Total Quality Management - I
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Lecture – 15
Introduction to Acceptance Sampling

Hello, good morning everybody. I am Raghunandan Sengupta, taking the TQM class, which is TQM, one total current quality management one. So, you where discussing in the 14th lecture about the needs between the customer requirements and how the attributes from the designer manufacture point of view can be considered such that there is a dovetailing between the requirements with respect to the total customer needs. So, to continue that in the 15th lecture and so on and so forth.

So, the QFD which is quality functional deployment, which we are doing, basically rates. It sets the right granularity and the level of importance, which you needed for each and every attributes. They do not apply to every type of projects which are there.

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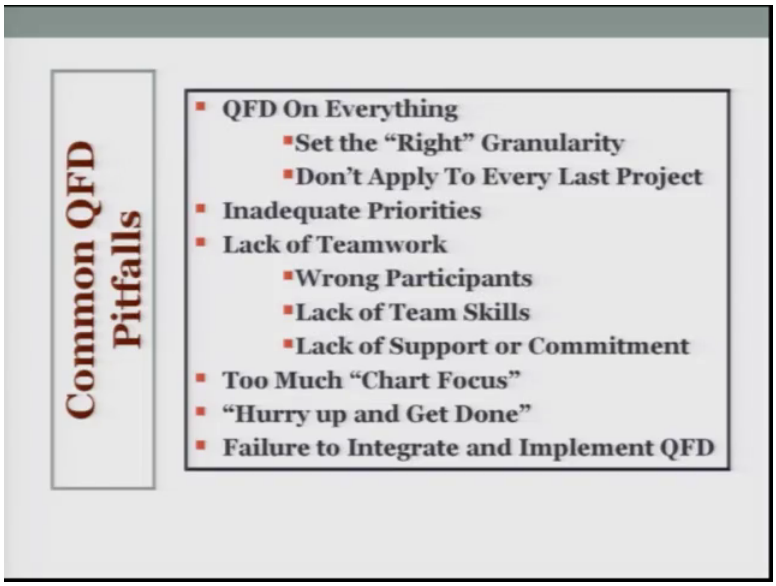

So; obviously, from the manufacturing point of view, they would have a lot of such differentiation, lot of analysis, but may be; see for example, from the point of view of service sector, the overall set of points in details as we discuss in the last class, which is the 14th one may not hold, but; obviously, the general plan of things for all the discussions do hold.

They may be possible that we give some inadequate priorities for different attributes or the characteristics. The main problem can be lack of team, workmanship should be there such that the level of relationship or level of work which should be done between the designer the procurement of the raw materials. Person set of the team the manufacturer may not be to that possible extent which you would like to have in order to meet the overall customer requirements. They may mean lack of team skills for each and every level, lack of support or commitment may be there, from the top level. And remember me for any good quality improvement, the actual emphasis should be coming up from the top level, who are basically the real main driving force for improving the quality in any organization; be it government, be it manufacturing, be it educational institute, be it any field.

They may me because, if you are going in too much detail, they may be too much to chart for too much details to consider, which may not be possible at the first go. When one is considering the relationship between the customer requirements and the needs with all the attributes, they may be some inkling to complete the work very fast which is not possible because, quality improvement takes time. So, what may be the actual problems which the customer is trying to portray to the design team to the manufacturer team, may not be immediately applicable or meaning immediately understood by the team, or they may be issues where the problem, the customer which is actually not implementable. We are not able to portray that or tell that to the customers as, because they may be some miscommunication happening between the customers; a set of customers, and the design and the manufacturing team or the unit which is basically manufacturing some product.

So, they may be failure to integrate all the information which is there, between the different four teams or four stages as I discussed. and as I mentioned the Japanese would like to basically go into details of each four levels, while in the western culture we would be more interested to consider the first 2 stage, considering their level of importance which is their or the QFD.

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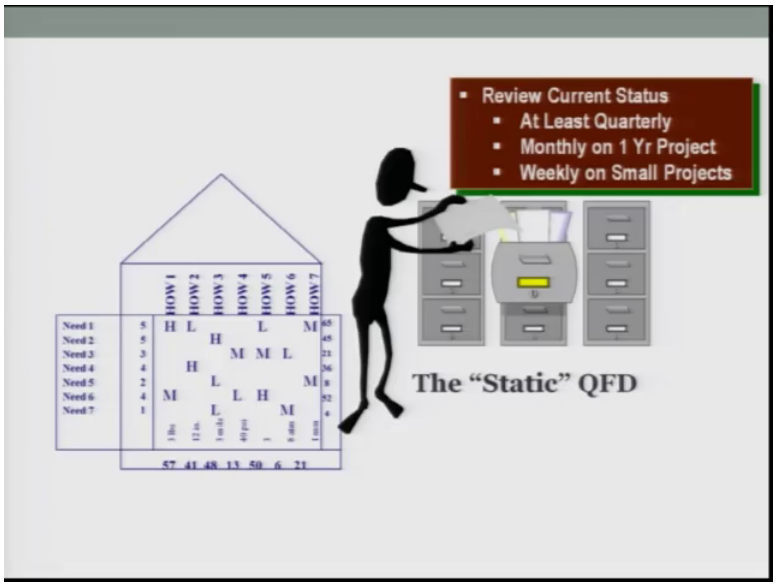

So, these needs and house as I mentioned. So, in one set, we will see. As we have seen that the house becomes the needs in the second level, and we continue in this way.

