Six Sigma
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Lecture No. # 18
Acceptance Sampling

Good afternoon, we begin today we continue with our session on Six Sigma and the particular topic that I will be discussing today.

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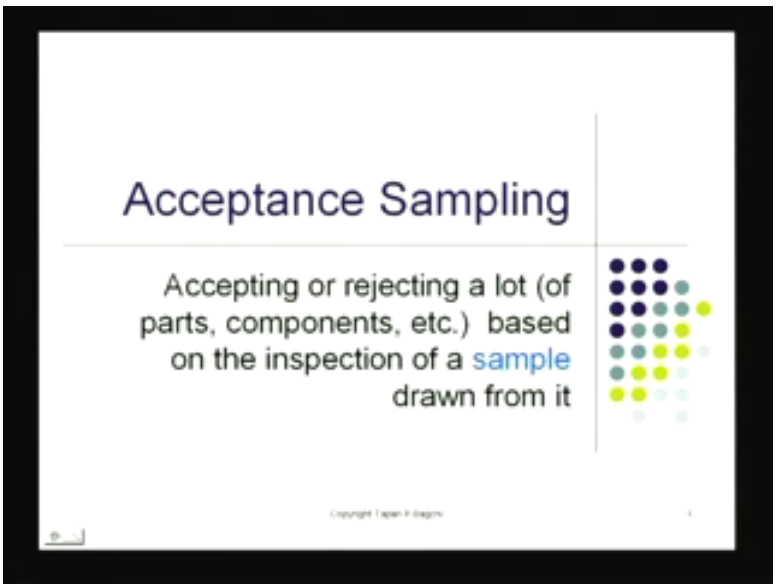

There are three lectures to be given today. These cover the area of acceptance sampling. This is one area where basically, the process that you are trying to utilize is how to sentence a lot. Let us say you are a supplier, and you have supplied a truckload of items to a particular company, and this factory is received your goods. Now they have to decide whether to inspect all the items that are on the truck; or should they just take a sample out of that truck. And on the basis of that, decide whether to accept the truck for their production or they should reject it and return it to you; this is to be based on a sample that is drawn from that truck.

The idea of acceptance sampling came along, when it was realized that many times goods are received in large lots; and it is almost impossible to inspect each and every part that is part of the lot, that is actually generally not possible.

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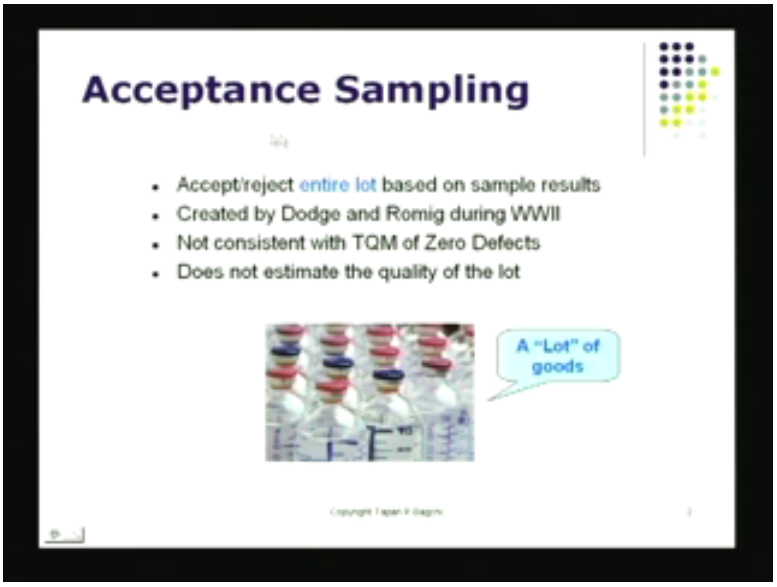

So, if you look at for example, I have here in the slides I have got a bunch of bottles, and these bottles have been figured out, they have been filled with some liquid, and we want to make sure that there is enough liquid that is within these specification that has been given out for the amount of liquid to be there in these bottles. In a manner in such a way that we are able to accept the lot, there is sufficient amount of liquid in each of these bottles on an average basis.

Now, if some particular bottle turns out to be containing less liquid, it will be the process of filling the liquid in these bottles is going to be then a defective one and the lot itself also will be a defective lot. So, in fact what we will be trying to do is we have this large lot we have this large lot that has been supplied to us. And instead of inspecting each and every bottle that is here, we would probably take a few samples out of this; and the on the basis of the inspecting the quantity of liquid in that bottle in those bottles in the within the sample we will decide whether to accept the lot or to reject it.

This procedure actually was created around world war II, when the military became the largest consumer of any kind of goods, that was supplied to the military, civilians certainly did not consume as many things but the military in large quantity they they obtain various types supplies and they wanted to make sure they had a procedure in their place.

So, that they could just basically, order order a lot but inspect only a part of that lot, which would be called the sample and on the basis of the fate of that sample they would decide, whether to accept the lot or to reject the lot back to the supplier. This procedure by the way because it does not inspect all the items it cannot guarantee zero defects, there will be a few items, that might sneak in, because you are really not inspecting all the items each and every one of them you are not inspecting.

Therefore, this procedure the acceptance sampling procedure is not consistent, with the objective of zero zero defect, that is something you got to remember, also the other thing we have to remember is acceptance sampling, this procedure this procedure that we are using does not actually give us much idea about the filling process about the production process, it does not do that it, basically talks about the quality of that lot, the overall quality of the lot itself.

And that is it says nothing about it will give you no hint, as to what is the quality of this supplies that you are receiving, on a overall basis and what is the production process is like, that also you will, have no idea about because you are doing it all the on the basis of just a few samples that you draw out of a particular lot.

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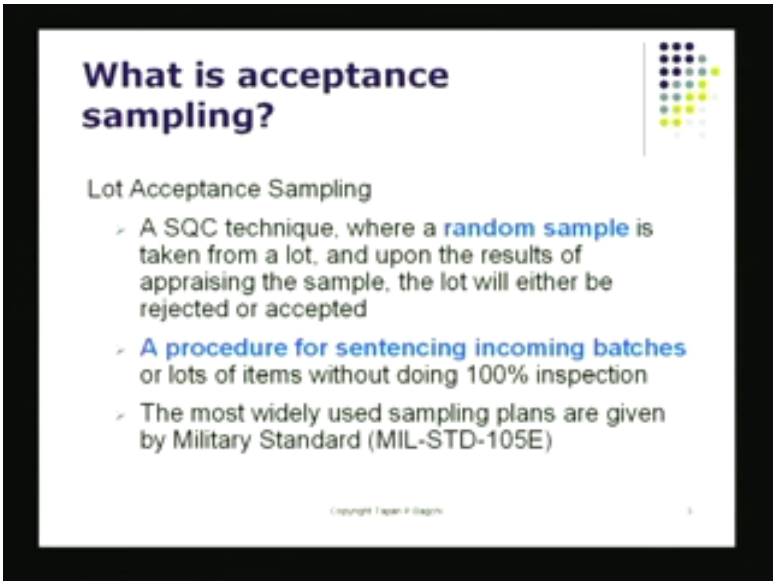

This sample that you draw it has to be random sample, it cannot be a sample that is selected by looking at for example, the bottles that are nearest to you or the parts that are easy to get from their full lot, is not to be done that way.

And also it say process it is a procedure that will decide sentencing the lots, these are incoming lots they are arriving perhaps by trucks or they may arrive in large boxes, boxes of transistors or boxes of certain electric bulbs or something like that or it could even maybe boxes of these pencils containing these pencils, we are not going to inspect all of them, we are just going to take a few samples.

So, I will take a few samples out of them and on the basis of the inspecting this sample we will decide whether to accept, that full lot that I have or to reject the lot, that is what the idea is; one of the most widely used sampling plans is provided by the military and that is called the MIL-STD-1O5E that is a sampling plan, that is utilized by the military. And it basically talks about talks about sampling the lot and then basis on the basis of some rules which are provided by the MIL-STD-1O5E plan, sentence the lot to be acceptable or not acceptable.

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What exactly is this business of acceptance sampling, the purposes are to fold first of all, we determine the quality level of an incoming shipment that is what we try to do by doing acceptance sampling. And also we try to determine whether the quality level of the part that has been parts, that has been supplied in the lot, whether it is within an acceptable level, acceptable quality level and again like I told you earlier it is not really possible for me to many make any statement for what process is producing those items that is not the objective of acceptance sampling.

