Engineering Metrology
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Lecture – 46
Quality Control, introduction

Good morning, welcome back to the course on Engineering Metrology and we are in the last week of this course. In this week, I will discuss about the quality control quality control as specifically statistical quality control, then we will have some light on acceptance sampling.

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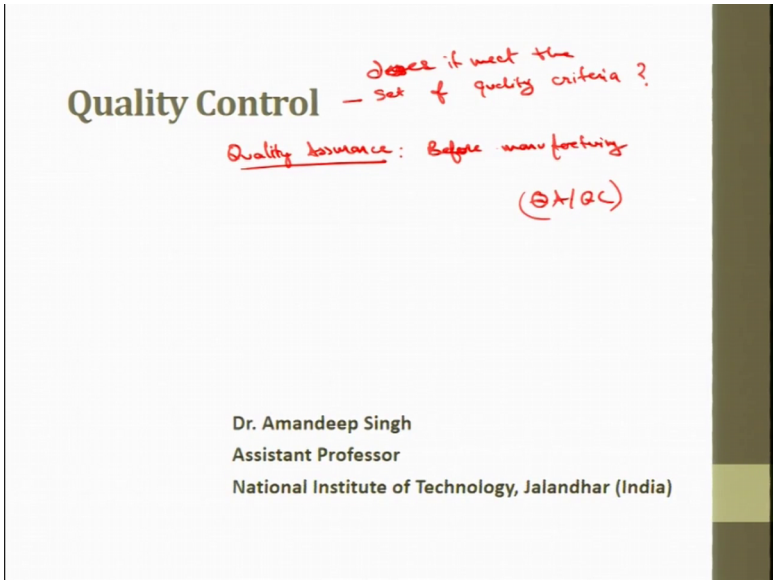

So, I will start this lecture with quality control. So, what essentially is quality control? Quality control is a procedure or set of procedures which are intend to ensure that a manufactured product adheres to a defined set of quality criteria. So, we have a set of quality criteria, specifically, in metrology we have the measurement limits like I said before I just touched this topic in the previous lecture that we have upper control and low control limit.

And after the production is done or the manufacturing is done and we do the measurements after that then we see that whether the product which I have produced

meet our specifications or not. More than specifications we will talk about the control limits. There is the difference between specification limits and control limit that I will discuss in this lecture. So, whether it adheres or does it meet I will put does it meet the set of quality criteria or not ok? So, quality control is similar to but not identical with than other term known as quality assurance, I will differentiate between the quality control and quality assurance is this in this lecture as well.

So, the quality assurance is defined may be defined as a procedure or set of procedure which are intend to ensure that a product or service that is under development that is before the work is complete. Before we have actually manufactured whether it adheres to the standards or not. So, this is quality assurance, this is actually generally before manufacturing. So, does it meet the specific requirements or not? Quality assurance is sometime expressed together with quality control or as a single expression. So, sometime it is said as Q A and Q C, the quality control department works with quality assurance as well.

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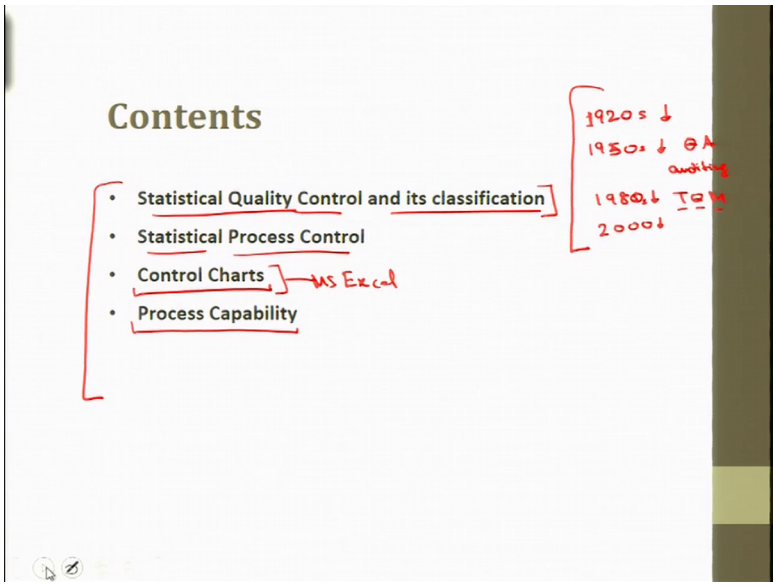

