Quality Design and Control
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Lecture – 09
Management of Quality- I (Contd.)

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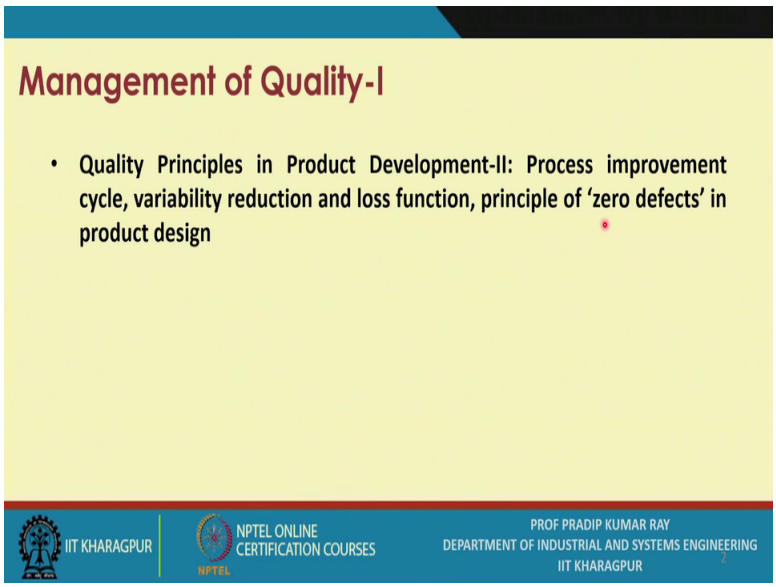

So, in this lecture session under management of quality, now I am going to discuss other important quality principles in product development. In specific terms I am going to discuss process improvement cycle variability reduction and loss function and principle of 0 defects in product design, this three principles are followed in any quality organization ok.

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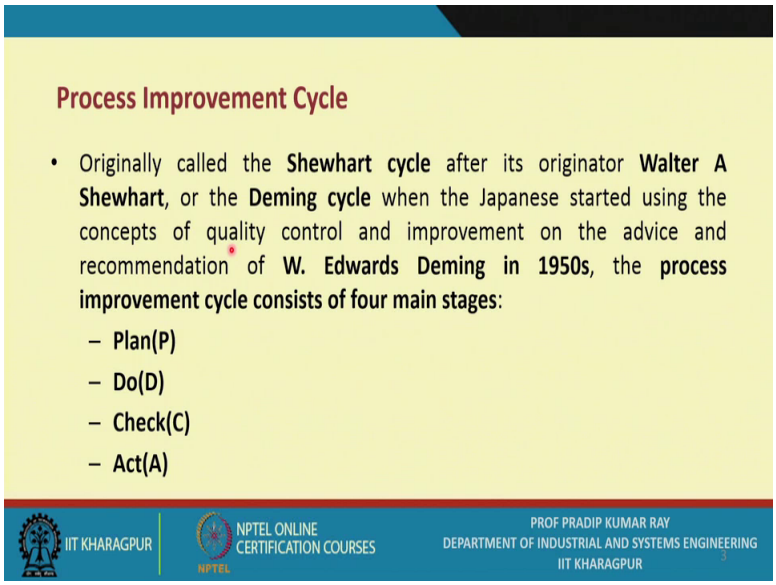

So, let us first discuss the process improvement cycle, now this particular cycle originally was called the Shewhart cycle, because walter a Shewhart is considered to be one of the quality gurus, he introduced this particular concept product process improvement cycle. And subsequently Deming has also used this cycle in several cases. So, that is why this cycle is also referred to as Deming cycle.

When the Japanese started using the concepts of quality control and improvement on the advice and recommendation of w Edwards Deming in 1940; they started looking at their process through this improvement cycle, that means look at your process and whether you can identify the elements in the improvement cycle or not, that means the process should be you know plotted or the process should be thought of as an improvement cycle and you must be able to identify the elements in this improvement cycle.

So, if you look at these improvement cycle it is referred to as a Shewhart cycle or the Deming cycle, then there are four main stages what are those first one is the plan, the second one is do means as per the plan you have to do something then you just check, that means you verify the weather you are performance is all right or not as per the quality norms and if you find that there is a difference between what you do and what you expect, obviously you have to take some corrective measures. So, you have plan you have do then you go for verification or the checking and the last one is acting.