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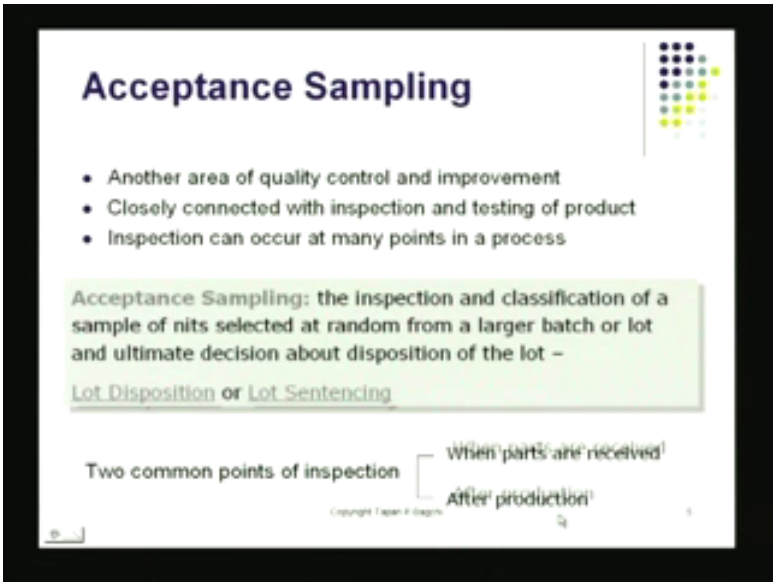

Now, acceptance sampling if you really look at what is this, it is a statistical procedure it is another the area of quality control and quality improvement it is closely connected with inspection on services and testing services. And inspection can actually occur many at many points in the process for example, when you got incoming parts, when you got parts which is just arriving, from a supplier you could inspect it before it enters your shop.

And after you have done your production then perhaps, when you are making shipments, then again at that you could do an inspection to make sure that the parts, that is supplied to your customer those are acceptable quality. So, in fact two two places you could do inspection, you could do you could do acceptance sampling, one is when the parts are received and the second point where you could also do your inspection and apply the acceptance sampling principles is after production to make sure, what ship out is within the acceptable quality level.

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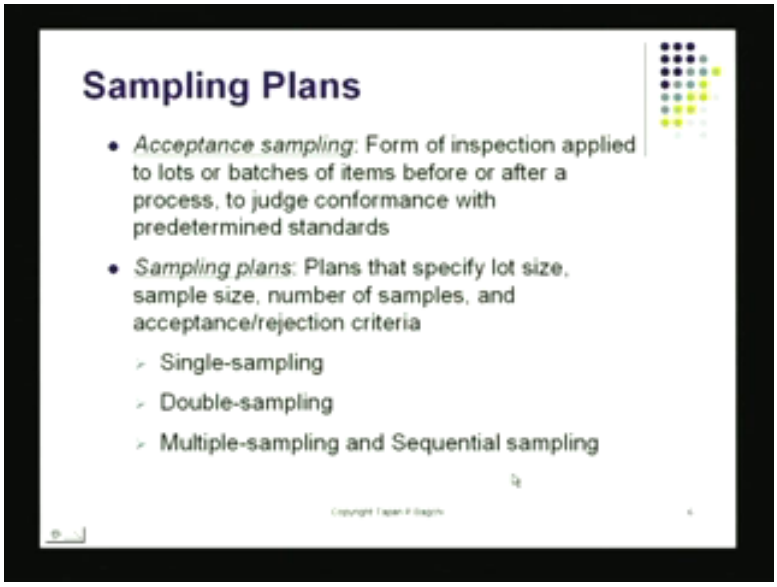

There are various type of acceptance sampling plans available and broadly speaking, there are three types of plans, that are utilized, one is called the single-sampling plan, the second one is double-sampling, then you have got multiple-sampling or sequential sampling and I should just tell you that, all of this is based on inspection of the limited amount of products that you pick up.

So, I from the lot I just picked up a small sample and on the basis of the results of inspecting this small sample here, I will decide the fate of the full part, the full lot that has been supplied to me. So, really it it depends on the performance or the quality level of these two parts or the three parts that are in the sample, I am going to be deciding the fate of the full lot, based on the fate of based on the performance of these two sample items, that is what I am going to be doing.

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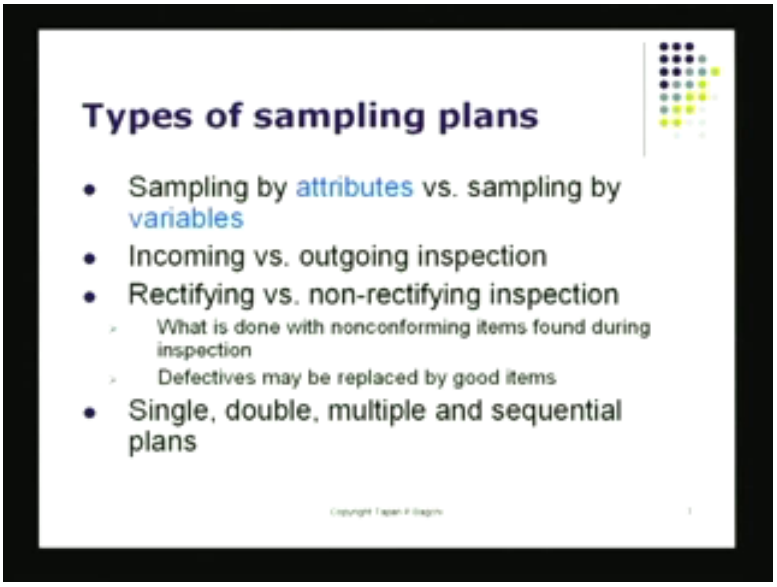

There are now couples of types of approaches to this, one is to look at the attribute of a particular item and this is like a quality attribute, that can be classified as acceptable or not acceptable for example, a pen may write or it may not be able to write. So, it is good or bad that is an attribute witting quality, writing performances an attribute which can be sorted between good and bad.

So, in fact that is like one way to try to do your inspection, the other way is to look at the dimension of for example, look at some quantity they can measure as far as the this particular pen is concern, will be certain items here, certain characteristics that I should be able to measure, such as dimensions, such as a viscosity and so on and so forth. Many of these characteristics they can be measured.

These are different now from attributes attributes are either good or bad and whereas, a whether whereas, a quality characteristic that can be measured on a scale, that is a variable sampling plans can be used both to check quality, when the quality characteristic is an attribute and also sampling plans can be applied in situations, when the quality characteristic is a variable quantity.

The approaches are different, the two approaches they are different but essentially in all of these cases, you are looking at a full lot and from that you have picked up a few samples and based on the performance of these samples, you are then going to decide, whether to accept the full lot or to reject it back to the supplier.

There is a there is another fate of course, that the rejected lots can be subjected to suppose, you have rejected a particular lot, it is very possible that you might like to carry on with your own production. You are the user of these parts it is very possible, you would like to carry on with your production what you would like to do is you will look at the full lot, now this lot is now the candidate for rejection.

So, I have got this part these parts are there they make this lot, this full lot and this lot of course, is such that the some of these are defectives some of these are, what I would like to do is I would like to continue using these parts I would like to continue using these parts. Now, obviously I cannot use the defective parts, I cannot really use a defective part and put that in my production, I cannot do that, so one way to tackle this this lot, that has been, let us say rejected is to remove the defective part.

And substitute that with a good part if I do that I still have a handful of usable parts and these are the parts that I can put into my production and carry on with my production, I am the user. Now this determines one disposition of the part or the alternative is, you reject the whole lot and let the supplier figure out what to do with the defective part, now if I am if I decide that, yes there is a there is a lot that is to be rejected, I can then inspect a lot 100 percent.

And remove of all the defective items from it and substitute for them good parts if I do that, then of course, I end up with a handful of good parts with me that is the lot, that has been rectified it is been the defective parts, have been removed from it this lot, I can then put into my production, I can carry on with my production. And this mode of acceptance sampling is called rectifying sampling, I have rectified the defect I have removed the defect and I have substituted that with the good defect, now this has a good good part.

Now this of course, requires me to have a handful of handful of good parts with me, I should not, I should have these in reserved, just in case I find a few defective parts in the lot, I should be able to remove that defective part. And I should be able to reserve from I reserve draw these good parts and put them in place of the defective items and carry on with production, that is something I should be able to do.

