Total Quality Management - I

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Lecture - 06
Introduction to Concepts of Probability

Welcome back my dear friends. This is the total Quality Management lecture which I Raghunandan Sengupta from IIT Kanpur is delivering and today we will have the sixth lecture and if you remember the first five or more of a conceptual understanding on quality as a philosophy as trying to bring into the picture such that we always strive in performing quality. Quality can be improvement of your life style all, quality can be improvement on your food habits, quality can be improvement on the way you deliver some work or the quality may be the way you try to do the household work, maybe the life type of work which you do on your shop floor.

If you are working as a manufacturing employee in a big unit, it can be from the level of the desk work which you do consider you are a manager in a company. So, all these things are there and even though I will be mentioning this words time and again, but still when I come into trying to discuss from the course perspective, it would be more qualitative quantitative in the way the how the concept of quality has been build up; and as I mentioned time and again our main emphasis would be for the text would be the book of Montgomery. So, considering the and continuing with the discussion of total quality management.

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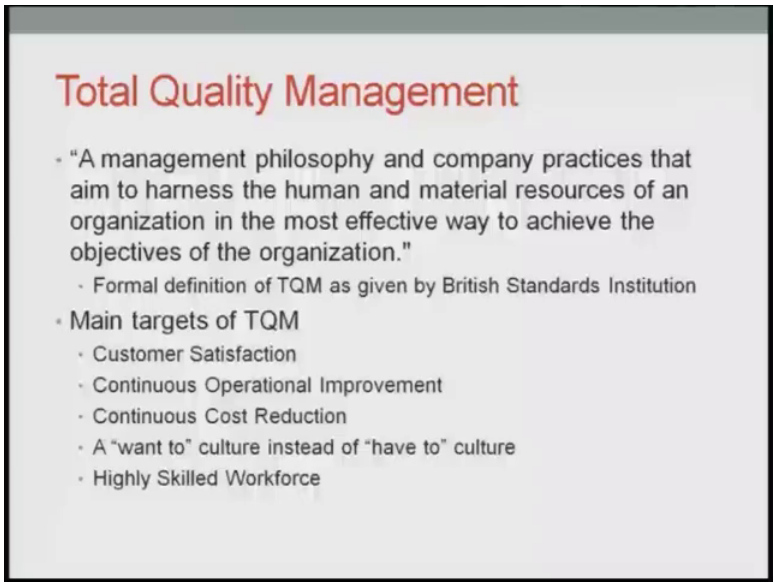

Management philosophy and company practices that aims to harness the human and material resources and level of confidence of the level of human resources of an organization is the most effective way to achieve the objectives of the organizations. The formal definition of TQM as given by the British standards institutions are the main targets which are customer satisfaction, continuous operational improvement, continuous cost reduction a want to a to a culture instance of have to a culture. That means, I want to improve I want to basically do in such a way that the overall philosophy is always one step ahead then what the customer needs. So, rather than customer demanding the services or the products from me in the level towards their satisfaction levels are for the come from the from the customers point of view.

I as a manufacturer, I as a service provider should always be one step ahead be able to deliver to them when he or she needs it or before that. Main targets of total quality management would be highly skilled workforce; highly skilled workforce means that he has a level of motivation, he has the required technical skills, he has the required conceptual skills or what quality is he is conscious that quality is important. He means it can be she also. So, he or she basically is conscious about quality, is conscious that that cost should be reduces, is conscious that best product should be delivered in the best possible manner.

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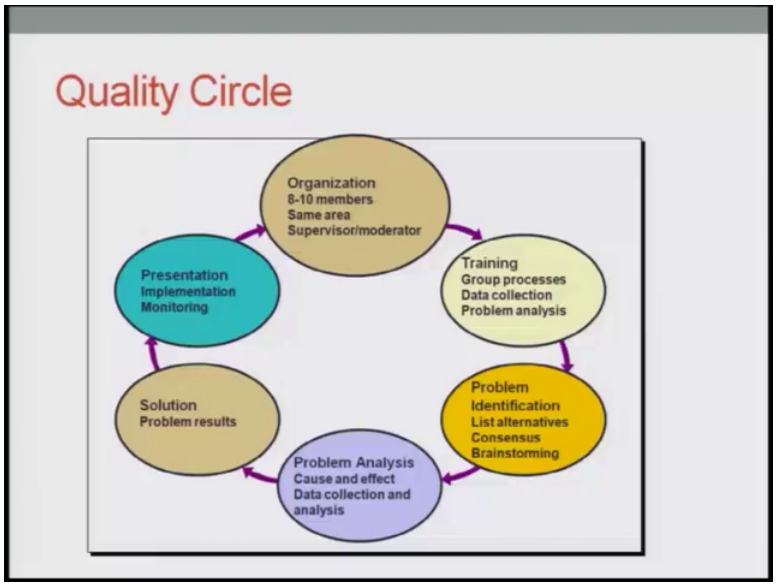