So, we will discuss this in detail but before actually coming to the statistical quality control that is more in the measurements. In 1920s just after World War I when it was industrial revolution and industry was trying to produce more a more goods. So, they that was at that point, there were a rise in mass production. So, it became important to better

define the quality of the products. Originally, the goal of the quality was to ensure that engineering requirement format in final products.

So, later on the manufacturing processes became more complex and quality developed into a discipline for controlling process. And we have the quality control department in every industry most of industries it has. So, the department is generally known as inspection and quality control department. Even if you follow the books, if you see the books or if you find the topic, you will find it has inspection and quality control. So, inspection is when we just check the specifications, like we use comparator or we use some measurement and we said yes or no ok, go or no go, acceptable not acceptable that is the inspection.

But, when we tried to plot that, the results which are of take more of inspection here. When you try to plot them and try to see where does the flaw lies, if the thing if our process or the manufacturing is not within the control limits. So, if we plot that is statistical quality control, so it is I think I would like to say it is an extended version of a inspection. However, inspection we will not go to that entrench, but will more focus in quality control, so in 1920s it is started.

So, then I can say set a milestone was in 1950; 1950s, it was after the IInd world war. So, the quality assurance came into place so, quality assurance was more known as auditing. The quality control techniques which we are implying here whether they are working properly or not so, it is kind of an audit so, quality professional expanded to include quality assurance and quality audit functions. So, the drivers of independent verification of quality were primarily industries in which public health and safety work paramount so, this was in 1950s.

So, in 1980s the term you people might be knowing total quality management came into pay. Total quality management is they maintain the quality while you are manufacturing. So, they have certain techniques certain tools of total quality management and people have worked extensively in this, so like quality function deployment that is the workers or the total productive maintenance in which the worker who is working is taught to maintain the process as well. The worker who is working in manufacturing or the operator who is there, he is also skilled enough to maintain or to control the process so that is total quality management.

So, in today's era if I call it in 21st century, I would call it in may be after 2000. Quality control became an utmost important thing and we had multiple instruments in this right. Instruments means are advanced instrument came into play like one year caliper was developer one year as I said in the 20th century itself. But, now the instrument what we have I will also discuss the 3D measurements in the end of this week.

3D measurement in 3D measurements we can do the measurement for the three-dimensions, like we can scan and we will discuss also we will take you to the laboratory here. And we will see the coordinate measuring machine 3D coordinates how these are measure, so that came into play and rapid manufacturing then rapid prototyping which is now additive manufacturing. So, those things came into play and with people are working on that. So, quality control travels through these milestones so, the I will cover this content in this lecture the statistical quality control and classification that statistical process control then we will discuss the control charts.

So, next we will discuss the control charts. Then I will discuss what is process capability control charts I will also like to work on the control charts in excel M S excel ok. I will like to show you what are the kinds of control charts there the variables and attributes of different kinds of control charts are there, then how do we plot those charts in excel. And if the process is not in control what step do will follow that after that so, process capability also we will discuss. Then in the next structural discuss about the acceptance sampling here.