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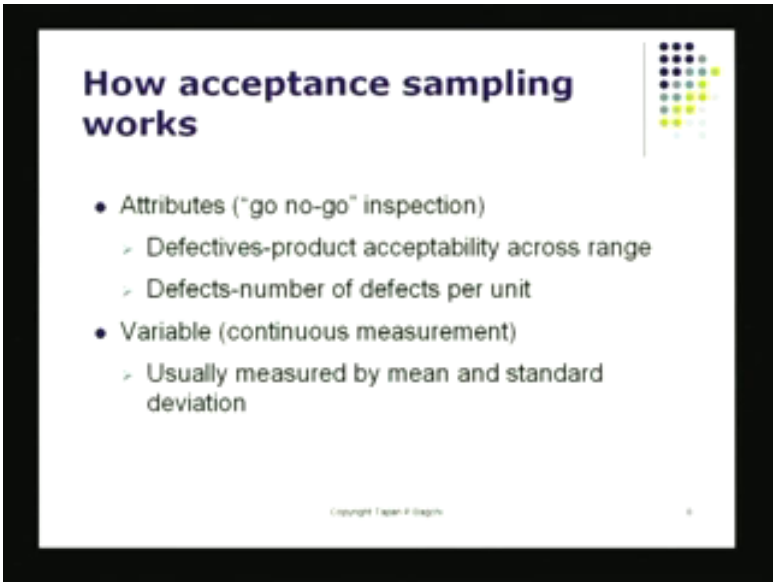

Attributes as I mentioned to you, attributes are measured on a go no-go basis, they are they are just on a go no-go basis and variables actually, they can be measured on a dimension. So I for example, I could have a I could have a measurement device and on that measurement device, I could I could on this scale, I could measure the quality characteristics, if it is dimension; I can set apply the scale there and I can actually find out what is the right length is the is the length right, is the length if it is not of course, then of course, I do that.

So, what I am doing is I am measuring the characteristic, which in this case turns out to be the length of the of the bar, that I have there the length of the bar and I measure that using my scale. In this case, I have got a variable characteristic and I am measuring with a measuring device, this can also be done during inspection, in fact this is like one way, to inspect a variable characteristic a variable characteristic here, is the dimension of the part that, can be measured with a particular gage that could be done.

So, there are two ways, now to evaluate characteristics, one is to apply a go no-go gage and this is how I evaluate attributes, which are basically they can be classified into into an acceptable quality level or a rejection, reject able quality level and this is like on a this is done on a go no-go basis on the other hand, I could also have dimensions and those dimensions can be measured using a scale and then I could really have a variable characteristic, that can be measured by using a gage, the scale here is a gage that can measure that attribute.

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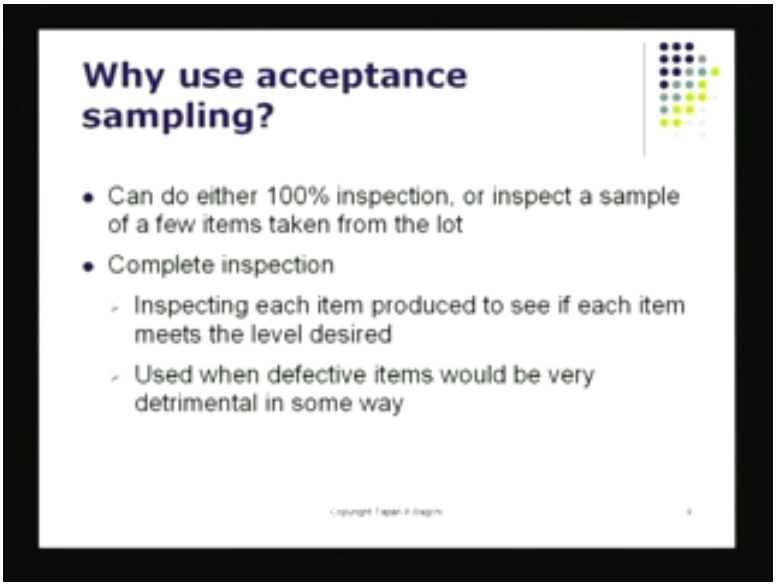

Why do not we use 100 percent inspection, why do we have to draw a sample and so on and so forth? Well, there are couples of reasons; one reason is if you try to do 100 percent inspection, you are going to be inspecting a whole lot of items. And there were couple of things that can go wrong, if you actually try to inspect all the items a, it is going to cost you a lot of money and b it is also very possible, that you will make some mistakes if you are trying to do a 100 percent inspection, you might make some mistakes and inspection itself.

So in fact, that is like these are couple of reasons, why one should not try to attempt one 100 percent inspection, except for critical characteristics that for example, if there is a electrical component, if there is electrical component, if there is some chance of this guy having a critical defect, if it can give a shock to the user; then of course, I have got to inspect 100 percent of these items. So, unless the characteristic is critical, I can generally do what we call inspection on a selected basis based on a sample that we could do quite easily.

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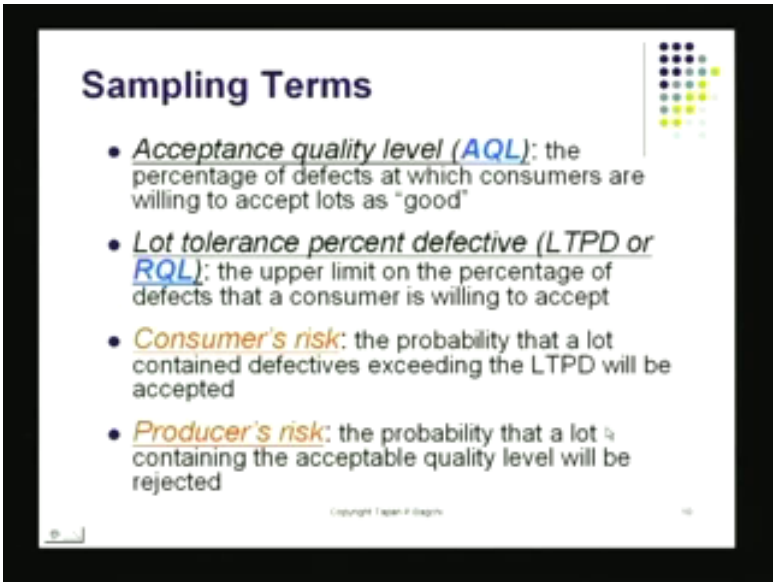

It is also possible that when I do my inspection, it is quite possible when I do my inspection, I am not able to really decide whether to accept the lot or to reject the lot, if I have no basis to compare, that quality to something. So, you got to have benchmark quality levels, what am I talking about, I have here some terms which I used in sampling for example, there is something called AQL which is the Acceptable Quality Level; acceptable quality level is that level of quality, that I am willing to live with I as a user.

It is generally expressed in percent level and generally speaking, AQL the quality level of a lot which is at AQL level, it is alright for me to bring this into my shop and to start using those parts, which are at the AQL level on the average basis. but then it is very possible that the lot that, I receive is at this level which is the RQL level Rejection Quality Level.

Now, this is the distinction between the two which is AQL and RQL is the following, a lot quality which is at AQL level is good enough for me to carry on with my routine production, yes there will be a few defectives there but I am willing to live with that, because I am not doing 100 percent inspection. And I am really banking everything on the basis of the acceptance sampling plan, that are put in place and I am going to be going along with that, yes I do end up with a few defective parts, in my production but I remove them or I do some rectification and so on and so forth; and I will live with them.

On the other hand RQL, the rejection quality is a defect level and overall defect level in the lot, which is not acceptable to me at all; in fact, it may be very possible that if I receive a lot which is RQL level, my production system is going to be interrupted very very often, very often, very frequently and that means, I will have production downtime. Now, what I have gained here, I have really gained not much I have really lost a lot, I am going to be losing some real production time, because I have got a whole bunch of defective parts in the lot that I have received.

So, generally speaking, what users would like to do is, they would like to receive parts as many lots as possible at the AQL level; and they should try to reject as many as many lots as possible, that arrive at the RQL level. In between of course, there is something that is called the probability of acceptance and we are going to be looking into this, as we go into our further further down in this study there.

Let us, take a look at couple of other things, one is suppose my parts have been received, suppose my lot has been received at the RQL level, which is also called LTPD Lot Tolerance Percent Defective; now this is certainly the rejection quality level this is the RQL level. Now, because I am not doing 100 percent inspection, I am inspecting just a few parts out of the full lot, that has been submitted, all I am inspecting is just handful of items, I am just inspecting a small sample that is been drawn out of the full lot.

I am taking some risk, the risk to the consumer the user is that a few parts even if this sample looks, when I look at the full lot it is very possible, that a full lot might contain a few more defectives, which will then sneak in because, I am sentencing the lot I am sentencing the fate of the lot based on the results of inspecting just a few items. Now this is something, that is actually exposing me to some kind of risk and this risk is called the consumer's risk, I am the consumer I expose myself to this risk, the moment I do sampling, I expose myself to be accepting some lots which are really not quite at AQL level but they are worse they they have worse quality level, that is actually consumers loss.

