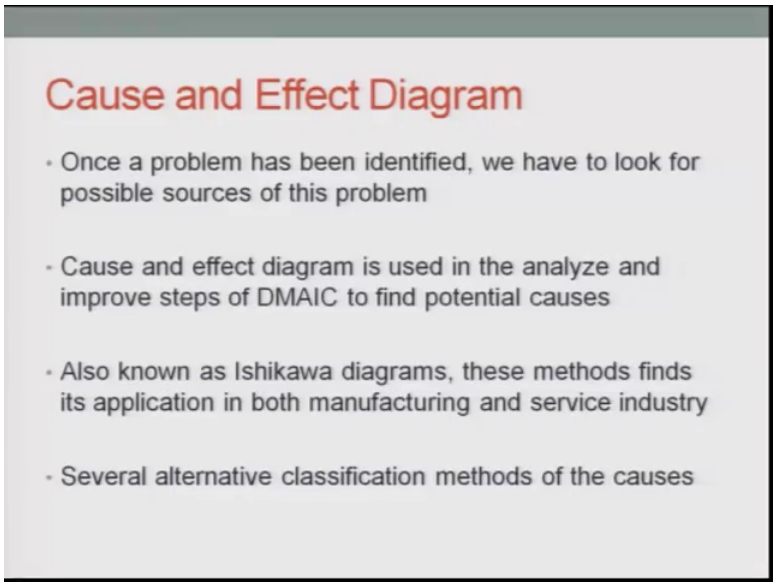

Cause and effect diagrams are used to analyze and improve steps to find potential causes and how they can be rectified also known as Ishikawa diagram. The method finds its application in both manufacturing and service sector in equal proportions. Several alternative classification methods of the causes and cause an effect ideas can be implemented such that we are able to increase the concept of equality which have been taking about for last so called 10 number of lectures or 11 no lectures whatever we are trying to complete as of now.

So, cause and effect diagram.

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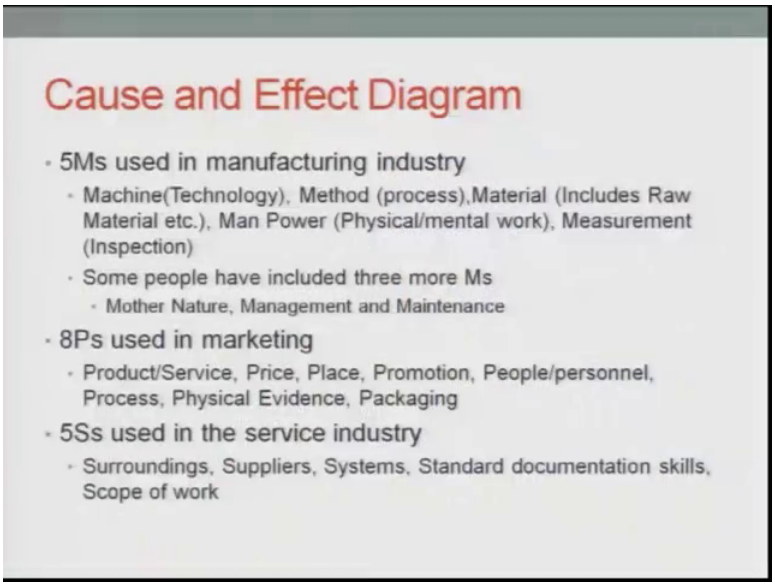

So, the 4 5 Ms are for my fetching things are basically machine and technology, method or process material which includes raw material evaluation of of what are the inputs, manpower both physical mental and how they have are being implemented utilized, implement in sense that how you are able to utilize the services of those manpower. Measurements are basically to do with its inspection some people have included three more Ms which are basically Mother Nature, management and maintenance. But basically the main focus is to try to reduce the level of variance in quality and try to basically it is the cost also at add the at will not use the word expense, but in such a way that both machines or methods or materials or man power basically are utilized in the most efficient an optimal manner.