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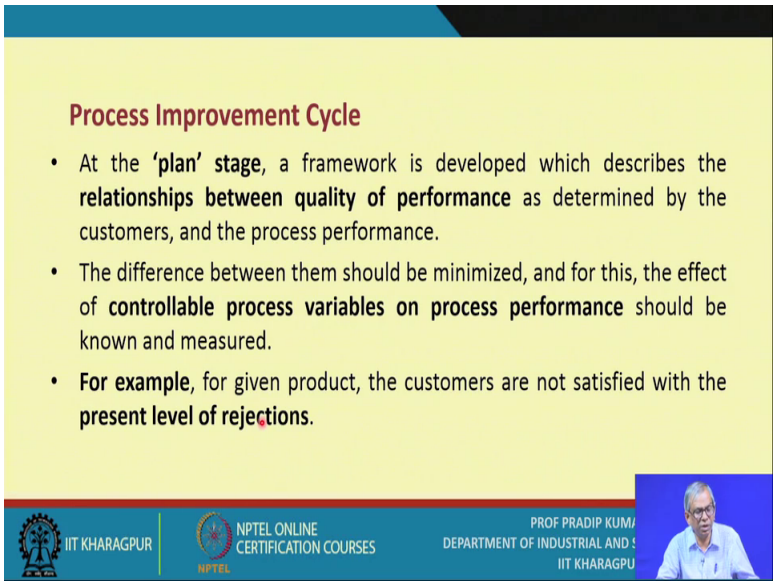

And so this is sometimes also refer to as PDCS cycle. So, this is an improvement cycle and sometimes this is also referred to as the quality improvement cycle. Now what do you do at each of this four stages like, at the plan stage a frame work is developed which describes the relationship between quality of performance as determined by the customers and the process performance this is very important if you where recollect there are three phases quality of design, quality of conformance and the quality of performance.

So, the quality of performance is the ultimate test of quality and this is determined essentially by the customers. Now obviously the this quality you get from the process or from the conformance systems or the manufacturing system, so the manufacturing system is conceived as a collection of interrelated process, so the process performance is ultimately determining the quality of performance, the difference between them should be minimized and for this the effect of controllable process variables.

On process performance should be known and measured, that means you know always related to a particular process there are the control parameters and what you need to do, that means against a particular say the quality of performance you need to have process performance through you know through an exercise called the process settings, that means you need to identify what are the controllable process variables and given the quality of performance or a set of quality performance the measures you have identified

to what extent you know this controllable process parameters are effecting in a positive way the process or process performance level as well as the quality of performance for the product.

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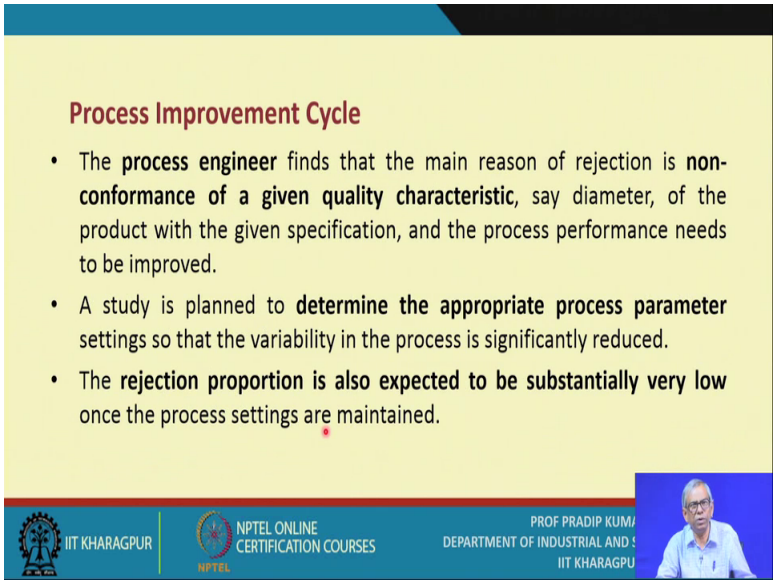

For example for a given product the customers are not satisfied with the present level of rejections, may be the reaction is 10 percent or 15 percent like this so the customer is obviously not satisfied with the performance, so what the process engineer does, the process engineer the process engineer finds that the main reason of rejection is nonconformance of a given quality characteristics say diameter of the product with the given specifications and the process performance needs to be improved is it ok.