Now, because I am doing sampling again and I decide the fate of the lot based on just a few handful of items and these are in the sample, it is very possible that this particular sample ends up having more than it is proportionate share of defective items, it is very possible. So, like here I have got five items and and one of them turns out to be defective

if there is one defective out of five items, that is a pretty high level of defectives but this could just be due to a chance.

Now, what will I do my rule, my sampling rule is going to tell me the moment you find one defective item in five that you have sample, reject the full lot; now the overall quality of the lot maybe pretty good but by chance I ended up with this one defective item in my sample, that is actually pretty bad news for this supplier, because the supplier says well I understand you are not doing, you are not doing 100 percent inspection.

But, the way you have set up your sampling plan you end up, sometimes you end up looking at perhaps by chance, defective items in the lot that you have, in the in the sample that you have and you reject my lot my lot. Otherwise has good quality but because of your sampling procedure, I this supplier or I the producer of those parts, I end up getting subjected to some risk and this is actually the producer's risk or the or basically the supplier's risk.

So, there are two types of risk here involve, as I show on the slide here, there is the consumer's risk which is like the probability that the lot contain containing defectives exceed the rejection quality level and still it turns out, that I end up accepting this lot it is very possible. On the other hand there is this this other item this other types of risk all the other type of risk called the procedure's risk, this is the probability that a lot containing and acceptable quality level will be rejected.

Now, these two risk are there because I am not inspecting everything, these two rejects have there because I am not doing one 100 inspection, if I did 100 inspection, I will know the exact quality I would know the exact quality of that lot therefore, there is no question of any kind of risk being subjected to one party the other.

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Why not do 100 percent inspection? If you know all this why do not we do 100 percent inspection, couple of reasons are there, one is generally speaking 100 percent inspection will mean for example, if I received all these pens, these have arrived in a lot. And all these pens they have arrived, then they could be like, you know a box could contain 200 such pens they have been brought in for the office. I have got all of them in a box if I do 100 percent inspection, I will have to inspect each of those pens that is a lot of inspection that is a lot of time spent on inspecting only.

So, that is like one reason, why this kind of deal which is like 100 percent inspection if it turn out to be something that is rather expensive, it is also a very possible that in the process of inspecting, I destroy the product, many times if you trying to inspecting something you end up destroying the product if I. If you trying to detect the strength of this for example, you might destroy it and that means, you are losing one good part, one one descent part which was otherwise quite useable, they are going to be losing that.

So, this is also one of the reason why you should not do 100 percent inspection, then when inspectors are handling these things, they may unnecessarily they may induce some new defects it is also very possible, that if you are trying to inspect something your your process I mean inspecting itself may make the item, may may may render the item defective, that is also possible also it is a very tedious job. Say if I have to got all these items to inspect I have got a couple of hours and I have got all these different items and I must inspect all of them my god that is pretty tedious tedious job.

So, it is very possible I may may go little (( )) if I have to inspect lot of lot items, say if I am using if I going to be using 100 percent inspection scheme, my job may become very tedious, I may get tired, I may make errors and so on and so forth. These are the different reasons, why doing 100 percent inspection is not the way, we should be doing on the inspection.

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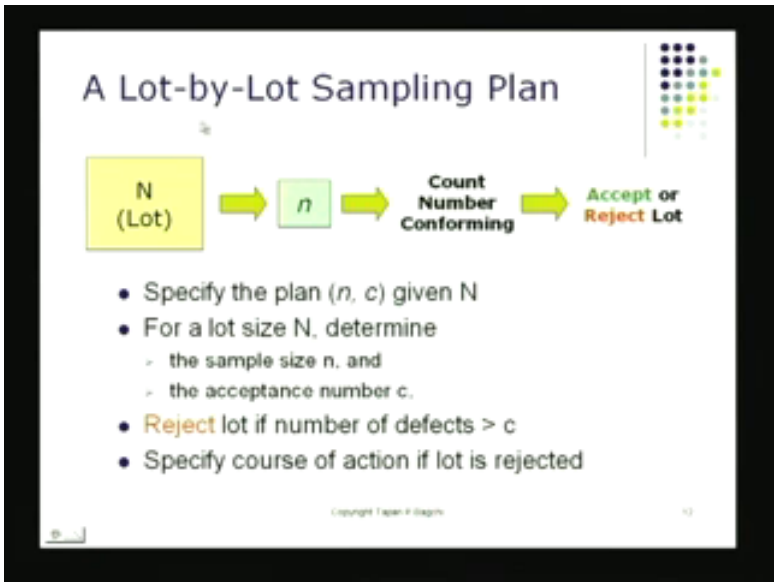

Let us, take a look at mechanics of Lot-by-Lot inspection sampling, I have the lot which is this yellow box here, that is the lot that I have received, I draw out of this n items and this little n items is basically my sample. My sampling plan tells me to pick n items and inspect them all; so they the sample itself is 100 percent inspected, so out of the big lot which comprised big N items, I pick pick small n items I inspect them all and then there is a control number this c, c is control number.

If the number of defectives in these N items exceed see, I will reject this lot and if the number of defectives in this in this sample here, if it goes only up to c but no more I will accept the lot. And then of course, I have I the movement, I have my sample with me I do I will count the number of conformer items which are like good items; and on the basis of how many items I find to be defective, I will either accept the lot or reject the lot.

So, again to go over the procedure again I received the full lot which is of size N, I draw a sample of n items sort of it, I have a little rule here which says if the number of

defective items which are found by 100 inspection of this sample, if that the number of defects if it exceed c, I will reject the lot.

Otherwise, I will accept the lot that is the sampling screen there, so in fact that is what is written out here in the in the statement that is down below here, specify the plan for a lot of size N, find little n which is the size of your sample find the accepted number of the control number which is c do 100 percent inspection of this sample. And reject the lot, reject this full lot, if the number of defects found in the sample exceed c, otherwise accept the lot this is the process, the that will be repeated over and over every time a lot of size is n submitted.

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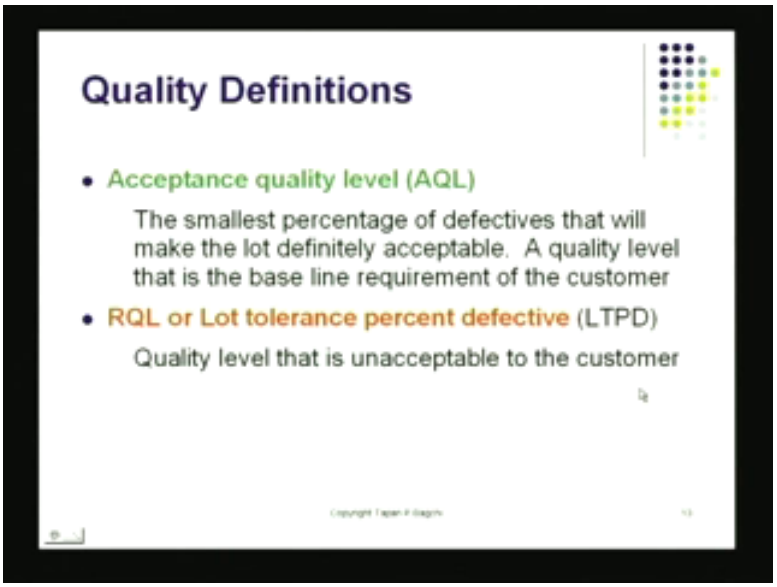

Now, again to basically define this quantity is there AQL is there is acceptance quality level, it is the smallest percent of defectives that will make the lot definitely acceptable, I can live with, I can live within the long term, I can live with the AQL level of defects in the lot that I could that; so basically if this is the baseline requirement for the customer, of the user.

Now, RQL is which is also called lot tolerance percent defective or LTPD this is the quality level, that is unacceptable to the customer, in any of one lot arrives and it process inspection, process the acceptance sampling process and it gets into the customer shop, that is going to be bad news. It is going to cause perhaps a lot of production interruption and so on and so forth; this is not something that the customer is willing to live.