So, 8 Ps in marketing are production services, price, place, promotion, people and personnel, process, physical evidence and packing. So obviously, they would also have a negative or positive affect how they are being utilized for in order to improve quality. The 5 Ss using service sectors are, so now we basically initially we discussed over the manufacturing sector now they are the service sector. So, the 5 Ss are surroundings, supply, system, standard documentation skills and the scope of work.

Constructing a cause and effect diagram; so, how do you do it that? So, the steps are, I just go through them simply very slowly. So, you define the problem or effect to be analyze. So, what do you want study you basically define problem, where the problem is

occurring you try to identify and take and make up plan that what you want to understand or going to the details.

Form the team to perform in the analysis so obviously, they would be core team; core team say for example, can be a good engineer can be the workers who working on the machine and all these things would be there.

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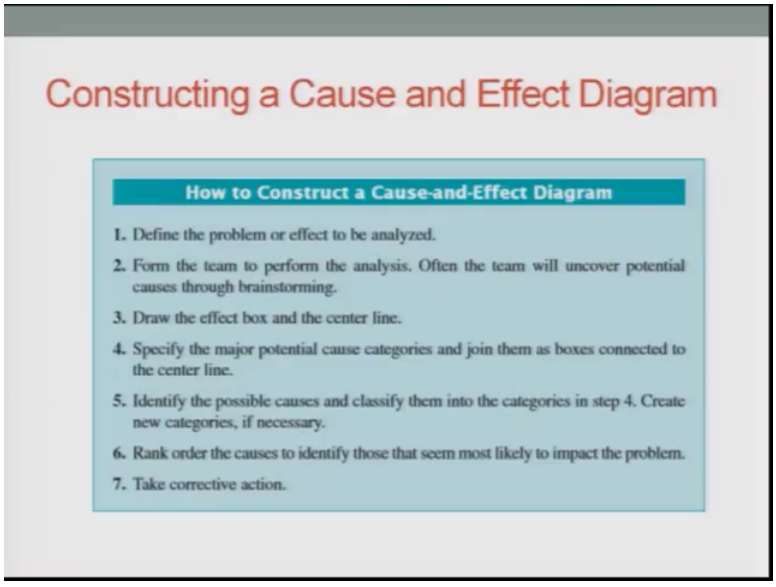

Often the team would will uncover potential causes through brainstorm sessions, draw the effort box and the central line and basically it see that where the outline or where the where the overall output, output means the overall system is producing some output can be services, it can be products and we basically try to find out that where do the product stand with respect to the overall efficiency of production or overall efficacy of the quality concept. Specify the major potential cause categories and join them as boxes connected to the central line.

So, basically, they would be central line and all the effects would be coming. So, if you remember the fishbone so that would basically have some idea that how the cause effect concept can be done. So, the fishbone there is a means main backbone and all the bones are connected to that. So, basically that that why the cause and effect can be analyzed accordingly. So, rank the orders and the causes to identify those that seem most likely to impact and take corrective actions accordingly.

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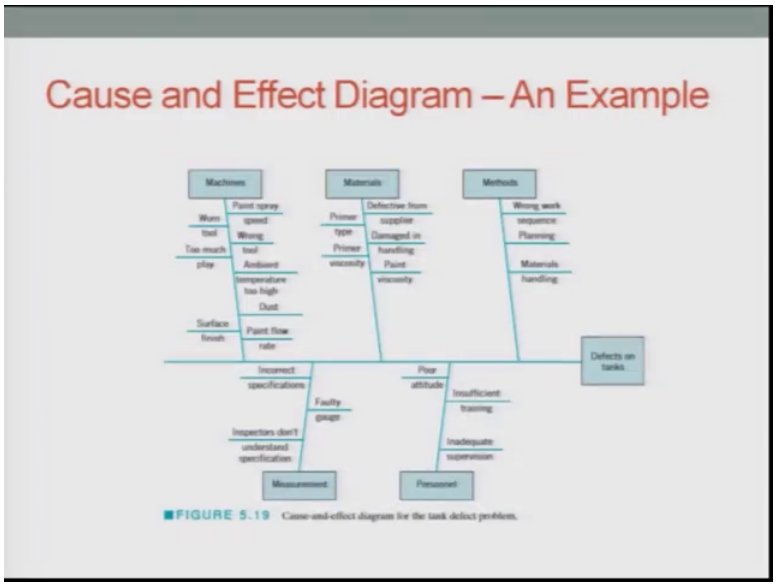