So, one should review the current status at least quarterly or a monthly, and such detailed analysis should be made; such that we are able to understand that in which direction the QFD and the customer requirements are being balanced, with the attribute set of attributes which we have basically thought for ourselves. So, generally QFD should not be static, they would be dynamic. So, in case if they are dynamic, the real problems are real issues, as the customer requirements change are portray in the attributes which somebody is considering.

So, points to remember is that process may look simple, but it requires effort, many entries looks obvious, but there it, but they should be written on in such a way that the simplicity should be coming out in the detailed perspective. So, if one somebody writes the needs in the house, and the next set up house becomes the needs in the second stage. So, the relationship should be portrayed in such a way, that the level of correlation given the points of very strong, strong weak negative should be coming out in such a way that the relationship or the importance of all that cubist between the customer needs should come out at each every state, and if you combine them, they should be coming out in the best possible manual.

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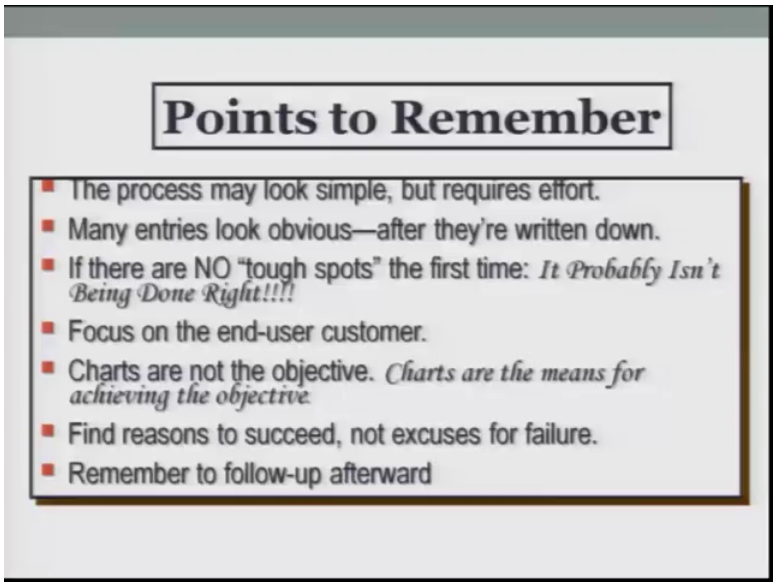

If there are no tough spots the first time, it is probably, it is being done. It is not being done in the right time. So; obviously, there may be issues and if the issues are very apparent, but if those apparent points are not coming out in the detail analysis, which means the digital analysis which has been, which is being taken into consideration does not consider those points in the right perspective. Focus should always be there on end customer requirement. So, my customer may be the second stage. The second stage customer; say for example, maybe the third stage so on and so forth, but in the overall perspective, the end-user customer requirement are the best possible, all characteristics or the inputs based on which, all the attributes are being analyzed, charts need not be objective, but if they are not objective; obviously, the attributes and the analysis may not come out to in the best possible manner, charts are the means for achieving those objectives.

So; obviously, we have try to bring more objectivity in the charts, that may not be possible, but what we are trying to implement, on what we are trying to basically portray is that, the chart should be the ways how objectivity can be brought into the analysis between the customer requirements, and the overall set of attributes, which we want to consider from the designer and manufacturing point view point; such that the customer requirements are met to the best possible extent.

We should find reasons to succeed no excuses to failure should be found also; obviously, will all should basically point in the direction; such that we are able to find out where the problem lies, and try to basically implemented the overall scheme in the best possible manner; such that the weaknesses are overcome and success is the main motivation based on which the whole work has been done.

Remember that the overall the stages; 1, 2, 3, 4 of the QFDS for four stages as we mentioned in details should always be analyzed in such a way that a follow up should be there. We should analyze the problem from the point of views that after the first initial set of analysis one has done, we should be able to take the feedback from the first set of analysis, and put it in the second set of analysis; such that improvements are always there.