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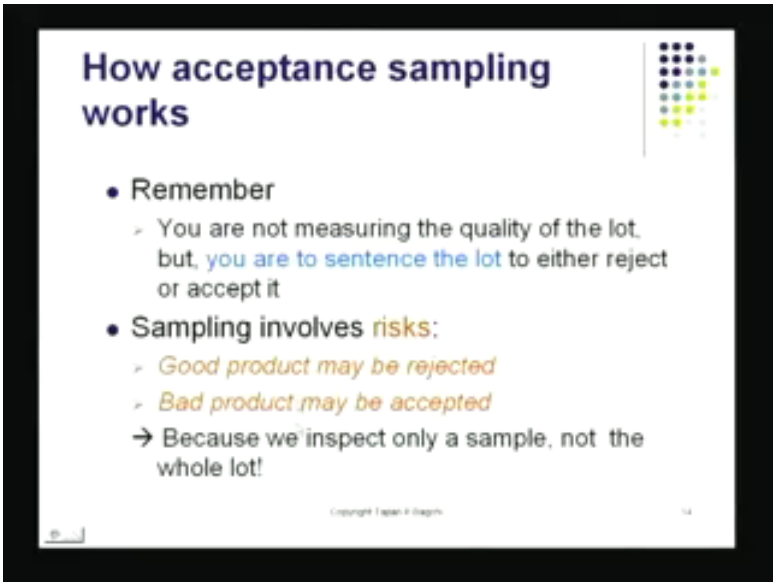

With say in fact what you have to remember now is that, I am sentencing the lot sentencing basically is basically says decide to accept it or to reject the lot return it to the supplier, based on whatever I see in the sample. The two risks which are involved here, because I am not doing 100 percent inspection I am basing my decision based on samples only, the sample that I draw and they are of size little n a good good lot may be rejected that also possible that is very possible.

And also a bad product a bad product, lot may be accepted these are the two types of risks which are there, a good lot may be rejected which is still only at AQL level of defects and a bad lot which is generally at near the RQL level, it may be accepted. And these two risk are there, because I am not doing 100 percent inspection, banking on the on the, basically the item that have come in the sample that I have got, on the basis of the quality of the sample that I pick pick from that big lot there, I am deciding the fate of that big lot that is there, either to accept it or to reject it.

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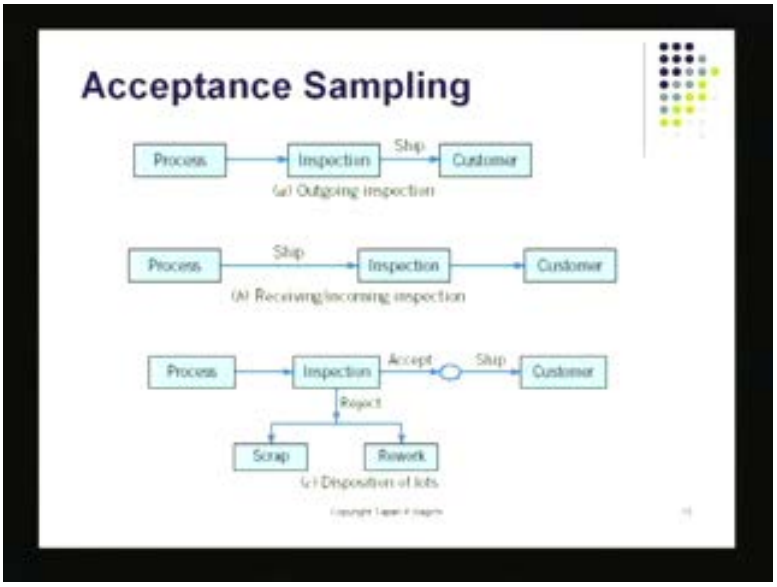

Now, where I do use acceptance sampling, I show of you process is here, the first process is I have got the production process, then I do inspection, at this stage I could do acceptance sampling this is called outgoing inspection. And whatever lots pass the outgoing inspection those are ship to the customer, this is like one particular process, then I process the products, process the items and I ship them to my customer and before the customer accepts it he does his inspection, this is called receiving or incoming inspection that is what the customer is doing.

My shipment took place here and the lot has arrived at the customer doorstep he does this inspection by using some acceptance sampling plan, then of course, there is the third process procedure which is available. I supply the parts and the customer does inspection by applying some sort of acceptance sampling plan, he accepts certain lots which he uses up but he reject also it is very possible he will reject certain lots. The rejected lots can either be scrapped or they may rework or they may rectify, they may rectify that particular lot and accept it. So, these are the different approaches, these are the various uses of the acceptance sampling, which are use by industry.

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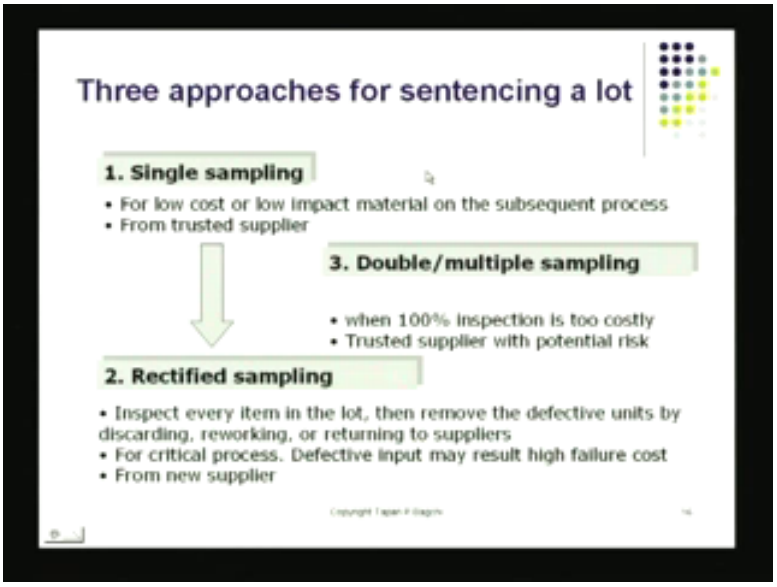

What are the different methods I could use, I could start with something that is called single-sampling, which really basically says as it show shows on the slide here, I draw just one sample I just draw one sample out of the lot. And based on the inspection of that one sample I either reject the lot or I accept the lot, all what I could do is, I could draw one sample do some inspection perhaps I cannot decide whether to accept the lot or to reject the lot.

And in that case, I draw a second sample and on the basis of the combine results of the first sample and the second sample, I decide whether to accept the lot or to reject the lot this is called double-sampling. If you generalized that you can go to multiple-sampling or you could even go to sequential sampling, that you could quite easily; then there is another approach, which is use sometimes combine with combine with the single-sampling plan that is called rectified sampling.

What we do there, is I look at the rejected lots, I have got now a production (( )) that is running and it is dependent on the suppliers parts, that I have a right and I have to keep my production plan going I have I have got to be make sure that my production keeps going. I have received this lot unfortunately the lot has been rejected by my acceptance sampling scheme; perhaps I use the single-sampling plan I have reject particular lot.

So, I have got a full lot here, I have got huge lot there that has been rejected, because there are the few defective items there. So, the few defective items in that lot there, what

I do is I take this reject lot, the two two possibilities here, one is I return this full lot the reject lot to the supplier I could do that that is like one way but that might stop my production, that might that might stop the supply of parts to my production shop.

So, this is something I have perhaps would like to avoid, what I would like to is I (( )) rejected lot to 100 percent inspection and I remove all the defective items and in place of that I substitute some good items, good parts and I accept the lot, I pass it on to production.

This what I done is I kept my production system going and I have also remove the defective items, I have remove the defective items from it. So I have got what I have got with me is basically 100 percent inspected lot, that really does not have any defect at all this is like one other way, this method for doing for applying, you are acceptance sampling is called rectified sampling, I am rectifying the defective lot that is there.

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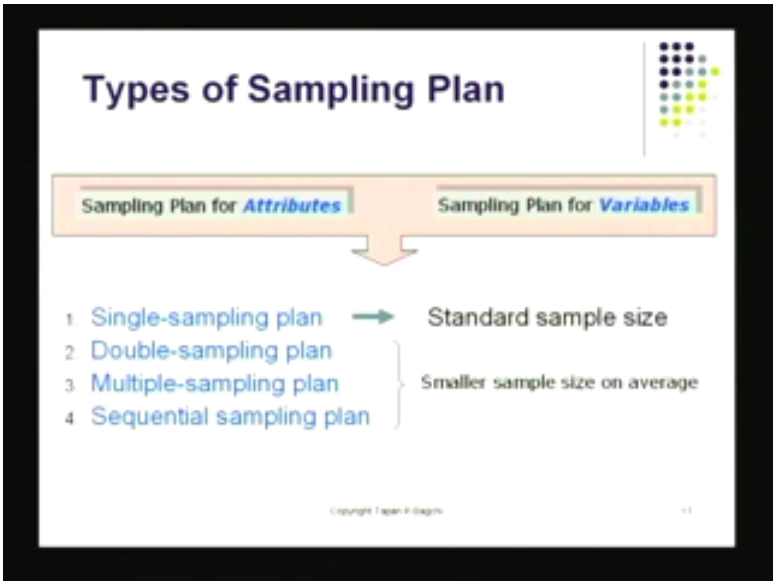

So, I have got now two different ways to summarize this, I can do my sampling based on attributes these are quality attributes, quality characteristic that can be classified between as good or bad this is like one way. When I am looking at attributes I do it either by I do inspection of course, and I sort items out between good items and bad items. And I do that based on some quality quality characteristic that I that I really call an attribute of that particular item.