If you see this is the cause and effect diagram of the fish bone diagram and example is given.

So, the defects on tanks are there on the main concern which is the main central line. And if you consider the 5 Ms or the Ss whatever there they have been marked according should. So, they would be for this thing they can be machines, the materials, methods which are there on the. So, where you place machines, materials and that's immaterial. So, it can on the upper half of the cause effect diagram, it can be from the lower cause and effect diagram, that doesn't matter. So, they would measure measurements personnel would be coming in the lower half and how they affect your total number of defects in that tanks have different n type of implications. So, say for example, for the machines it can be one tool too much plays there, or the coolant is not being utilize adequately or you are using wrong tool or ambient temperature outside is very high or their dust, their humidity.

So, all these things are starting in such a way that you can at least find out what are the variables which affect the main component based in which you are trying to analyze the effect defects of the time. So, once thus that's done you basically analyze each of them individually and try to find out in a sense what is the level of important based on which you can analyze all the inputs which basically makes the cause and effect diagram so effective.

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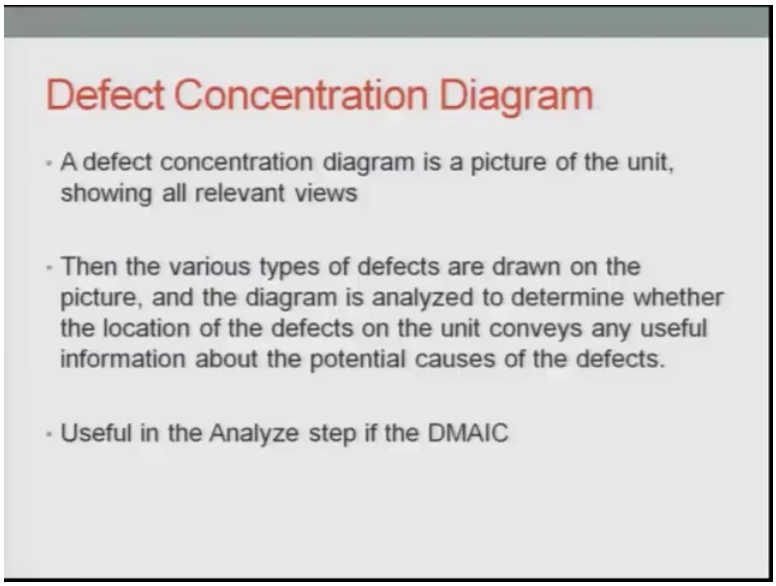

Defect concentration diagram are here are defect concentration diagrams is a picture of the unit showing all relevant views. Then the various types of defects are drawn on the picture and the diagram is analyzed to determine whether the location of the defect on the unit conveys any useful information about the potential causes of failure or causes of not so efficient performance of the system.

So, as I keep repeating not working efficiency does not means the production is low. It can basically mean total cost is high, it can basically mean the overall technology which is being used is very old still we are getting very bad products or it can be that you had you trying to utilize the new technologies still we have basically getting bad products. So, useful analysis in the step are only implementable and applicable as and when we try to implement all the sequence of the fishbone diagram of the cause effect diagram and the which we basically the Ishikawa diagram and the concept of say for example, the Pareto diagram or the leaf and stem diagram, we are basically utilize in a collective sense in order to give the best possible picture or best possible set of information for the overall working process of the manufacturing unit or the service sector unit.