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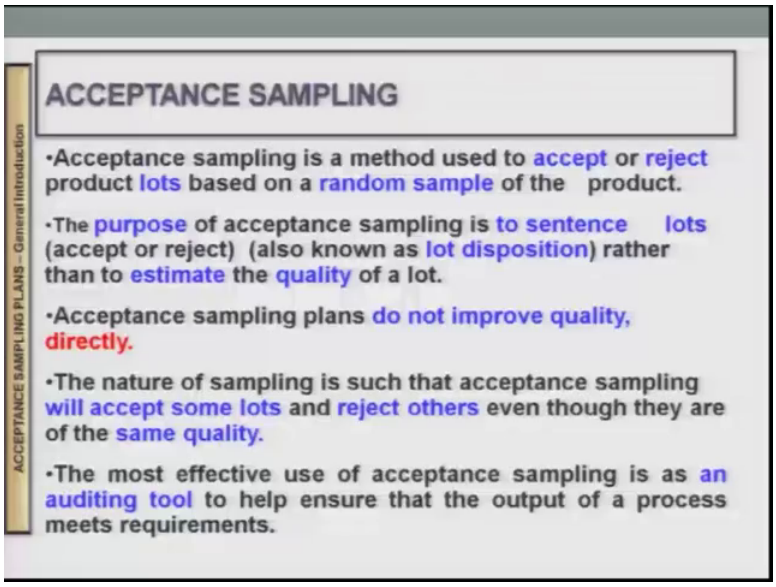

So, when having said about QFD, I would like to go into the concept of acceptance sampling and this will take some time in order to understand that and I will strongly urge my friends, my students and whoever is basically trying to understand that, some amount of reading has to be done there may be issues which he may become very technical, but as I said statistics and if you remember I did not discuss about the level of probability distribution not in details, but about the normal distributions which would basically be the building block, based on which will be considering the concept of the sampling and accepted sampling.

So, acceptor sampling basically means is a method used to accept or reject products based on lots, which are drawn at random samples of the product. So, randomly a pickup set of lots, it may be 3, it may be 4, it may be 5, whatever it is and we pick up the lodes depending on what your overall scheme of sampling is the purpose of acceptance sampling is to sentence lots, which is basically to say them there accepted or rejected also known as lot disposition rather than to estimate the level of or the quantity of a lot. So, what we want to do is that pick up a lot study the characteristics of the lot and say whether you want to accept or reject or basically take some in between policies. What are the policies; I will come to that later. Such that when able to take up overall objective judgment of the overall set of sampling or set of population which we have in front of us.

So, if you remember that and from basic statistics, we know the overall population which is the overall set of things which are need to be sampled. It is technically not possible to sample each and every product. So, in order to overcome that like you know, we pick up lots and the picking of the lots and sampling the lots or testing the lot is done in such a way that we are able to give the property of the overall population from the sample; which has been picked up.

Acceptance sampling plans do not improve quality basic directly. Basically, only gives you the indication in which direction you should go in order to improve the quality. The nature of sampling is such that the acceptor sampling will accept some lots or rejects some lots, considering the overall sampling plan, which you have in front of you. So, the sampling plan one let us mention is as number one maybe 2 for some set of products, which is product 1 where the sampling plan 1 may not hold for product 2, we may be utilizing some sampling plan 2. So, how we use sampling plan 1 or sampling plan 2, would depend that how the things are being done.

The most effective use of acceptance sampling is an auditing tool to help ensure that the output of a process meets the requirements to the best possible manner.

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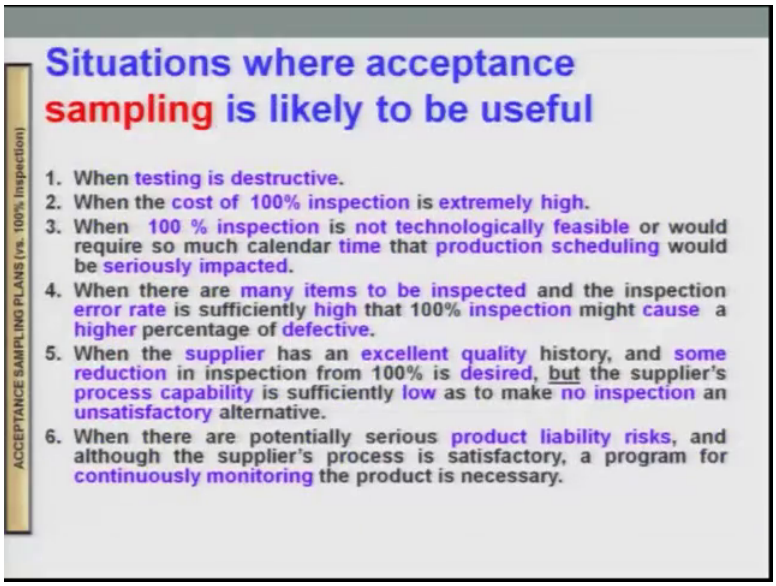

So, situations where acceptance sampling is likely to be successful are when testing is destructive. So, say for example, we have a testing machine or a bulb or say for example, a product where destructive testing is used. So, if you are using destructive testing it means that once we test that product is out of use. So, we cannot use that. So, here in the in situations where destructive testing is used their sampling; a lot size samplings are important based on the size of the lot we are choosing.

When the cost of hundreds inspection is extremely high as I mentioned that if rather than picking up each and every observation from the population is best to pick up a small set of lot and do the testing accordingly when 100 percent inspection is not technology feasible or is very costly or would require. So, much calendar time period that the production scheduling would be seriously affected. So, time cost and impossibility of trying to basically test each and every product are few of the important reasons why acceptor sampling is done.