So, the quality cycle basically consists I am basically going to the very brief outline and just discuss what are the important points in the cycle. One with the organization, one would be the training, training required for those set of peoples who are going to manage the overall shop or related to quality. They would be the problems and how you identify the problems they would be problem analysis how you do the analysis of the problems when you understand where the problem is occurring, then you propose some solutions you means the team who is doing that work then you present and then the feedback is taken and further improvements if required are done.

So, the organizations would be about 8 to 10 members in the same area of the shop floor or the same area of the surface area, they would be supervisor or moderator who would basically be looking and how the work is being done. Then the group will process do some data collection do some problem analysis, the team and the shop floor. So, say for example, c n c machine is not working or there is some problem not working means not working as per the norm or the grinding machine is not working or the furnace is not working or the paint booth is not working. So, the people who are in that particular area in and around that paint booth, would basically do the collective job of data collection.

And processing the data and trying to analyze what are the implications of the data and how it can be improved consoling they did some problem. So, the problem has to identified; obviously, I this training and when the discussion is going on between the

employees at the point, who are facing a problem who want to improve; obviously, for them the problem statement is quite crystal clear that what they want to do. You list the alternatives there is a brainstorming session and people basically give the feedback, based on the feedback the a overall work for the next stage is started which is more to do with problem analysis where you find out the cost effect.

So, you have the fishbone diagram concept utilize that. Required as required will be discussing that in a little bit later on in the course they would be ishikawas diagram, he will try to utilize those concept in order to actually understand where the problem occurs and what is the problem what is the implications then after the brainstorming session after the analysis has been done the problem solution is stated once the problem solution is stated is basically the implementation and the monitoring of the work if you remember the pilot project concept which I said it is taken up in its always earnestness.

And depending on the feedback one gets as a team from running that pilot project running the implementation then again the overall process is brought into the picture in the actual mainstream and see seen that how it can actually improve the overall process and the quality of the whole system. So, generally there are many reasons for limited success and what are the reasons. I will just briefly go through them this ineffective training and lack of proper impact measurements and the actual emphasis which should be there on the employees is missing.

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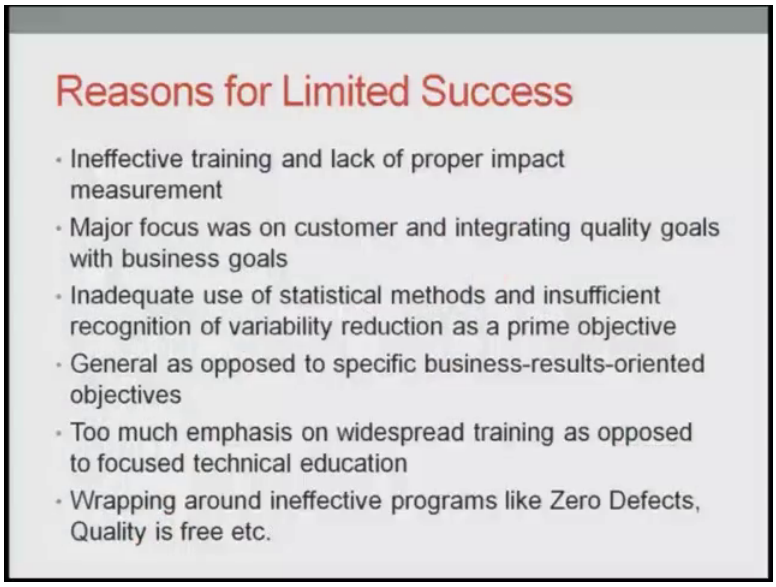

So, they have not been either being given the training or they have not been actually told what is the implication of quality and why quality is important.