On the other hand I could basically measure some quality characteristic of the incoming items and those would be the movement I am applying a measurement. The movement I am applying a measurement to the device, I am using some sort of gage and I am trying to measure the at length or diameter or something, the movement I am trying to do that, I am looking at a variable characteristic, I am looking at variable characteristic, sampling can be done both using what I called the attribute sampling basis and also the variable sampling basis both can be done.

And how I am going to be doing my inspection, I could apply the single-sampling approach, I could apply the double-sampling approach, I could apply the multiple-sampling approach or the sequential sampling approach. I am going to give some details on these, also I am going to show you how to design these plans, given your AQL, RQL that is acceptable quality level, rejection quality level and the consumer's risk and the producer's risk.

How do I combine all this information and come up with an acceptable, acceptance sampling scheme which could be double double-sampling plan or a single-sampling plan or perhaps a sequential sampling plan, we are going to discuss that as we move along in this lecture there.

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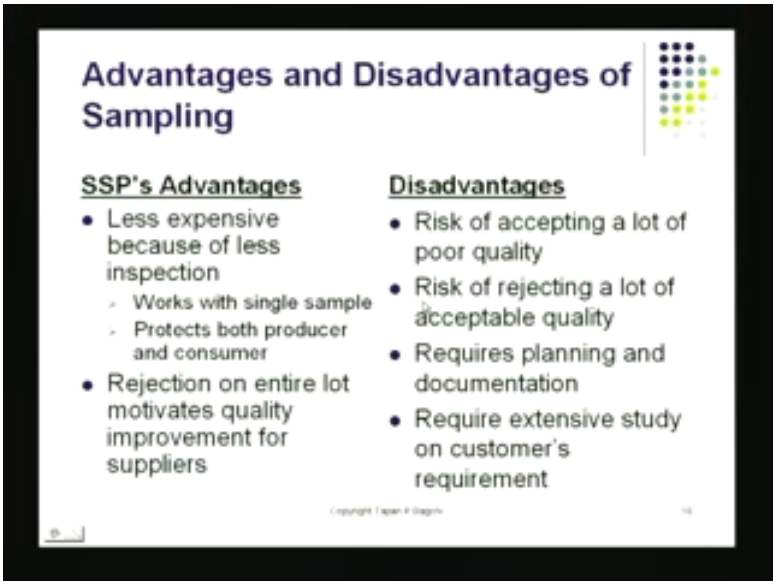

What are some of the advantages of the single-sampling plan clearly, because the sample size is small, sample size is just one sample actually it turns out to be less expensive and

I am doing sampling only once. So, it is less less expensive and there is less inspection involve and it works with single sample only, a single sample that means I just pick, I reach into the lot and I grab only one sample out of it, that is a single sample.

It is very possible that I could also use double-sampling, which is I use my first sample then I reach back into the lot and I draw another sample and then I look at the fate of the first sample; and I look at the fate of combine that with the fate of second sample. Find out how many defective there are in the first sample and in the second sample, then apply some decision rule which will tell me, whether I should accept the full lot or should reject.

This single-sampling plan comes up with a simple rule, either to accept the entire lot or to reject it, if lots have rejected generally that provide some incentive for the supplier to come up with good parts, to come with good supplies, what are some of the disadvantages of the single sample plan.

Now, I told you single-sampling plan is based on a limited number of items, that you pick from the lot therefore, there is some risk involve, there is the risk of accepting a lot of poor quality it is very possible; because all I am doing is I am banking on the performance of this sample as far as sentencing that full lot is concern, I am banking on the performance of this the item in this sample only it is also possible, what I am doing accepting sampling.

I might be rejecting lot, which are really of acceptable quality, that is also possible again because this very it is very possible that is sample that I pick, just by because of randomness it might have ended up with defective item, even if the sample size is small it might have ended up with this, with a with a item that is defective and that is actually a bad news and unfortunately this leads to perhaps unjustifiable rejection of the full lot, that is something also something, I have to worry about.

And also it is something that is that is either you know it is to be taken up by the consumer or by the marketing people, someone has to study extensively the requirements of the customer, basically we have to determine these quantities the AQL quantity, the RQL quantity. And of course, we also to figure out the risk, that are acceptable to the consumer and to the supplier, those all those those different items also we have to figure

out. So, if I trying to do acceptance sampling as suppose to 100 percent inspection, you have these advantages and also you have these disadvantages.

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How I going to form the lot, now I will give some examples how to form the lot, basically a lot is something that is considered to be homogenous, all these items all these items that have been submitted to me as a lot. If they came in a box of pens they should have been produce together, their quality should be more or less uniform and they should be produce by the same operator, if possible on the same machine from same raw material. Otherwise if I just look at few items sort of this it is very possible, that these items have different characteristic from those that I left in the lot; so I would like to make sure that the full lot has uniform characteristic.

So, if I look at a full lot they should have homogenous characteristic around, then you have some defects but the percent of that defect would be the same, what I am looking at the top of the lot, the middle of the lot or the backend of the lot it should be uniform. In fact, also it is it said that if you take larger lots, that tend to be more representative of the overall quality, if you take small lots, they tend to reflect local conditions of production that is why it is also preferred, that you worry wart that you accept large lots for your for your supplies.

And then you of course, you try to acceptance sampling and you try to decide, whether to accept the lot or to reject the lot, also sampling has to be done sampling has to be done

basically by randomizing. Let me see if I can work, this I have vertical camera here, it shows you these different items there, I cannot just when I am sampling from this lot imagine that this is the lot, if I am doing that I cannot just go and take this item, then this item and then this item (Refer slide time 39:34) and found my lot, I found sample I cannot do that; basically I have to pick the items that I pick for my little n, that is the sample that I am drawing by homogenizing this thing.

And in fact in this case, I will probably have to mix everything and in this case, if I am going to be it three times, I look at the full lot I close my eyes look at my eyes; my eyes are close then I go to the table and I pick one item put it away and I go to the second item put it away and I go to the third item put it away. In fact what I have done is I have done randomizing and by doing that, I pick these three items that have been picked randomly from this, lot that I have there. So, this this item these items that I pick there, these are now, going to be an unbiased sample taken out of the lot, I have not really used any kind of bias there and this is what I show when I show you this cube here.

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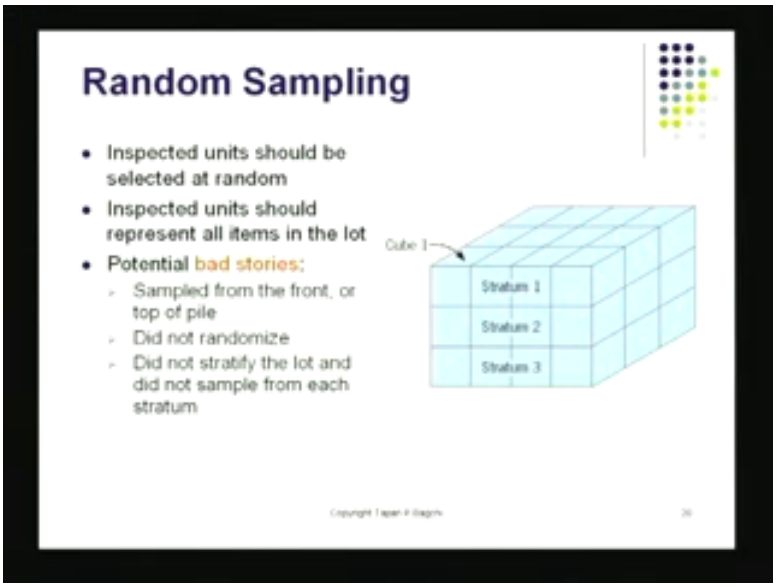

This cube is let us say the full lot that is there it is a truck standing there, has got layers of these boxes there is of course, the backend of the truck, there is frontend of the truck; when I am doing sampling I have got to make sure that I randomize, may be I will take this one, then I will take this item there, then I will go back and I will take this item, then I will take that item and may be some item over here that(Refer slide time: 40:56).

So, in other words what I have done is I tried take a representation of the full lot, that is there this is something that I would like to be able to do; unless I do this there are these possibilities sample from the front or sample from the top of the pile, these are some mistakes which are made sometimes when sampling is done also it is very possible that I did not randomize.