So, other reasons are when there are many items to be inspected and the inspection error rate is sufficiently high such that 100 percent inspection might cause a higher percentage of defect. So, you want to basically pick up a lot understand that if the lot different number of defects in that lot is over a certain percentage, we would definitely be tempted or have a policy where you want to reject that not rather than trying to find out defect in the overall population.

It may be possible other reasons being when the supplier has an excellent quality history and some reduction inspection from 100 percent is designed so,, but the supplier process capability sufficiently low. So, as to make no inspection and unsatisfactory alternative fraud from the point of view of us; that means, we are procuring some products from the vendor on the supplier and there are say for example, supplier has an excellent quality history, but due to the supplier process capability being weak or process capability not being up to the standard what we need.

So, we may be forced to bring that lot sampling into an action, such that we can find out the concept of accepted sampling in such a way that it gives us some information that what is the problem the process capability of the cost of the supplier and we can do 2 things number one accept or reject the lot and be very careful in what is the overall quality level of the products we are accepting and also be in a position to tell the vendor or the supplier. There where the problem lies from the point of view of the process capability or on his or her end.

The other reason is that whether a potentially serious product liability risk and where the risk of trying to basically get a product, which is where if you basic or on trying to accept a bad product maybe disaster say for example, for a pacemaker or say for example, for a very sophisticated instrument, which is being used in an airline industry or in a plane or very sophisticated component, which we want to use in building a bridge over a river where many travel the huge amount of traffic flow is very huge. So, where there are such problems, we may be in a position be tempted to use acceptor sauce sampling concepts such that we are able to BBV sanguine about the type of product which we are using.

So, it continuing that when there are potentially serious product liability risk and although the suppliers process is satisfactory a program for continuously monitoring the overall process capability product requirement and products level of quality is of at most important to us. Types of sampling plans are in a very simple way, I will discuss one of the major classifications is by data type.

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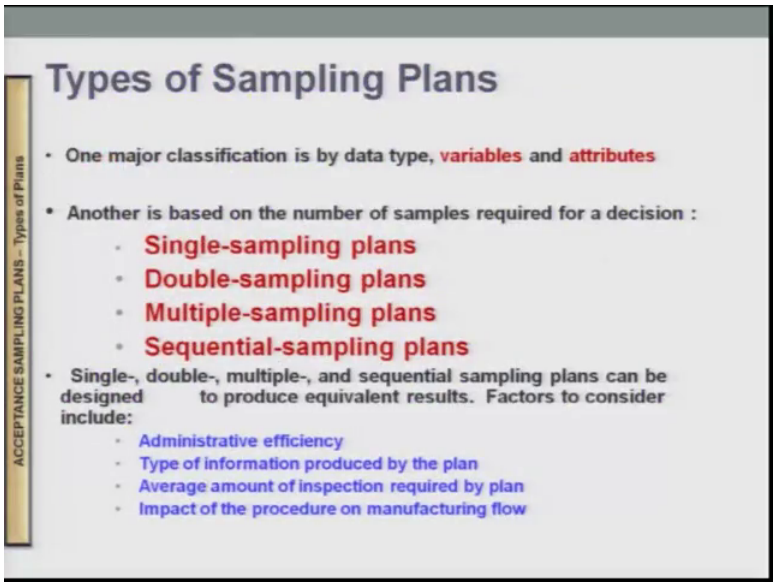

So, they would be either variables, which you can measure using quantitative variables or 2 quantitative characteristics. They would be attributes which would be more qualitative in nature; another is based on the number of samples required for our decision. So, they may be single sampling plans with a may be double sampling plans. They may be multiple sampling plans, they may be sequential sampling plans and so, on and so, forth.

So, if somebody goes into the deep depth of sequential sampling; you will understand the work done by world Abraham Wald and the different type of sampling plans, which have been given, has really spurred a huge body of literature in the area of sequential sampling in sequential analysis or inference techniques. So, single double multiple and sequential sampling plans can be designed to produce all equivalent results factors to consider include what are the administrative efficiency, what are the administrative cost, type of information produced by each and every plan, to what level of efficiency we want, the sampling information to be available to us. Say for example, if you pick up each and every observation; obviously, it will mean that will guess they get the past best possible sampling plan; that means, we are aware of the quality level of each and every product

But the flip side is on the negative side is that if you do the sampling for each and every product then the amount of cost and intertwined in the overall sampling process becomes very huge, on the other hand if you take only lots signed size of a very big number and

basically pick up only is few samples to do the testing; it will mean that the cost would definitely decrease, but the overall efficiency of trying to basically predict or forecast or find out what is the level of quality for the whole population may or not be that possible extent what we want it to be lot formation and random sampling is an important point to be considered.