So, the exact reason must be known the exact cost must be known and here in this case the process engineer can identify the exact say the quality characteristics where you know there could be some deviation in it is values. A study is planned to determine the appropriate process parameter settings so that the variability in the process is significantly reduced this is very important and the rejection proportion is also expected to be substantial very low like say suppose it is 10 percent today, so you set a target of say 5 percent at the next stage and when you can achieve 5 percent rejection then further reduction you also plan for and may be the next target could be from 5 percent to 1 percent is it ok.

So, in all the what you need to do; that means, to reduce the rejection percentage or rejection proportion what you have to do, that means constantly you have to improve the process settings of a given process. So, this is basically you know at the for the first stage you do that is at the plans stage.

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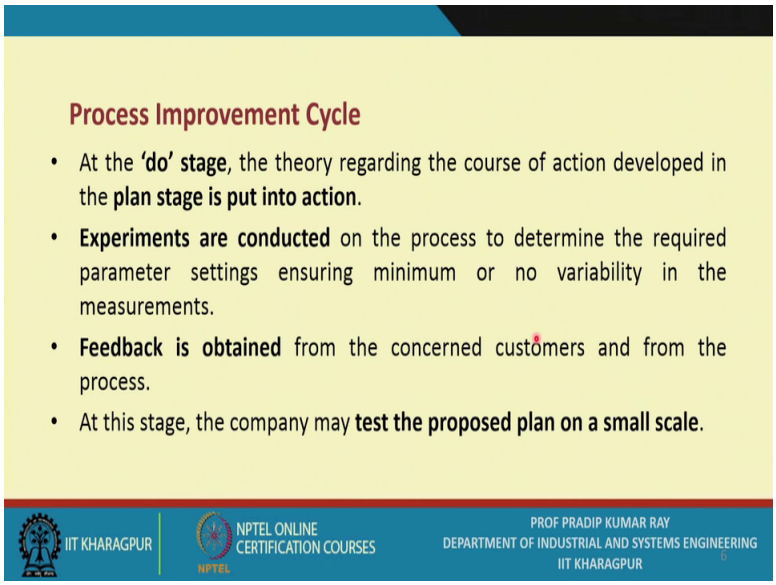

At the do stage the theory regarding the course of action developed in the plan stage is put to action, so that means you have you have created the knowledge base that means difference scenarios you have explored and from each scenario, that means scenario number 1 so 10 percent reaction so what is the process settings, scenario 2 like say 5 percent rejection what could be the process settings of a given processor this way you generate the scenarios and then what you do now you opt for a strategy or you start doing it, that means now you actually you are you have started processing the component ok.

So, experiments are conducted on the process to determine the required parameter settings ensuring minimum or no variability in the measurements that is very important. And feedback is obtained from the concerned customers and from the process that means the experiment is conducted on in a particular sample of the components so the sample of products and then you just check to what extent you are able to meet the standards and accordingly you know the process settings are determined at these stages the company may test the proposed plan on a small scale that is I have been telling you small scale mean for a sample is it ok.