So; obviously, they do not have the motivation to work based on that. Major focus was on customer in integrating quality goals with business goals so; obviously, the focus was the customer, but the end of the day the implementation was more on the organization like yes customer is important. So, rather than trying to improve the quality I will try to basically decrease the price and win the market share. Customers are happy initially, but in the long run it will be seen that the customers disaffection always starts because the moment they are getting bad quality products; obviously, they would protest market share would decrease.

But in the initial phase as I mentioned customers are happy prices are low, it has a positive effect from the shareholder positive effect on the company, company is doing fine. Later on when customer dissatisfaction increases, market share decreases the overall the implication of the cost basically has a negative effect hence profitability in the company decreases which is not good. Inadequate use of statistical methods and insufficient recognition of variability reduction is as a prime objective mean also be problems. So, if I am not aware that how actually the statistical process control charts can be used, they can be detrimental in trying to give me the information where things are wrong.

So, rather than giving me the true picture where quality improvement, wet process control improvement, where actual emphasis should be paid or we should basically emphasis on those steps the overall focus now shifts to another sphere, where actually rather than considering the real things we would be more bothered about the secondary factors which may not actually at all happen in a way that it will basically improve your quality. So, maybe my paint booth we think is a problem, but in action in reality it may be possible the overall quality of the goods which is coming is a is an issue.

So, rather than concentrating only on the paint booth if we are able to judiciously and intelligently find out the problems happening and the vendors end for the raw materials which he or she is supplying, then it would must be a much better way in order to improve the overall quality of the process of the product which we are manufacturing. So, generally general as opposed to specific business results oriented goals, we are we

should be generally be more focused on the quality improvement. But obviously, if the focus shifts and as stated here these may be one of the main reasons why we have limited success. Too much emphasis on widespread training as opposed to focus technically in education may be a problem.

So, we are giving training which is fine, but actually what is the in depth analysis how the analysis should be done, if it that is actually missing and the people core people who is who should be given that training they are not being given the trainings; obviously, you have to have not that amount of success which is required. So, educating people training people is fine, but not giving the proper education training to the core people who will do that implementation part may have limited or negative way of try to basically pull up the system. Wrapping around ineffective programs like we should always do is have zero defects, qualities free, quality should not does not come at any cost.

So, all these things are jargons which would definitely not have any positive effect or have limiting success on the overall process. So, if you are always saying that quality is free or we would definitely want some zero defects, which is not possible because; obviously, having zero defect would mean that everything is perfect, which means there is no white noise which in practical sense is not true. So, we should aim in order to the fact that quality should be decreased we should improve the quality, but in such a manner that it should be within the limits and if you are able to decrease the level of defects to the maximum possible extent so obviously, it would 10 toward zero defects which is a theoretical notion at which we are aiming for.

So, we always try to aim for the best possible manner considering that their practicality which would have an a limitation on our success, but that does not stop us from trying to improve the overall process. Now having said that if you remember I did mention the course would be more an emphasis on probability, and more on emphasis statistical process control. So, I will very briefly go through the concept of what we mean by probability and how probability and different about distributions would have an implications on the study of quality.

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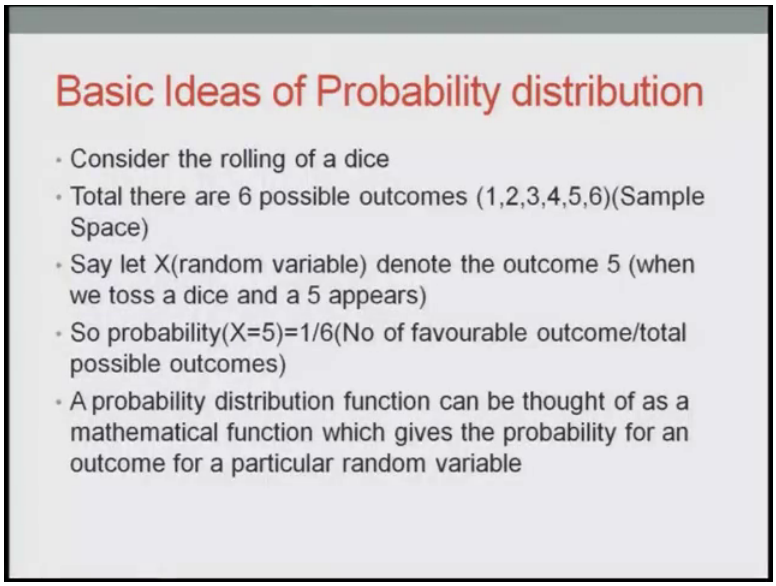

So, the basic concepts of probability is that, we know probability in a very simple way as the concept of relative frequency and how relative frequency in the long run basically would give us an idea about probability.