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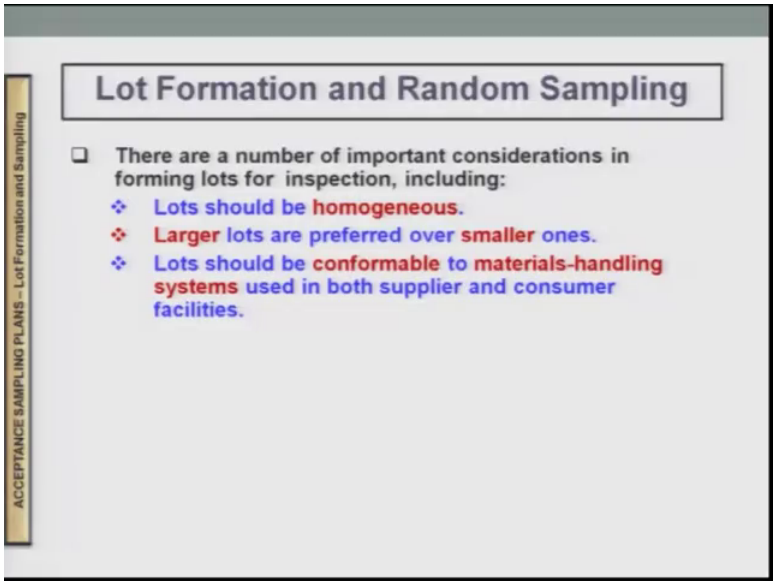

So, there are a number of important consideration in forming lots of instructions, which include lots should be homogeneous not heterogeneous. Larger lots are preferred over small lots, but; obviously, there is a flipside also, as I mentioned that more the lot size; obviously, you have to be very careful the characteristics which are portrayed by taking a larger lot sites actually give us some information of the overall population. Lots should be conformal to the material handling system, which are being used in both the suppliers and the consumer's facilities and in their respective ends.

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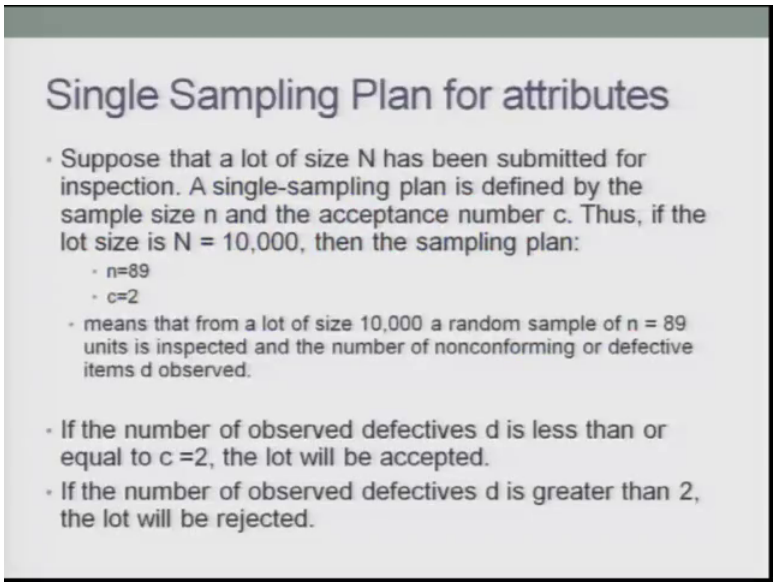

So, single sampling plan of attributes as I said symbol single double multiple sequential. So, we will just very briefly discuss the single sampling plan for attributes. Suppose that the lot of size N has been submitted for inspection. So, this N, I am considering as the big so, called population. So, in general we know that population actually size in infinite, but we see that if N is very large, it can be considered as a population and we can do the sampling based on the small, capital N which is which is as mentioned here.

A single sampling plan is divided by the defined by the sample size N and the accepted number C. So, there are three numbers one is basically the so, called no overall size of the population, which is capital N. From that we pick up a small chunk, which is small n and we basically, accept or reject that particular sample such that we have some say on whether to accept or reject or total population based on the fact that what is the accepted number see in that total sample size N. Thus, if the lot size is given as in this slide is 10,000, then the sampling plan can be that you pick up a size of 89, 89 is just arbitrary and we find we are, we have depending on the pass data, depending on the past experience. We put a number 2 to the accepted sample number C, which is 2 means that from a lot size of 1, 10,000, a random sample of n small and 18 S picked up is inspected and the number of non-conforming or defective items is observed. And if we accept or reject depending on the number C which is 2.

If the number of defects D; so, that we pick up find out of the N 89. Some number are defective if D is less than equal to C, then the lot will be accepted. If D is more than say for example, see; obviously, that lot is rejected see the number of observed defective D is greater than 2, then the lot would be rejected and we can proceed of picking up the second set of sample which is 89 or we can basically reject the overall lot depending off on the overall experience which we have from the past data.