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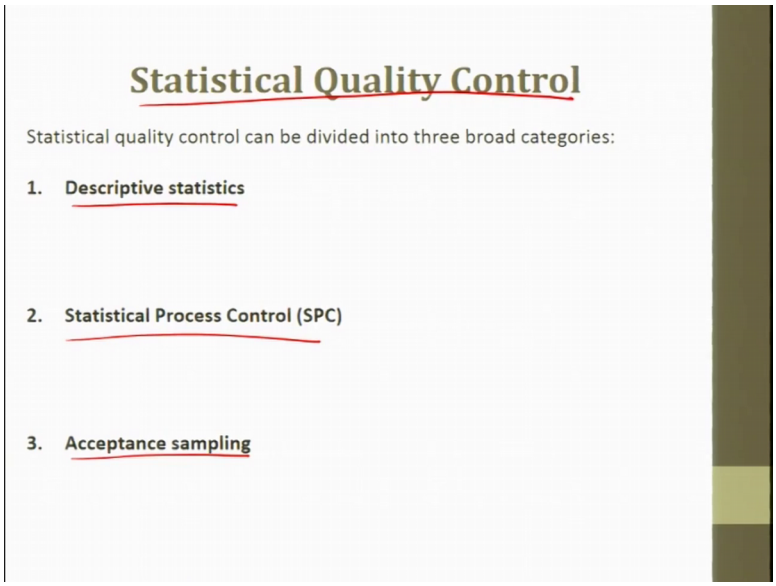

So, statistical quality control can be divided into three major categories descriptive statistics, statistical process control and acceptance sampling. Descriptive statistics we have discussed this a lot in the previous lectures. Descriptive statistics are these are used to describe the quality characteristics and relationships. And this include statistics such as mean standard deviation range, we have measures of central tendency then we have measures of dispersion, all those things are discussed here.

So, SQC or Statistical Quality Control is a term used to describe the set of statistical tools ok. This I have said before, now statistical process control involves inspecting a random sample of the output from a process and deciding whether the process is producing a product with the characteristics that fall in the predetermined range. So, process control answers the question whether the process is functioning properly or not.

Some people say some offers if you read books, some people would say that quality assurance deals with statistical process control and quality control deals with this one statistical quality control. So, S P C do come in the quality assurance part, but some people would describe in this way as well, I will take in this way the statistical quality control is there. And when we talk about the quality the describing the data descriptive statistics is there, then statistical process control is part of that.

So, I take it in this context then acceptance sampling what is this I will also discuss that also comes into play there in SQC. So, because we use the this statistical tools in

acceptance sampling as well. Statistical tools means we can when we generate the data, we can do some calculations to get some inference and we can plot the graphs. And while viewing those graphs, we can have some information and we can abstract some knowledge of that, and within we can work on that. So, this is that is why statistics term is here.

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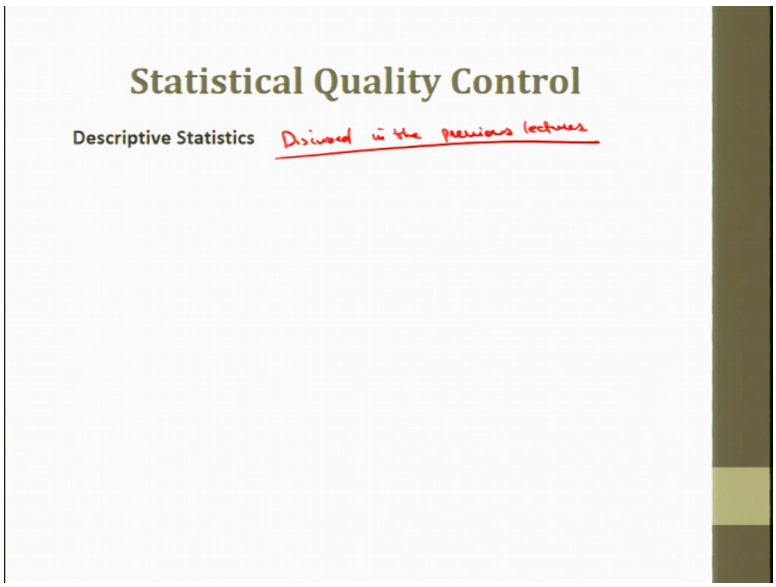

Now, next is the descriptive statistics I have discussed in the previous lecture. So, this is and we have mean rate standard deviation all those things I am not going to more details of that.