So, consider that we do or die and there are six possible outcomes. And the considered a die is unbiased actual die. So, all the numbers which are marked on the faces are 1, 2, 3, 4, 5 6. So obviously, the experiment could also have been done where rather that have one to six the faces could have been marked with the alphabets like a b c d e f and so on and so forth or say for example, when you are tossing a coin, we actually have an head and tail rather than have an head and tail it could be the coin has been painted one side as black another side is white. So, whatever the implication is the actual concept of probability should definitely be very clear from these two examples.

So, these six possible outcomes which we consider are a samples space. Sample space means from the space from where or from all the observations from where you picking up that set which is relevant for the experiment when you roll the die or to toss the coin. Consider x is capital X is the random variable which would appear when you roll the die or toss the coin. Toss the coin means the x would basically have two values either head or a tail or if the color is black or white and when you are considering x for the rolling the die, the actual x value can be one of the numeric value starting 1 to 6 or the alphabet

say for example, a b c d whatever it is depending on how you have basically design your experiment.

But one should remember the value of x is unknown to me before the experiment is done, once the actual face comes up say for example, when I roll the die and the number three comes up, then I will say that capital X has taken a realized value small x which is equal to 3. So, before the experiment has done x is unknown to me, after the experiment is completed I know the actual value which I am seeing and then I assign that particular value to that capital X and say that small x which is the realized value is the number 3. So, so and corresponding to that I try to find out the probability now when you are basically taking a coin and tossing it 100 times say for example.

So, it may be possible that out of the 100 times, head comes 55 times and tail comes 45 times so; obviously, the sum 55 plus 45 is 100 in the next case again when you have basically 100 tossing and of this unbiased coin which I am talking about, head may comes say for example, 40 times and tail may come 50 times. So, the number of heads and number of tails which we do and when we toss may be different for different example for different experiments as we continue, but the main implication what we know that once we toss the coin and the head comes and we say the probability is half or 50 percent.

And when we make the toss and the tail comes and we say the probability of getting the tail is 50 percent, it means that if you keep repeating the experiment infinite number of times added (Refer Time: 15:35) then the overall proportions of the heads and the tails are equal in number. This if you think very logically actually that is the case similarly when you are basically rolling the die numbers mark 1 to 6 so obviously, it may mean that in one of the case when you roll it 6 number of times or 10 number of times, it may be possible the one comes maximum, two comes then and may be possible number 6 does not appear in the other case.

When we roll the die the same die in 100 number of times, it may be possible that only 6 number comes other number come does not come, but if you keep repeating the experiment as we did for the unbiased coin, it would be seen that the proportions or the relative frequency or the probability. Probability means in the long run as basically the number of such events or number of a experiments which we do basically becomes

infinite, then it will be seen the actual probability of the numbers coming either 1 or 2 or 3 or 4 or 5 or 6 considering the fact it is basically an unbiased die the probabilities would be 1 by 6.

So, as mentioned in the fourth bullet point, the probability of capital X taking the value small x which is equal to 5 is basically is equal to 1 6 which means the number of favorable outcomes divided by the possible number of outcomes which has come. So, in the ratio which we have in the numerator we have the number of favorable outcomes which basically adheres to the fact the number 5 has come, and in the denominator we have the total number of such tosses which has happened in the long run.

So, the number of tosses in the long run if you tends to infinity obviously, the numerator will also increase but in the long run the overall ratio of the numerator denominator for this example would tend towards 1 by 6. So, for to analyze this type of problems we will basically have a probability distribution function, which can be thought of as a mathematical function which gives the probability or the functional mapping of what is x what is the value of x comes, and what is the overall relative frequency of the probability of that value coming out of x. So, basically is a mapping depending on the realized value and what is the overall function and implication between the x value and the probability. So, probability function which we said basically can be of two types, one is the probability mass function for the case when x is only discrete.