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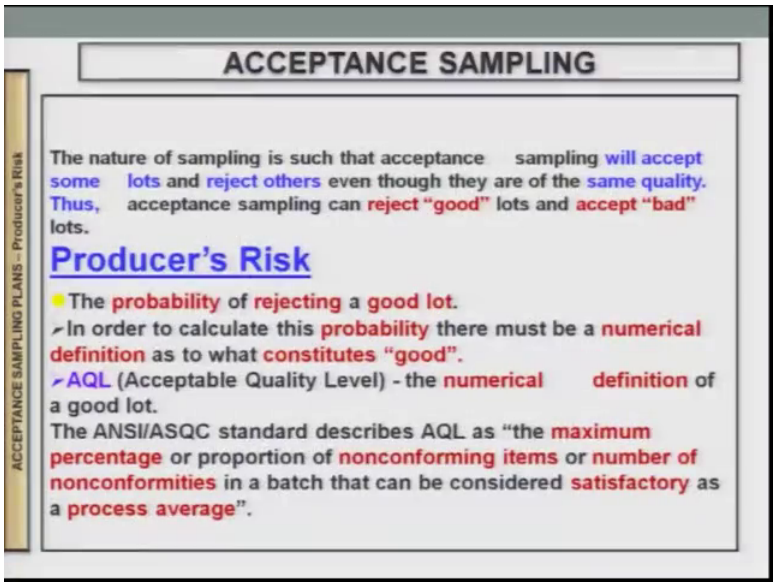

When you are doing that except a sampling then there is a concept of consumer risk and producer risk also. So, this is very important which will depend that as we increase the lot the size of N the level of. So, called confidence which we have on the producer risk and the consumer risk will change and how it changes; I will come to that discussion in a very simple terms.

The nature of sampling is such that the accepted sampling will accept some lots and reject others even though there are of the same quality so; obviously, if you pick up 89 each and every time the D number in some case may be less than 2 may be equal to 2 and in some cases may be more than 2. So, if it is less than equal to 2, we accept that if it is more than 2; obviously, we reject that. So, each time we do that that overall acceptance and rejection would change accordingly.

Thus, acceptance sampling can reject good lots and accept bad lot. So, it means that actually when you are basically picking up a set of observation the number of defects in

the overall population percentage wise. So, if you think it in a very rational form, if you are picking up 89 and if 2 or less than 2 are than total number or the percentage which is acceptable to us. So, we will say that 2 by 89, on a personal sense would also have some implication on the overall total such population and the number of defects which we have which means that in a very simple sense 2 by 89 and should be equal to the number of defects which is therefore, the overall population divided by 10,000.

So, if the total in the value which you want to find out. So, 2 by 89 is equal to say for example, X by 1 10,000, if X is basically that number which would be 2 into 10,000 divided by 89. So, we would be saying that that actual total lot of 10,000 sighs should be accepted, but it may be possible then when we pick up a size of 89, the number of defects maybe say for example, more than 2 in that case we are rejecting that lot even. Though the total number of defects in the overall. So, population of 10,000 would be less than the value which you have found out. So, what is that value as I again said, I am again repeating it would be 2 into 10,000 divided by 89.

But in other case the flip side would be; that means, in the first example which I gave; that means, we are rejecting a particular lot when the overall number of defects is not that high as per the stipulation which you have put for ourselves. In other case, it may be that the number of defects D is less than equal to 2 and we may be tempted to basically accept that over a lot,, but we find out pick up each and every observation out of the 10,000 and measure at the number of defects may be larger than the value of 2 into 10,000 by 89, which means that we are accepting a particular lot where the overall number of defects in the total not is more than what we want it to be.

So; obviously, there is a risk on both the sides in in both the cases. If we combine the risk R we are basically accepting a lot where the number of defects is much higher then we want it to be and another case the number of defects would be much lower than the one which we basically want to accept. So, in this both this cases we are facing a risk and these risk R as mentioned is reject a good lot and accept a bad lot.

So, the producer risk based on this R and the consumerist would be like this. So, let me basically further discuss the producer risk the probability of rejecting a good lot is basically the producer risc in order to calculate this probability there must be smear numerical definition to ask to what constitutes a good lot. So, what we do is that we have

a set stipulation or level which is known as the accepted quality level which is the numerical definition of a good lot. So, if the value of the overall lot is greater than or less than a EQL which is the acceptant quality level then we make a decision whether to accept or reject that particular lot.

The ANSI or a SQC standards this is the quadratic a standards may describes AO AQL as the maximum percentage or proportions of non-conforming items or number of nonconformity in a batch that can be considered satisfactory as a process average. So, if you are basically picking number lot one after time on an average. If AOQ will value is as stipulated by the ends and C and A S Q which is American statistical quality a concepts. If those values are greater than or more than those particular average we will take a decision accordingly and basically define the producers this accordingly.