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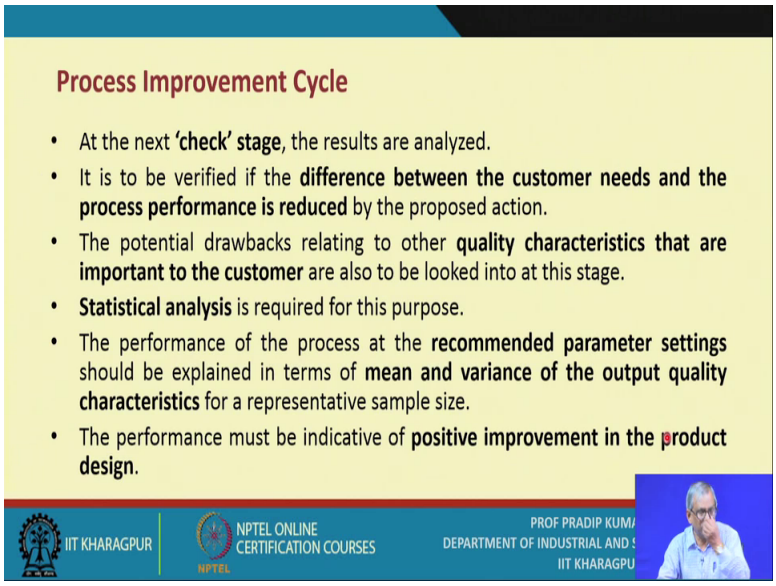

So, for a sample of items you do you produce a sample of components and then you check that to what extent you are able to meet the standards as proposed in the plans stage. At the next check stage the results are analyzed it is to be verified if the difference between the customer needs and the process performance is reduced by the proposed action this point we have been emphasizing, that means the customer needs are satisfied by the quality of performance is it so if the quality of performance is very high we might assume that the customer needs are almost fulfilled, whereas if the quality of performance is extremely poor you may assume that the customer needs are hardly fulfilled.

So, and this product which you offer to the customer actually you know the quality of this product is very much dependent on the process performance. So, there is a strong relationship between say the customer needs and the process performance, so the potential drawbacks relating to other quality characteristics that are important to the customer or also to be looked into at this stage, that means it is a kind of explore deep study that means, you start with one quality characteristics that is the main quality characteristics.

Now, when you control that one, but along with the main quality characteristics there could be other quality characteristics and now when you are success where in the successful in meeting the requirements of the customers with respect to the main quality

characteristics, then you look into you know the meeting the requirements of the customers with respect to other the so called secondary or tertiary quality characteristics also.

The performance of the process at the recommended parameter settings should be explained in terms of the mean and variance of the output quality characteristics for a representative sample size now this is very important. So, many units you are producing, so many products you are producing now obviously you know there will be unit to unit variation. So, to get an idea about unit to unit variation, so against a particular quality characteristics the many values will be generating obviously in a continuous production system and the with respect to a quality characteristics you need to calculate the mean and the variance of the quality characteristics ok.

So, this is very important that means both are very important, that means the when you look at the mean that means whether the mean is your target value or not that is to be checked and the variance means whether the level of variance, that means the level of or say you know or the variability in the process or variability in the product performance is acceptable to you or not and it is this variability is in a evitable so obviously, present level of variability you must know and if it is not acceptable to you use various means and the methods to reduce this variability significantly the performance must be indicative of positive improvement in the product design.

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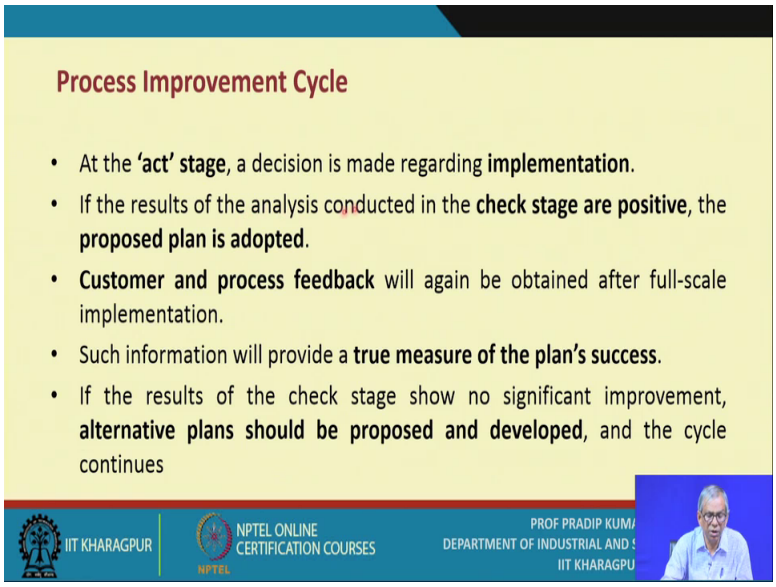

At the act stage a decision is made regarding implementation, if the results of the analysis conducted in the check stage are positive the proposed plan is adopted that is very important customer and process feedback will again be obtained after full scale implementation such information will provide a true measures of the plan success. If the results of check stage show no significant improvement alternative plan should be proposed and developed and the cycle continuous ok.