So, the examples which were discussed in the last slide where when you are tossing a coin or basically rolling a die then the values which are coming out is discrete, but considering the case when you are trying to say for example, measure a length or measure the total quantum of say for example, fluid which is flowing at a particle unit time; obviously, the fluid flow rate is not a deterministic or the height or the length of a of a person or say for example, of a tie rod. So, height would be as I mentioned for a person and length would be for a tie rod when you are measuring, they would be basically be possible theoretically that they take all the values between.

Say for example, 0 and 12. In that case we will be saying that the distribution function based on the random wave length or the height would be continuous in the sense x can would take all continuous values, hence we will be saying that the probability function which will be utilizing would be used by the word of probability density function. So, in

the first case when it was x was discrete it was probability mass function, the y the what mass because the concentration on the probabilities are at any particular points depending on what the x values are, and probabilities distribution function would be the case when x are all continuous.

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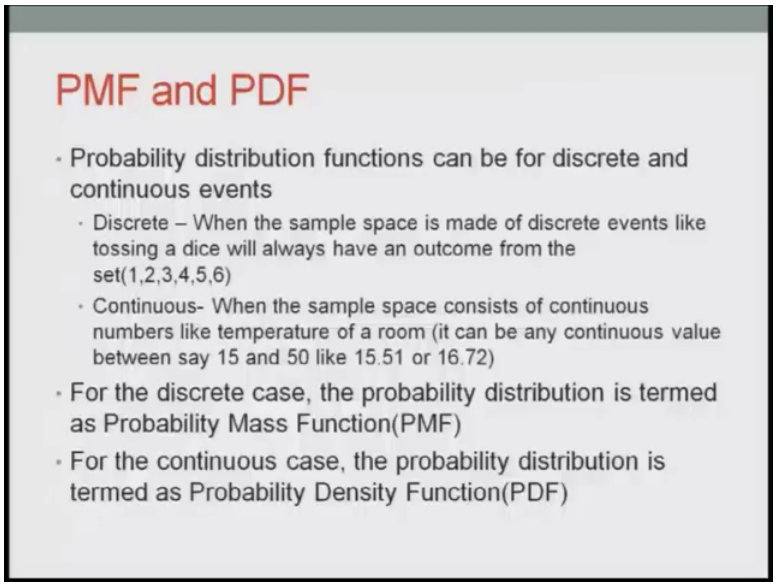

So, probability distribution functions can be discrete or continuous density functions which I mentioned, where the values comes out to be basically from 1 to 6. Continuous when the sample space consists consists of continuous numbers like the temperature in the room, it can be any continuous value between 15 to 50 or 15, 15 1 can be one value or say for example, 15.5126 can also be a value depending on how accurate your temperature measuring equipment is or it can be 16.72 consider the two just examples or the notions which I give when you measuring the height.

The height of a person can be 5.125 meters a feet sorry or the height of say for example, another person can be 5.1369 feet when you measuring the tie rod say for example, the tie rods can be between 12 to say for example, 13 feet. So, it can be 12.025 feet also it can be 12.7562 feet also. So, depending on the accuracy they can be any continuous values between the range what do I have mentioned for the tie rod on. So, for the discrete case the probability distribution a function is basically denote as probability mass function as I mentioned, for the continuous case it is mentioned as probability density function.