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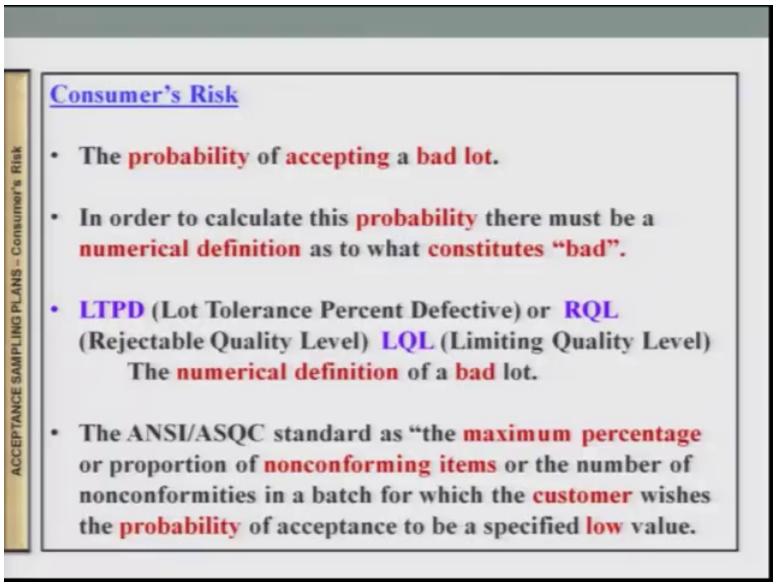

On the other hand so; obviously, there is a producer who manufactures and passes on to the customer. The customer risk and now we are going to discuss which is the other way round the probability of accepting a bad lot so; that means, that the quality of the product is bad, we should definite should have rejected that,, but that is being accepted. So, there is basically the problems on both sides of the coin in one case we accept a bad. I am a good, a bad lot and in other case we reject a good lot.

So, continuing with the consumers risk in order to calculate the probability there must be our numerical definition and that definition basically is given by lot tolerance percentage

defect of LTPD or RQL and which basically means rejectable quality level or limiting quality level. So, a numerical definition is basically of a bad lot. So, as per the ANSI and ASQC American statistical quality control norms; it basically means as the maximum percentage of proportion of non-conferring items on the number of non-community in the batch for which the customer wishes the probability of acceptance to be specified into a low value.

So, in all both the cases they would be risk and this risk, we will see later on and somebody would have studied the concept of hypothesis testing. They are basically the concept of level of risk which are given by alpha and beta; that means some good items. We are rejecting some bad items, we are basically accepting.

Now, based on this level of alpha and beta which is the producer risk and the consumer risk will basically have the operating characteristic curve. So, operating characteristic curves will depend on the sample size. We depend on the capital value of N which will depend on say for example, the value of C and all these things depending on the distribution which is there so; obviously, they would be underlying distribution for the products which are being sampled. So, it can be the discrete distribution, continuous distribution, exponential distribution, normal distribution then all this distribution would be there. So, how would you basically have OC curves based on the level of producer risk and consumer risk would basically be specified for each and every example as per the ANSI and ASQC norms.

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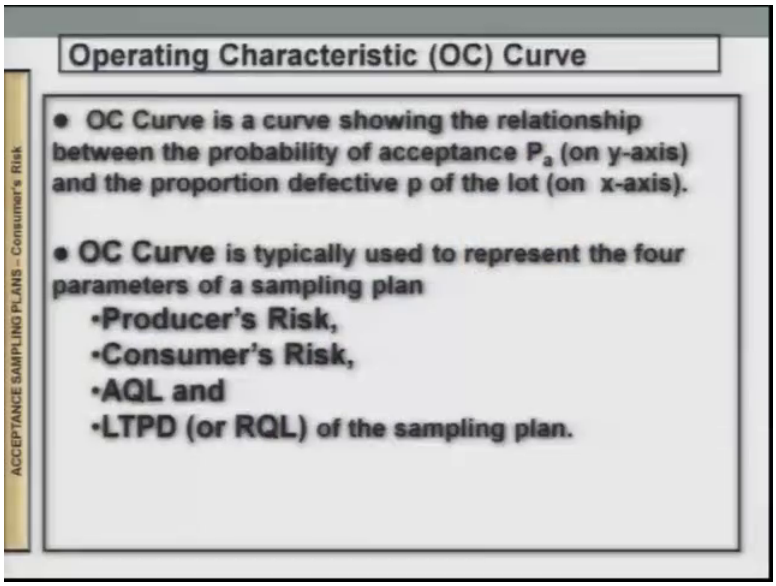

The OC curve is a curve showing the relationship between the probability of acceptance which is basically measure along the Y axis and the proportion defective P on the lot on the X axis. So, you will basically measure the proportion defective along the X axis and the probability of acceptance along the on the Y axis. So, both these things would also entail that as I mentioned the capital N, small n c values will also be considered in such a way that for different curves you will have different values of N C and small n or else to put in other words for different values of capital N small n and small c. You will have different curves, which can be plotted along the X and Y axis where X and Y as I have already mentioned basically means there a proportion or defect along the X axis and probability of acceptance along the Y axis.

OC curves are used to reverse represent the four parameters which is the producer risk, the consumer risk which we will see are some combinations of alpha and beta. If you consider the hypothesis testing concept the AQL which I just mentioned and the LPDE LTPD which is the RQL for the SAM sampling plan both from the producers point of view and the consumers point of view.