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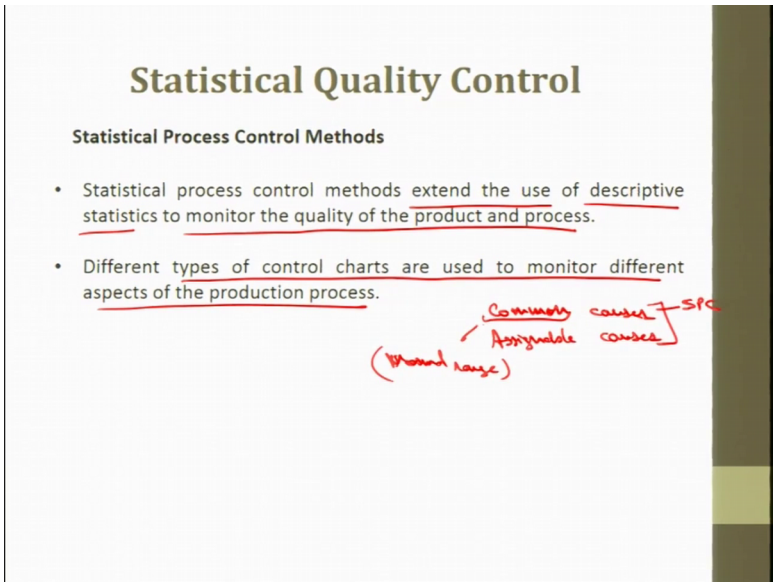

So, next is statistical process control methods; statistical process control methods extend to the use of the descriptive statistics it extend the use of descriptive statistics to monitor the quality of the product and process. Different types of control charts are used to monitor different aspects of production process. So, as we have learned so far that there are common and assignable causes, when we do measurement as we said, there is a systematic error, there is a random error, systematic error sometimes we cannot work on, but yes we have working on the random error.

So, they are I would say common causes and assignable causes ok. These are causes of variation in production every product. So, using SPC we would like to determine the amount of variation that is common or normal, we use SPC here it is common or normal. Then we monitor the production process to make it sure that the production stays within the normal range within we call also, we call it common or normal range.

But, the point I am trying to make here is that we would like to make sure that the process is in a state of control. And most commonly used tool for monitoring the process is the control chart that we will discuss. So, different types of control charts are there to monitor different aspects of production.

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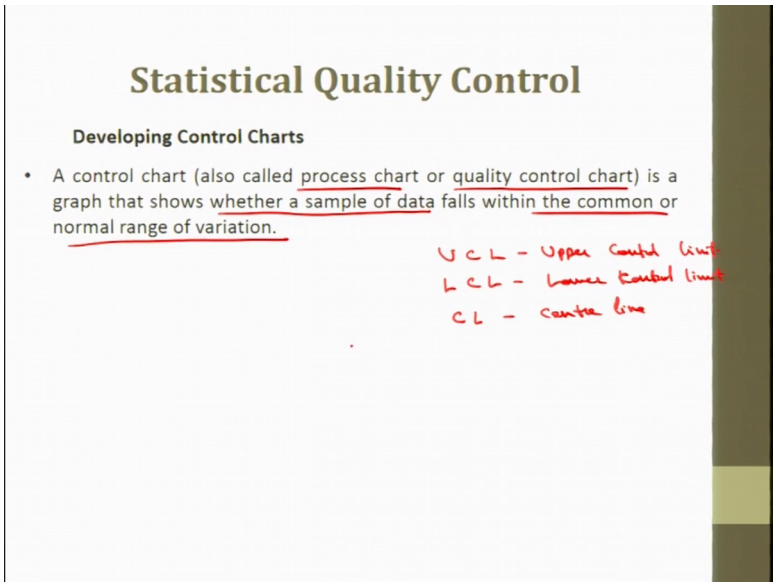

So, how to develop the control charts? A control chart also known as process chart or quality control chart is a graph that shows whether a sample of data falls within the common or normal range of variation. So, whether it is a common or normal range of variation the control charts has upper control limit it has U C L that is Upper Control Limit. It has L C L that is Lower Control Limit and it has C L that is Centre Line.