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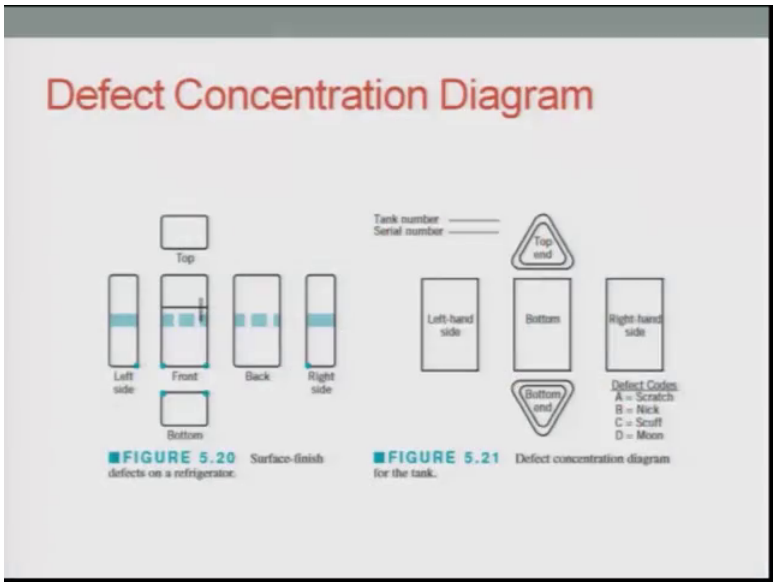

So, defects are diagrams, I am just considering from diagram point of view. You have basically in this diagram which you considering, the tank diagram is given from top view, the left side view, the back, the front, the right side and the defects are basically marked. And based on that you find out the number of the defect codes are done for A, B, C, D or say for example, 1, 2, 3, 4 depending on how you want to implement the overall system of defect and analyze the defect of the tank.

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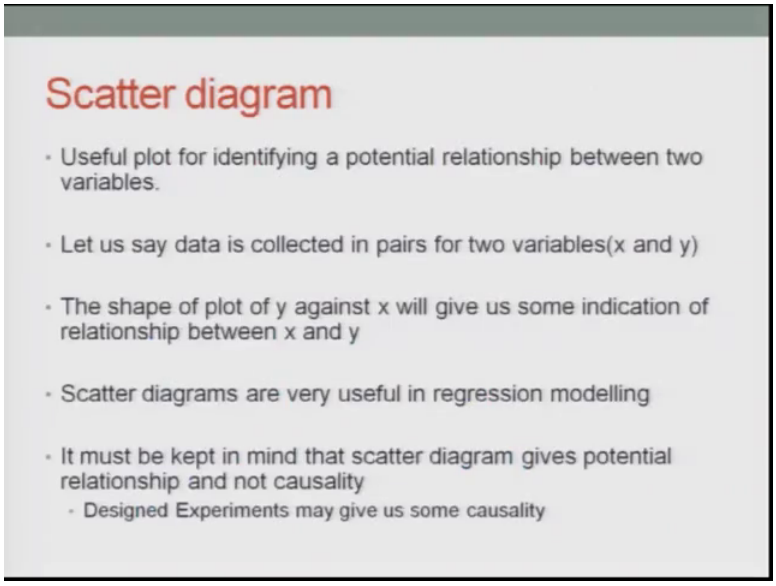

Now, scatter diagrams are useful plots for identifying a potential relationship between two variables. Let us say data is collected in pairs of two variables x and y. Say for example, like I am given a very simple example, it can be humidity and temperature when you are trying to find out what is the tensile strength of product which being manufactured. Or it can say for example, speed of the turning machine along with what is the temperature of the coolant which is being utilized, or say for example in in in a in a in service sector it may that be when the order of for food has been made by the customer and when actually the for food is delivered.