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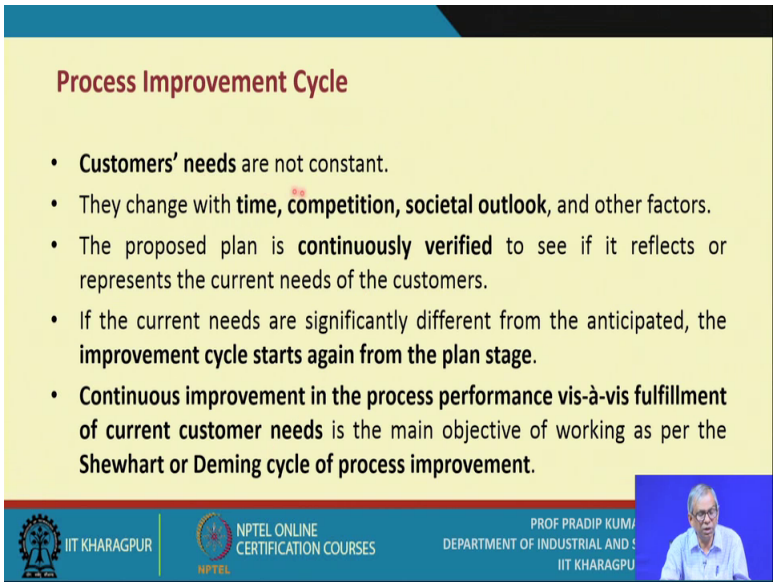

So, customer needs are not constant these are the points to be looked into the change with time composition societal outlook and other factors, so the proposed plan is continuously verified and if the current needs are significantly different from the anticipated the improvement cycle starts again form the plan stage ok. So, the point is to be noted is that continuous improvement in the process performance vis-a-vis fulfillment of the current customer needs is the main objective of working as per the Shewhart or Deming cycle of process improvement so.

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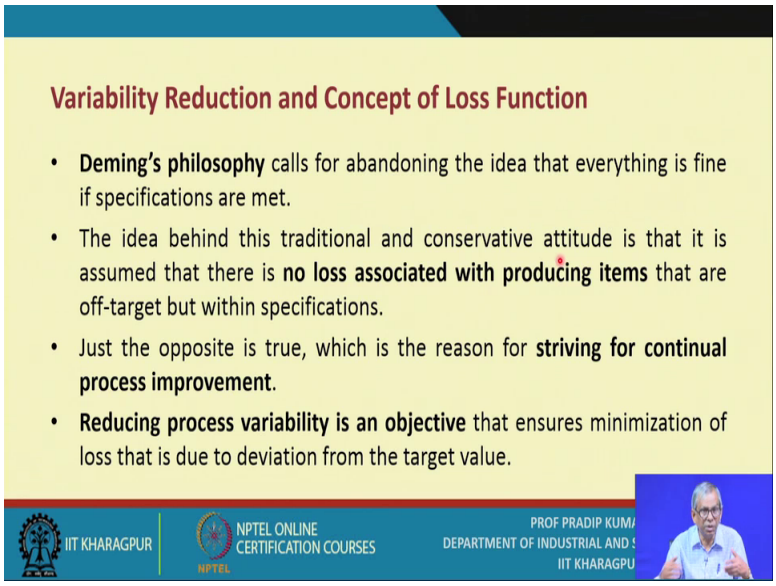

So, demings now this is the next important the principle I am going to highlight that is the variability reduction and the concept of loss function. And we are aware of the demings philosophy and it calls for abandoning the idea that everything is fine if specifications are met is it ok.