So, centre line might it be the true value for something close to true value, so that we need to achieve. So, upper control limit and lower control limit are the limits within which our measurements of data should fall. So, how to construct the control term we will discuss this so, we say that the processes is out of control, when the plot data reveals that one or more samples falls outside the control limits.

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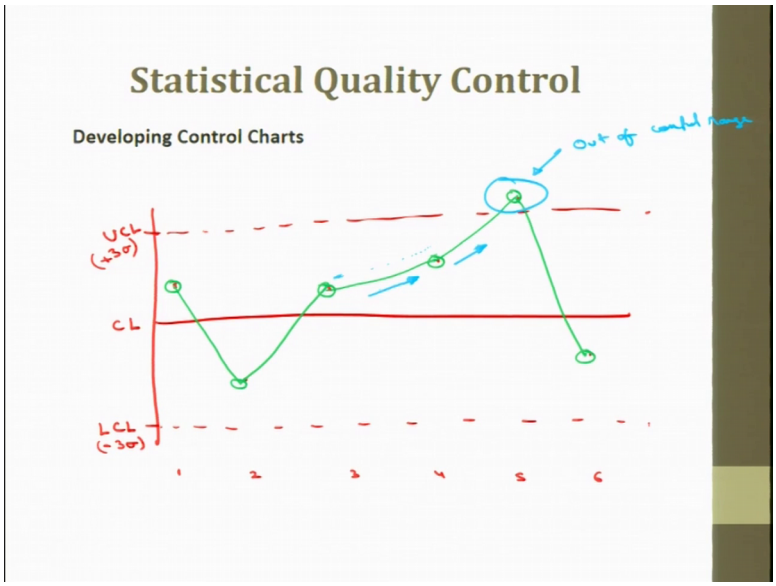

So, I like to just give you a illustration that how to control chart is plotted this is central line. And we have upper control limit and we have lower control limit. In general, in general I am not saying for sure this can be 3 sigma plus 3 sigma this can be minus 3 sigma. Specifically, in case of x bar chart this value is there. So, we have this line here this which is a upper control limit, this is a lower control limit.

Then we will have about process or our points here. Let me say if this is sample size, sample 1, 2, 3, 4, not sample size, this is sample number, this is just a nominal scale1, 2, 3, 4, 5, 6, I can say 6 points 1 2 3, then it can be a something 4 can be here, then let me say 5 and then 6.

I can draw a line here as well so, you can see that there are 6 points. And this value this specific value the value number 5 is not in control is out of control range. So, this kind of error if you can see sometime it is random like that the plot is like 1, 2, 3, 4, 5, 6, 7,8 it is 5 comes 9, then it comes down this can be random ok, now no assignable causes. So, this kind of plot which have just made of just picked some random data or I am just plotted something, you can see there is an increasing trend.

So, it may be input from here I am just saying maybe is a not for sure, but we have to see the actual experiments and we have to see whether that is 3 or not that and error started from here from point number 3. And it kept on increasing and it went out of control then it came down. It might be that we know the value is increasing here, it might be that the

instrument that you are measuring with that might have got some deterioration in that or the observer who is observing is having some parallax error any kind of error could be there, but this is a kind of an increasing trend ok.

This is what the control charts or the graphical or the data visualisation do help us to see whether this could be the reason or not. Actual reason we will find out we are actually go to the instrument we will find that all observation of being taken a what error is happening actually there so, we can what form that as well.