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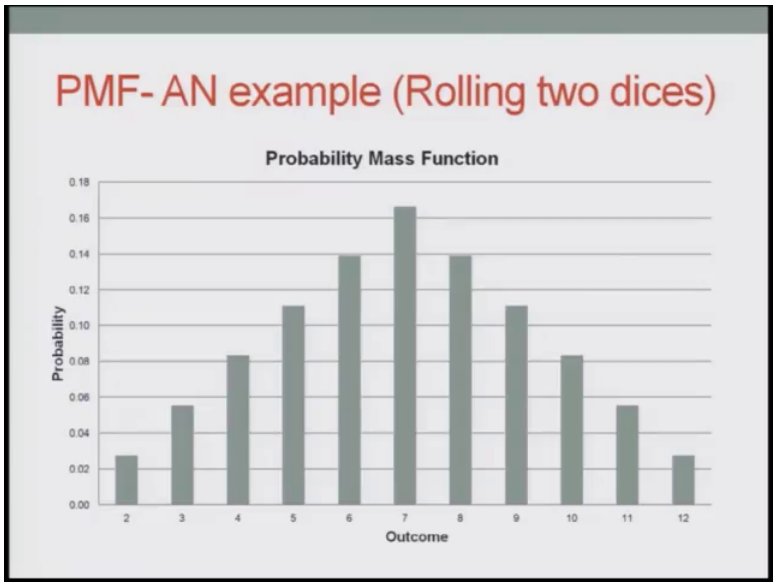

So, this is the probability mass function which I have. So, the outcomes or the realized values are measured along the x axis which you see. So, this is the x axis where I have this is the x axis and these are the outcomes. So, the outcomes are measured and this is not the example which I have when we when I am talking about the tossing the coin or rolling the dice, and along the y axis you basically would based plot. So, those two figures which I am going to mention now are not there, but based on those we get the probability mass function. First we will try to basically have the frequency along the y axis, then utilize the concept of relative frequency along the y axis.

And if you remember the concept of probability basically comes from the concept of relative frequency where in the ratio or the relative frequency we have the number of events which are favorable divided by the number of total events and as the number of total events considered tends to infinity, hence the relay frequency becomes the probability. So, if you consider this diagram along the y axis you have the probability, and it the histogram this is the histogram looks like a normal distribution and this is the notion why I purposefully brought a histogram in such a way that somebody would understand the implication of normal distribution and the whole amount of utilization of normal distribution will be utilizing for a total quality management course.

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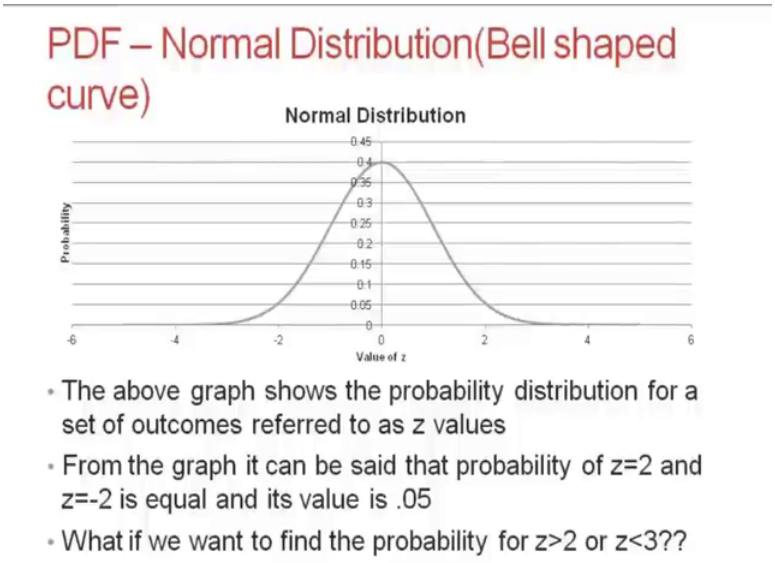

So, this is the PDF as I mentioned this is the PDF of the normal distribution on the bell shaped curve. So, the above graph if you see the graph the mean value which is the central value is given as 0. So, I am not going to go to the details, but I am going to give you a brief outline that why the diagram has been drawn this, is the standard normal deviate distribution curve which when we try to utilize the x value as the discrete or the continuous random variable for the PMF or the PDF.

But for the case when you come to the utilization of x as a continuous random variable and try to plot the normal distribution, that the mean or the median or the mode value which is the central value for x need not be 0 it can be anything. Say for example, when you measuring the height the average height or the mode of the of the mean value basically can be say for example, 5.25 feet or when you are basically measuring the tie rod it can be say for example, 12.766 feet. So, those values which you consider using the simple transformation from the normal distribution to the standard normal deviate, the graph which you get is shown in this slide which is the standard normal deviate with a mean value of zero and the standard deviation of basically 1.