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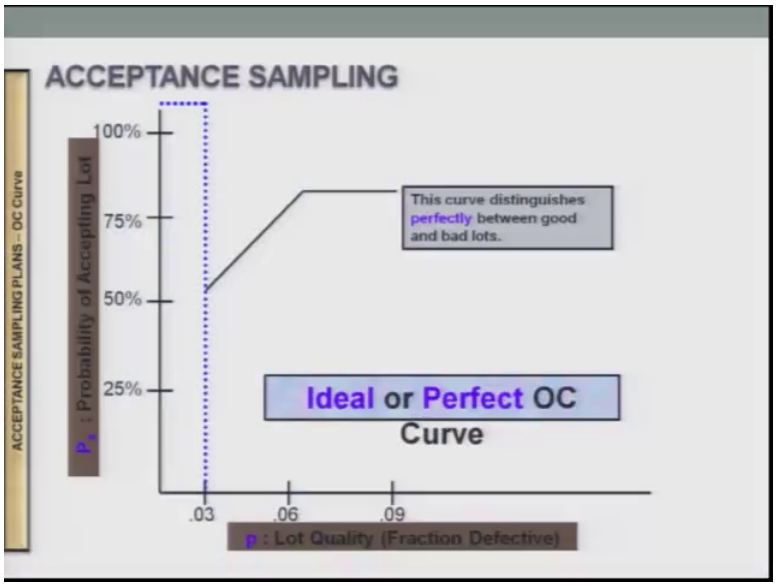

So, the ideal plot for the acceptance sampling would definitely be not a curve basically it will be a curve which is basically moves vertically up and then its go straights. So, if you see the probability of acceptance are being measured along the Y axis. So, they are basically measured from 0 to 100 and along the X axis. We have the lot pro quality for our fraction or defective which basically can be from 0 to 100.

So, basically between a scale of 0 to 1 on a probability scale or 0 to 1, on a probability scale on the Y axis basically, you will have that curve which would basically give you the information. So, this curves distribution between the perfectly between the good and the bad items. So, what you have is if you follow my mind, my finger. So, generally the curve would basically go like this. So, it will be S curve and the inclination and the way the S curve have been drawn would basically depend on the level of alpha and beta and the produces risk and the consumer risk.

So, S which I am denoting maybe flipped on the Y axis depending on how you have been able to portray the level of lots quality and the level of probability along the Y axis and the first point of the lot quality along the X axis. So, this is the idol of the perfect operating characteristics curve.

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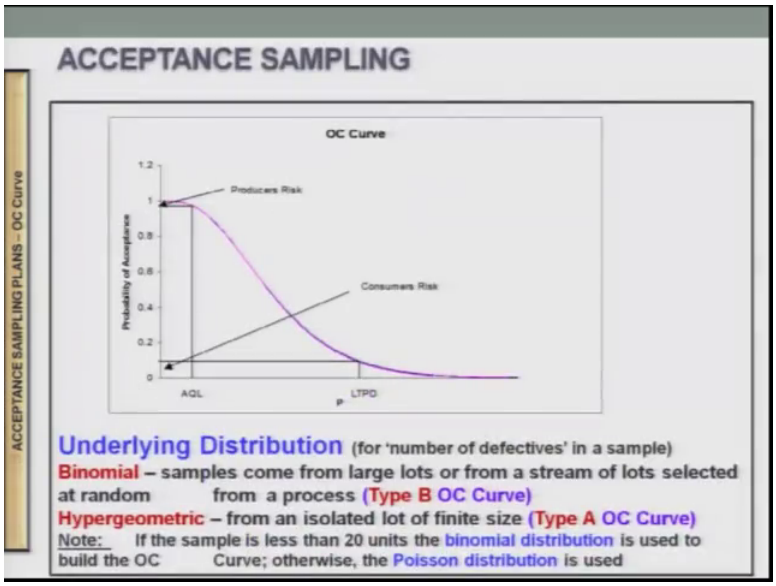

So, the generally the operating characteristics curves for a general motion would be the pink line which shows the OC curves and what is important for you for all of us to note is that the AQL or the LTPD, the values which have been mentioned by that from the point of view of the customers and the producers are marked in such a way that they will give you the level of such risk which both the parties are able to sustain without compromising on the CO overall quality of the lot.

So; obviously, if I accept the bad lot its problem for me and in on the other case, if say for example, I reject a good lot is a problem for the customers. So, customers this from the person who am I, I am taking the products or not, to whom I am selling the products. So; obviously, a compromise has to make made. So, the level of compromise would be based on the producers risk and the consumer risk which would be basically, we denote by alpha and beta and the values of AQN and LP LTBD.

So, the underlying distribution 4 numbers are defective in a sample considering binomial distributions samples come from a large lot, where you can either reject on accept. So, that type of curve would be known as the OC curves or type B and for the hyper geometric distribution, where you have a huge population. Those would be known as type a OC curves. So, if the sample size is less than 20 units, then the binomial distribution will be hold and otherwise the Poisson distribution will be utilize, I will

discuss these in more details as we continue the discussion in the 16th lecture and further one have a nice day.

Thank you very much.