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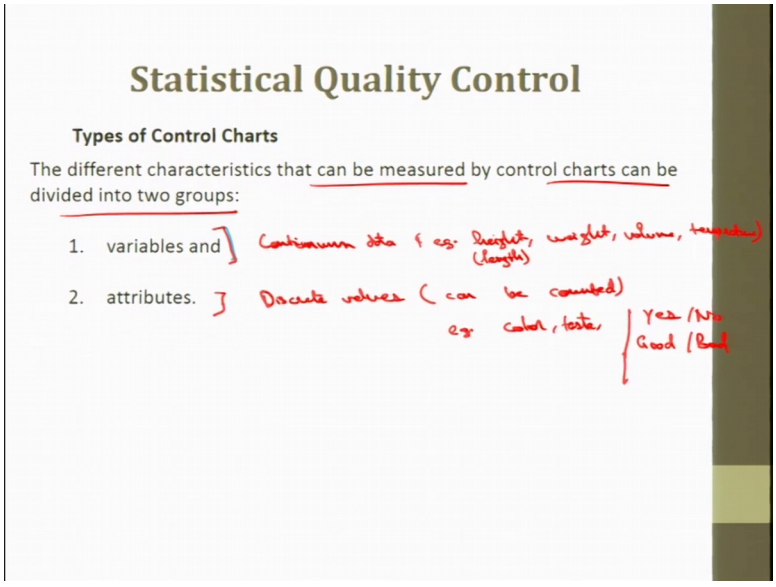

So, next I will like to talk about the types of control charts. So, control charts are one of the most commonly used tools in statistical process control. And they can be used to measure any characteristic of products such as weight number of pieces in a box, then volume in a bottle, then sizes of the shops, then the temperature differences, then the temperature in a room in the morning or in the evening.

So, we can measure any any data we have two kinds of control charts for variables and for attributes. When I say variables is more close to or more we define the continuous data, any data that we can fit on the normal curve continuous normal curve that is a variable ok. Attributes that cannot be continuous data for instance number of pieces in a box pieces in a box pieces in a second box, so or the defects in a product may be available.

(Refer Time: 17:41) manufactured a car number of defects or the number of defects in the tyres of the car ok car 1, car 2 number of defects per piece of the car number of (Refer Time: 17:55) piece and some time proportionally taken to the variables. Those are, so the attributes variables can be length then variable can be rate all those continuous data that we have discussed ok.

So, the different characteristics can be measured using by control chart can be divided into two groups variable and attribute so that of the control charts. For variables is used to monitor characteristics that can be measured and have a continuum value like I said height, weight or volume. A few example that I could quote here is that for instance a soft drink bottling operation is a kind of a variable measure. Since the amount of liquid that is filled in a bottle is to be measure the volume has to be measured ok, then we know that this much volume is there then we close bottle.

So, then other example may be the temperature of a may be the baking oven. If you are doing some kind of experiments of the temperature baking oven temperature is a good example. Then the diameter of the pieces that we have manufactured the size of the gear tooth and all those these are variables ok.

Attributes; so attributes can be used to measure or to monitor the characteristics that have discrete values and can be counted so, I would better put it here. So, it is used more for discrete values or can be counted for instance colour, taste ok, I will put it colour for example, then taste, then attribute can be colour, taste that with the answers there can be yes or no or good or bad; good or bad ok. So, acceptable or unacceptable can also be one of the term, but I will better use that in acceptance sampling.

So, the attributes these includes colour, taste and smell, the monitoring of attribute will be takes less time than variables, because variables needs to be measured completely. We measure the variable then we note on the reading, then we can have we can just put it in our descriptive statistic, we can describe it and put it in a table, then we can plot it the way we like ok, the way that fits proper to the specific data that we are obtained.

So, variables I mean better this is a kind of a continuous or better continuum data ok. These examples here can be height, weight, then volume, sometimes temperature, then pressure all those things. When I say height it can be dia or any length it better to put length here any length for linear measurement so, in case of attributes that can be

acceptable, non-acceptable instance number of non defective pieces or number of defective pieces in a box.

Then whether the light bulb that we have produced to works or not, bulb on the gets on or does not get on; whether the go, no go gauges would have both are working or not. Both the like, if the shaft or the hole or the bearing in the sense (Refer Time: 21:42) we need to see the hole size whether the go no, go gauges are both working properly with that or not so, this those can be attributes.