I did not close my eyes and as in fact I was looking at what I am picking, what I was picking from the table that is not such a such a fair deal; and also I do not stratify, what a strata strata layer the top layer the middle layer, the bottom layer, the also should get equal chance to be picked when I pick when I pick this sample when I pick this sample these should have come from any of those strata in randomize manner, that is really the idea of doing randomize sampling.

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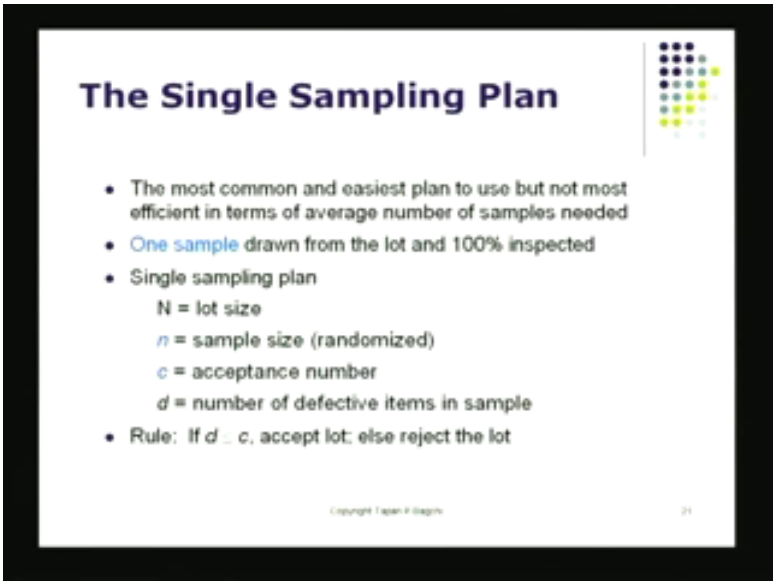

Let us now get into our nuts and bolts of the single-sampling plan, first of all this is to be recognized as the most common and they easiest to plan and the one that is easiest to use but is certainly it is not very efficient in terms of the average number of item, that you have to sample; now, this will become little more clear when I get into this.

So, what I am doing in my single-sampling plan scheme, I am drawing one sample one sample of size little n, I am drawing an item that is of size little n, that is just one sample I draw if in consist of n different items, it must consist of these n different items then I

have this control number that goes along with this n. This control number c is chosen very carefully.

In fact, together the number n and the count c these together they guarantee the risk protection, that the consumer has and also the supplier has, these two numbers n and c they together guarantee the risk that the consumer will be subjected to and also the producer will be subjected to; so these n and c they are to be determined very, very carefully you cannot arbitrarily, I cannot go to a lot and decide then I will pick two items from here.

And my control limit is going to be one defective item, I cannot do that, because that will give me an unknown amount of risk as far as the producer is concern, consumer is concern and as far as the producer is concern, it will be the same story. So, I must use a I must use some sort of a plan, which is the systematic plan and has been what doubt keeping in mind AQL, RQL and the two risks the consumer's risk and the producer's risk.

So, those four items they have to be taken together AQL, RQL consumer's risk and the producer's risk, those four items together will determine this n and c and let us see how I do that, what is the rule now, my lots size is big N, my sample size is little n, my control number is c and the number of defective items that I find in that n items, that I pick little n items, that I pick from sample to be d, the rule for rejecting or accepting the lot is as follows; if this d is less than or equal to c accept the lot d is the number of defective items I found and this little n items, if this d is greater than c reject the lot, that is the rule.

So, what is the plan doing it is giving me a sample size, is giving me a control number and it says now you go ahead and inspect your sample, which has little n items, find the number of defectives; if the number of defective items is less than or equal to c accept the lot, there is nothing wrong with it. You could go ahead and accept it will be fine it will guarantee you the kind of protection that you want, and by chance if this d exceed c you must reject the lot; otherwise you will not get the protection that you want.

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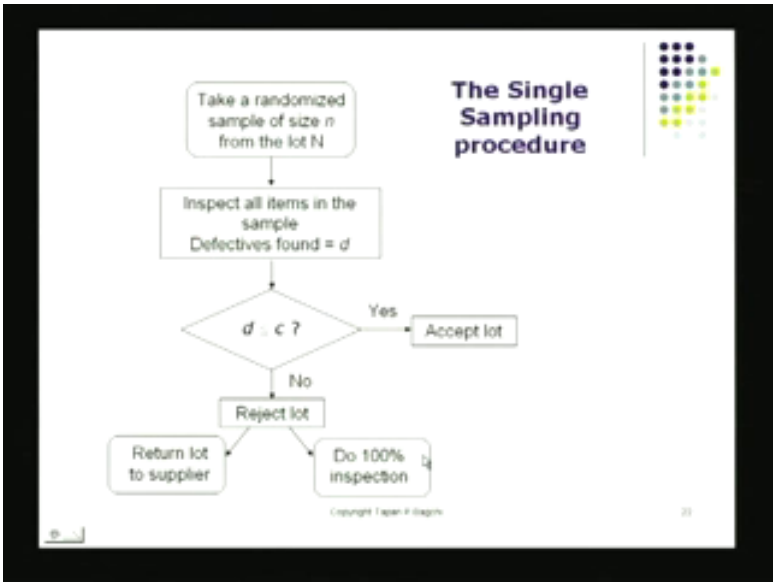

Now this same thing I have drawn up as a flow chart here for you, I take a randomize sample of little n items, from the large N items which is the lot, lot size is my big N and sample size is little n, inspect all the items in the sample. Now sample, now consist of little n items, so inspect all the items in that sample, I am not inspecting the full lot I inspect.

In fact and the only item size inspect are those that are inside the sample there, unless say I found d defective items in that sample of size little n, then I compare that d to this control number c, c corresponds to little n c and n they are tied together, they together provide us the risk protection that we want; if d is less than or equal to c accept the lot this lot is quite all right but if this d exceed c I come down this way I reject the lot.

Then of course, I can either decide to return the lot to the supplier or I may do 100 percent inspection, remove all the defective items from that lot there and accept it for production or my use in my production. So, the the single-sampling plan procedure it goes as follows, out of big N items big N items inspect them all find out how many defectives, you got compared the number and defective you found to this control number c, if d is less than c accept the lot if, d is greater than c reject the lot; then of course, either you can return it or you could do rectify inspection and this is the total single-sampling plan scheme.

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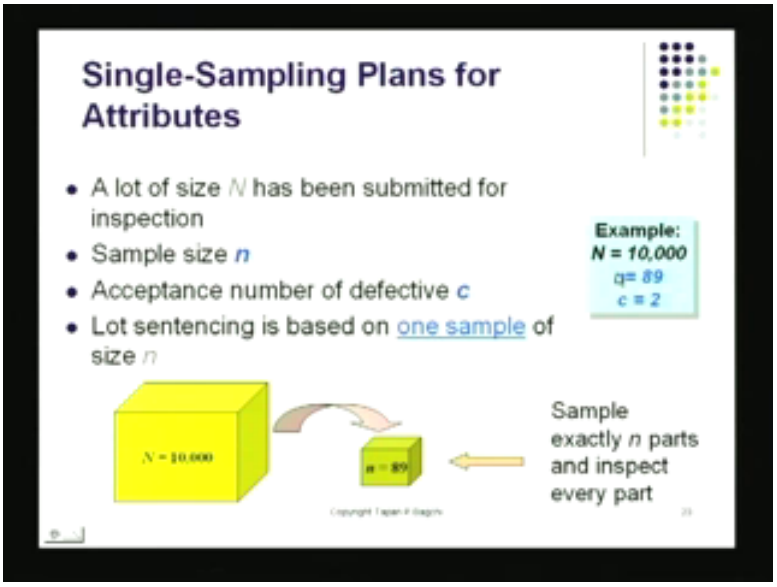

And the same thing is shown out here, what are done here is I have given you an idea of the size of the lot, that is 10,000 items and this would be just too many to inspect, if you wanted to inspect all these n items, all these 10,000 items they are just too many to inspect. but then I have look at my AQL and look at my RQL and I look at my consumer's risk and I look at my procedure's risk and then I have applied a process some analysis, some calculations have done.

And from those calculations I have determined the size of the sample to be little n and that in this case turns out to be n is little n is 89 items, that is in this little green box there I sample exactly those parts, those items and I inspect them 100 percent and I compare the item to c to equal to 2. So, (( )) corresponded to be 89 number, there at this control number call 2, I compare the number of defectives I found find found to do (( )); in fact this number 2, if d is less than 2 I will accept the lot, if d is greater than 2 I will reject lot, that is the single-sampling procedure.