So, the along the y axis you are measuring the probability along the x axis you are measuring not x, but z which is the standard normal deviate random variable. So, the above graph shows the probability distribution for a set of outcomes referred to as z values. So, if you remember just few seconds back I mentioned that x has been

transformed to z with the standard deviate random variable, and we are trying to plot the standard deviate random variable along the x axis along the y axis we have the corresponding probability to the fact that how as z changes and it takes the realized value of small z what is the probability along the y axis.

From the graph it can be said that the probability of when small z is two; that means, the realized value is known to us and when realized value is known to us as minus 2, the if you see the probability of values are equal. The reason being it is a dumbbell shaped curve which is symmetric and is equally dispersed along the mean value which is 0. So, if you move the same quantum on to the right; that means, plus 2 and same quantum on to the left which is minus t2 the overall probability values would definitely be the same. So, what if you want to find out the probability of z is greater than 2 or z is less than 3.

So; obviously, we know that the distribution curve PMF or the PDF is such that the overall area underneath the curve would always be one because the probability sums is always 1. So, if you have the discrete case you will basically sum it up and if it is the continuous case you will basically integrate. So, integration and summation are all are the same concept. So, when you want to basically find out the value of z is 2; obviously, it would be the sum of all the z values starting from z is more than 2 till the infinite value because if you see the graph here which is being displayed now. The z value basically can take any value starting from minus infinity which is on to my left hand side to plus infinity is to my right hand side.

So, any values adding up starting from z is equal to two till the infinite value would give me the first value what is the probability that z takes a value greater than two in case if I want to find out that what is the probability that z takes a value of less than three. So, I can give you two way of how you do the calculation one would be basically to add up all the values starting from minus infinity to z is equal to 3, on another implication would be how you do the calculation would be to first find out all the probability sums stating from the starting from the fact that z is equal to three till infinity and once you add that subtract that value from one because the total value under the curve is always 1.

So, 1 minus that would give me the next value which is probability of z is less than 3. Now CDF value which is the cumulative distribution function is basically the sum of the PDF and the or the sum of the PMF.

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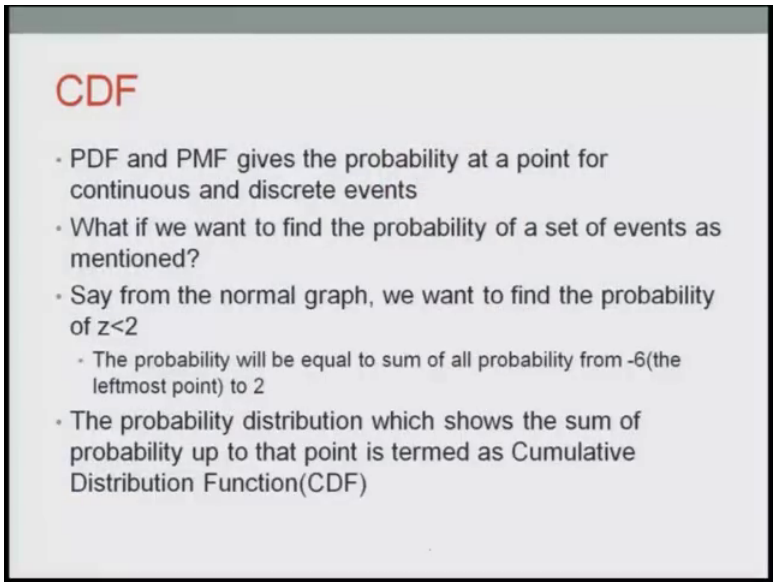

So, is gives the probability at a point of the continuous and discrete events, what if you want to find out the probability of a set of events as just mentioned in the last graph where the probability is to be found out for z value greater than 2 or the z value less than three for these two examples see for the normal distribution we want to find out the probability of z less than two the probability, would be equal to the sum of all the probabilities from minus six that is the less much point.

So; obviously, minus six is being shown because you other values cannot be shown here, but technically they are from minus infinity till that value of z. The probability distribution which shows the sum of the probability up to the point are termed as the cumulative distribution function, and this concept of cumulative distribution function would be the same for the PMF or the PDF.

So, with this I will end this sixth lecture and continue the discussion about probability distribution functions, probability mass functions and CDF, and see that how these concepts can be utilized in statistical process control later on. Have a nice day.

Thank you very much.