So obviously, there would be some implement implication based on which you can study 2 or more variables in order to understand the overall process which you have try to analyze. The shape of the plot of the y against x will give us some indication the relation between x and y. So, scatter diagrams are very useful in regression models where you want to predict forecast depend of y depending upon different above set of variables of x which you have. It must we kept in mind that scatter diagram give potential relationship and not causality. So basically, they give you the relationship, but actually they do not give you any actual cause and effect concept. Like say for example, a plot rainfall with say for example, age of the children in one district of India.

So obviously, I will get different type of a plot, but what is the actual relationship? What is the cause effect that may not be analyzed from the scatter diagram which I have. So, you should be careful that drawing blind is scatter diagram may not give you the best set of information which you want. So, so here you will basically utilize the concept of design of experiments of a such that we are able to find out what are the actual variables based on which you can understand where the problem is, how the quality improvement can be done, how the total cost can be improved in the sense the overall negative cost can be decreased or the variability can be decreased and an on all these points are important.

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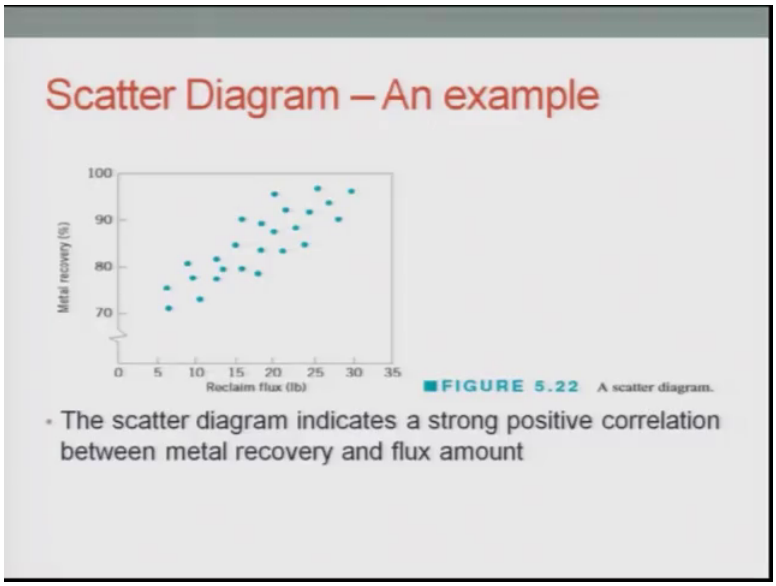

So, this is the spatter plot. Scatter plot, the scatter diagram indicates a strong positive correlation between metal recovery and flux. So, for the diagram which we studied in few slide back you have basically trying to understand that there are some problems in the in the tank. So, how they can be analyzed? So, you have in the Y axis you have the metal recovery percentage wise and you have the reclaim in in flux in bounce in the X axis. So, based on that can understand there is some relationship between X and Y.

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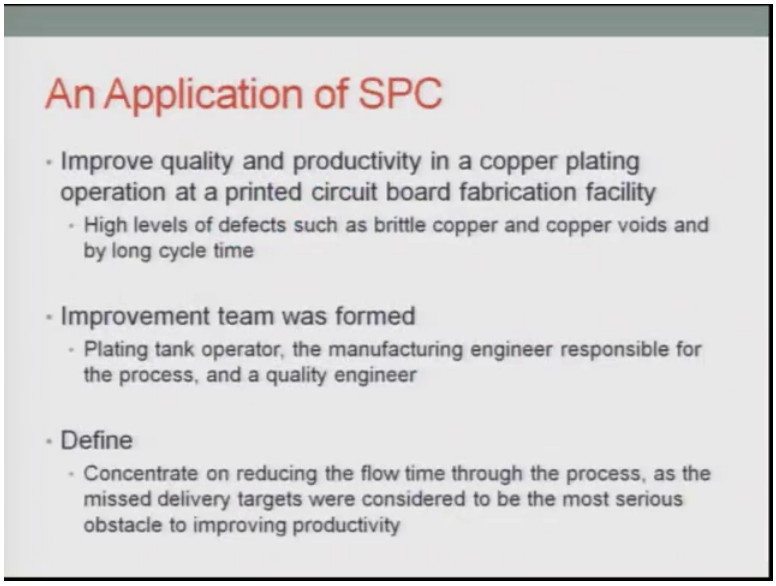

And application of statistical process control improve quality and productivity in copper plating operations at a printed circuit board fabrication facility can be done. So, high levels of defects such as brittle copper and copper voids that in the long cycle. So, can be utilize and reduce in actual run such that you are able to improve the quality.