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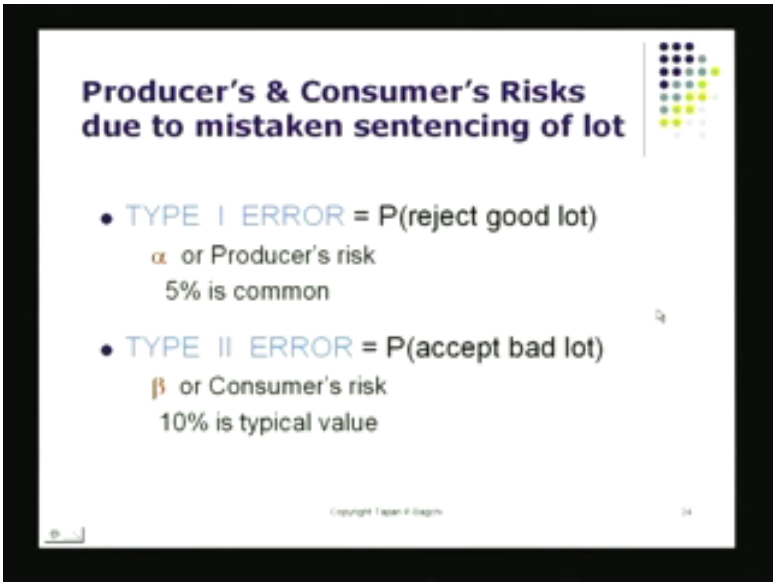

Now, let us try to take a look those risks, that I was talking about I was talking about two types of risks, one is because, I am doing just basically I am just drawing a few samples, I am drawing a few samples out of the full lot that is there; and I am not really accepting I am not really attempting to do full 100 percent inspection of the full lot, I am not doing that I am just randomly picking two or three items out of this I pick little n items.

And on the on the results of the inspection done on these little n items I decide whether to accept the full lot or to reject it, when I am doing that, it is very possible that I have otherwise I have a good lot. Now what is a good lot a good lot is of quality level that is near AQL. AQL is the acceptable quality level for the user it is very possible that the overall quality level of the full lot is near AQL.

Now ideally speaking I should not be rejecting any of these lots any of these lots which are at quality level that is near AQL (( )) happening, because I am doing sampling I am just picking up some items from this and using that using those sample items sample items. I do my inspection and I deiced the fate of the full lot based on the results of the sample here, I might be rejecting a good lot it is very possible, that my sample by chance turns out turn out to be a defective a bunch of defectives there in my sample and I end up rejecting otherwise good lot.

Now, this is a loss to the supplier, this is the rejection of a good lot and this is the supplier or the procedure's risk say if you look at my screen here, alpha is the

procedure's risk which is the chance of commenting a type one error, which means the probability of rejecting a good lot, which has got an average quality, which is near AQL that is the producer's risk.

And generally speaking this is kept at on 5 percent in industry, and then of course, you got the other type error also possible, which we call type two errors, which is like acceptance of a bad lot; if you accept a bad lot which is generally near your RQL level. RQL level is certainly a pretty high level of defective and now, there are high high number of defectives in the when the overall lot quality is near RQL, you end up with a lot of defectives in that lot, there those are the one that should really been rejecting.

But, it is very possible because your only basically sampling you are not doing 100 percent inspection of the lot but you are doing just sample, you are just drawing a sample and based on those n items, little n items you are deciding the fate of the full lot, it is very possible that it will end up accepting a bad lot. A lot which is which has got quality level that is near, what we call RQL level; RQL level is the rejection quality level now, this is now a problem for the user, so this is what we call the consumer's risk or beta, this is beta or the consumer's risk any industry generally this is put around 10 percent.

Now obviously, there are businesses that use far more Indian standard, they use standards which are you know far smaller than 5 percent and also sometimes they also use beta number, which are far smaller than 10 percent these are norms that are set by industry. If the company is very (( )) they of course, would like to make sure that they do not accept any defective items or mostly they should not be accepting any defective items, defective lots. In that case they would like actually to reduce beta to pretty low value, on other hand it is also very possible that a producer is a very fussy and he does not want to see good lots return to him.

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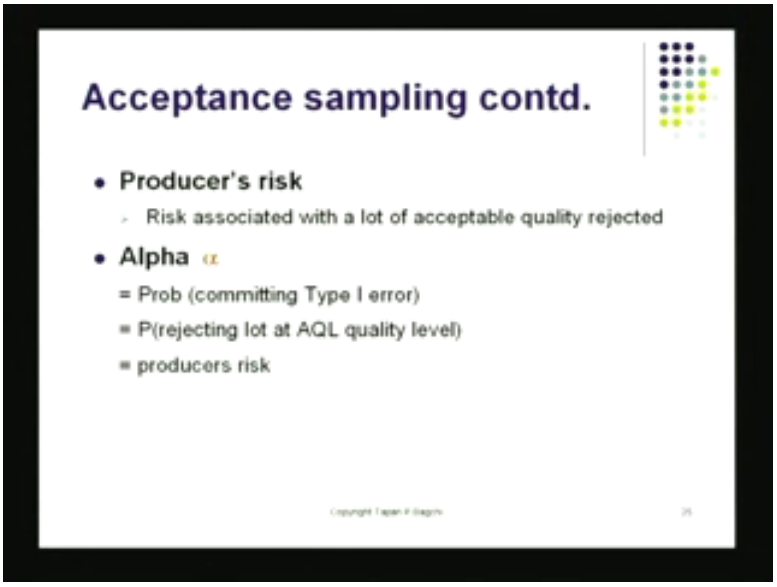

So, he would like to work with a alpha number, which is quite small; so in fact these two rotations alpha and beta they signify now, the producer's risk and the consumer's risk then, there is something that actually puts all of this in a picture.

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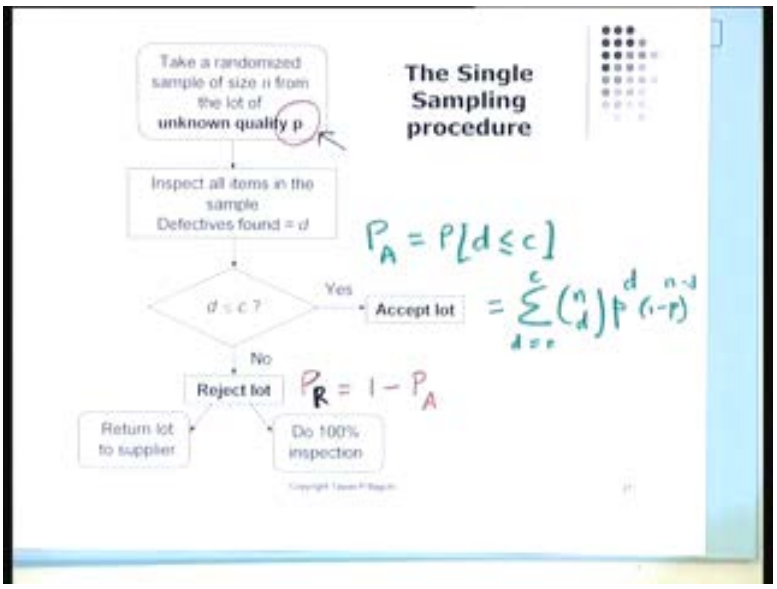

Remember now, what we are talking about is the probability of accepting a lot, and the probability of rejecting a lot. Now I could actually I could take a piece of paper, I could show you exactly what that those quantities are. Let us try to do this I have the same picture that you have there. Let us try to work out the probability of accepting the lot, in

this case, the probability of acceptance is going to be equal to my probability of finding c or less defects in the lot, then there is formula called the binomial distribution, which I am going to explain to you little later, that will be like this this d, will go from 0 to c n d P to the power d and 1 minus P to the power n minus d this is the little formula.

Let me move this paper little bit, so you can see it all. This is the probability of accepting the lot the probability of accepting lot is you are doing this (( )), the number of defective c found there was a less than c, c is your control number. And that can happen if d is equal to 0 or d is equal to 1, 2, 3, 4 and so on up to c, and that probability is given by this binominal distribution, if the lot of a large size, you can use this binomial distribution to evaluate this probability, this is the probability of acceptance.

What is the probability of rejection? The probability of rejection P R is then going to be 1 minus P A, this is the probability of rejecting the lot. So probability of rejection is going to be 1 minus P A, this is the probability of you are rejecting the lot. And in all of these things we assume, that the input quality is P; in all of these we have assumed that the input quality is P. So, input quality is p, given that input quality is P if this is the probability of accepting the lot, this is the probability of rejecting the lot; this is these are two very, very important quantities P R and P A. In fact they determine, how the overall sampling plan is going to work, and that we will proceed, that we will follow on with as we moving to the later part of this lecture then, thank you very much.