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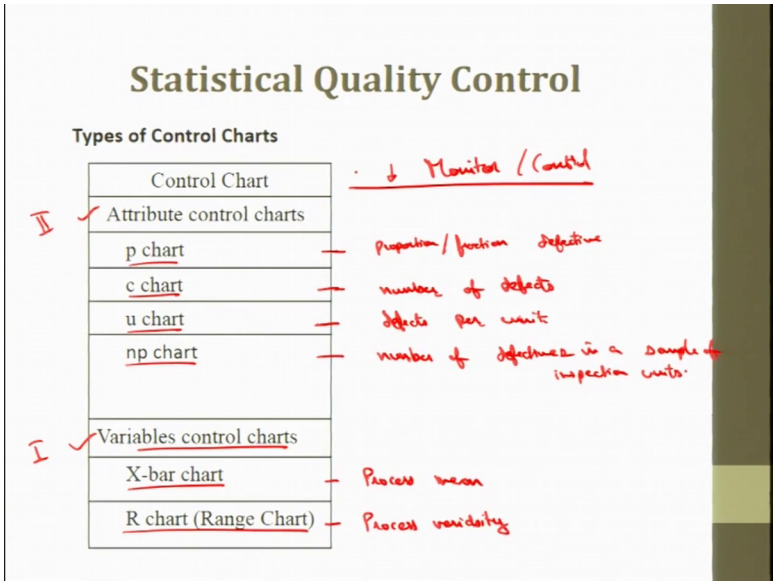

So, the next is types of control charts; in attribute control charts we have p chat, c chat, u chat and n p chart. I will take them one by one and try to pick some data and try to plot these in excel and try to explain you that how do we use this specific kind of data if it is available in that specific form and plot this charts. In for variable control chart we have X-bar chart and R-charts or range chart.

So, I will first take the variable charts, then I will take the attribute charts to give and broad information that this in this x bar chart monitor what be monitor here is the process mean. For instance, if you are doing some casting and we need to maintain the temperature within specific range and we will measure temperature various instances it has to maintain the temperature for an hour, we can measure the temperature at each 5 minutes that each 5 minutes in an hour would give us 12 readings.

And that 12 readings will take the process mean the mean temperature, so that is to be monitored the mean temperature would be taken as the different observations that we have got. We will try to see that within whether those are within the limits or not, the two limits control limits and specification limits, I will tell you.

So, next is R-chart; so, R-chart is range, range like I said what is range, range is our difference between the maximum and the minimum value. So, what does this tell? This is actually the measure of the process variability ok. So, p chart is the p is for fraction defective, p for the proportion of defective. So, I can better put it to used to measure the proportion or fraction defective.

For instance, if we are taking certain samples and out of 10, sample we have seen that 10 samples mean each sample size could be different. We have seen that in first sample 2 pieces are defective out of 10, in the second sample may be 3 pieces are defected after 20. In the first samples 2 out of 10, would mean 0.2, this is would the fraction defective how will plot this chart, I will just come to that.

If c chart is, when we have the number of defects like I said number of defects in the car or number of defects in the specific section of the car when it is manufactured so, it is number of defects. So, u charts is when we have number of defects it is c chart, when you have defects per unit when we trying to defects per unit is it is u chart. So, the difference between u and c chart will try to see these are very similar, because we are dealing with defects in both the charts, but the differences is that when the sample size is different we use u chart when a sample size is same, we use the c chart.

For instance, the sample size defects the 10 samples and each sample has 20 pieces in it. So, out of 20 pieces, we have we are now trying to note the defects number of defects so, it we will c chart. But, if you are picking random number of sample size is, then u chart can be used because we will take the defects per unit. Like we says for first 20, then 30, then 10 may be we will try to normalise data and we will bring it to the single scale.

Next is np chart; so, np chart is number of defectives in a sample of inspection units. I would put number of defectives in sample of inspection units. So, these are the things which we are trying to monitor or control in these specific charts. So, let us meet in the next part.

Thank you.