Improvement teams were formed for, for this example for trying to find out the defect in the tank and trying to improve the overall working of the process. So, plating was done for the tank by the tank operator, the operator, the manufacturing engineer responsible for the process and a quality engineer basically got together, brainstormed find out the cause and effect diagram, analyze the problem and they came up with the solution. They would basically define concentrate on reducing the flow time through the process as mixed missed delivery targets where were considered to be the most serious obstacle in improving the productivity of the whole working process of the example which have considering.

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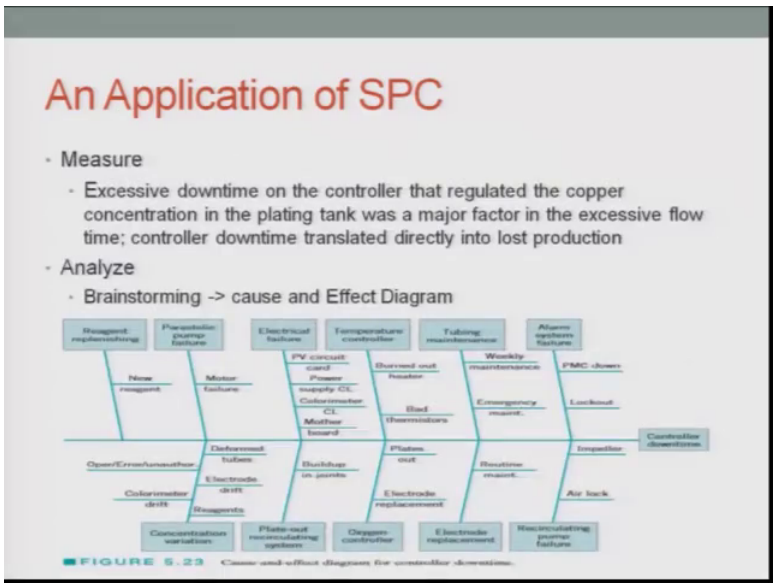

So, an application of statistical process control would be here you measure. So, excessive downtime in the on controller that regulated the copper concentration in the plating plant tank was a major factor in the excessive flow time; controller downtime translated directly into lost production. So, you will basically analyze, brainstorm, try to find about what are the cause and effect diagrams and what are the analysis and basically it will take actions according. So, this is a little bit cluttered, but here the cause and effect diagram

for the controller downtime are analyzed, where on the on the upper part of the diagrams you have the reagent replacing paratonic, pump failure, electric failure are all these things are analyzed. And how and where the problem occurred are basically gone dealt in depth.

So, an application of statistical process control would be the data collection for the controller downtime was necessary and the cause and effect diagram would basically have this. So, in the, in the, in the leftmost column you would have all the concentration variations, what are the failure causes, they were reagent replace replenishing problems was their oxygen controller had problems. So, all these things are analyzed, the operator basically goes into data that gives a description on the second last column and basically analysis more on the actions which are taken to rec rectify that or remedy the whole set of actions which are taken.

So, based on the data the Pareto charts can be made. So, you again you have on along the X axis the different errors of the defects which are there and you analyze the level of concentration, what are the defects and numbers which are patterned on the Y axis they would give you good feedback that how the process is doing and if improvements are done based on the feedback or control or the engineer how they can be implemented for the whole system. So, with this I will end this lecture and continue with by twelfth lecture the next day; have a nice day.

And thank very much.