The idea behind this traditional and conservative attitude is that it is assumed that there is no loss associated with producing items that are off target but within specifications. So, there is a specifications range upper specification limit lower specification limit and the nominal value, so whether the value which you get the actual you know the value you get it may be very near to USL very near to LSL or very near the nominal value or the nominal value, but still all the values are treated equally and this is the traditional approach.

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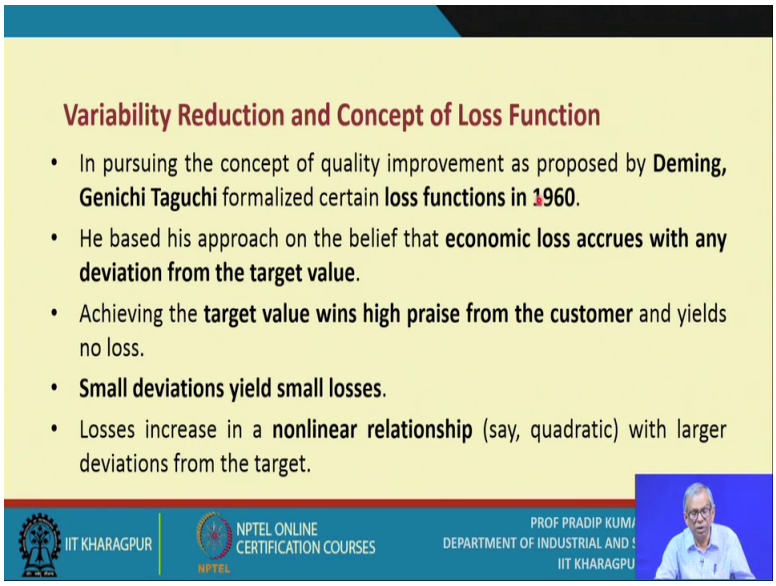

So, that is reducing process variability is an objective that ensured minimization of loss that is due to deviation from the target value. So, in perusing the concept of quality improvement as proposed by deeming the Genichi Taguchi formalized certain loss functions in 1960 I have already you know the discussed what is this definition of quality that is the qualities are lost they imparted to the society after the product is shift.

So, this is it is definition, so if the quality is more the loss is less if the loss is more the quality is less, he based is approach on the belief that economy class accrues with any deviation from the target value, that means achieving the target value is your main goal and if you achieve the target value you will win high praised on the customer and yields no loss. So, that is the basic assumption and the small deviations yield small losses but if the large deviations are do occur obviously you expect a large losses.

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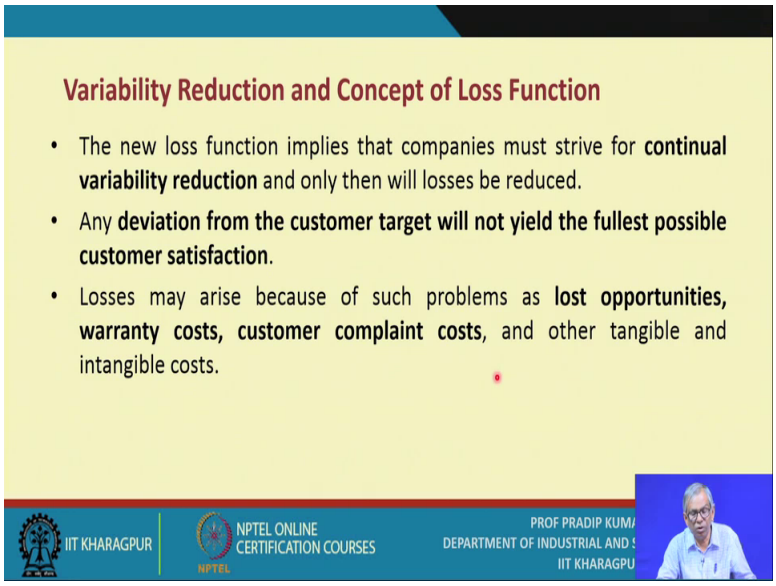

So, losses increase in non-linear relationship say quadratic with larger deviations from the target and that is why whenever we talk about the loss functions so we refer to a particular term called quadratic loss function. So, the new loss function implies that companies must strive for continual variability reduction, this we have been emphasizing all the time that any exercise on quality is essentially an exercise of or variability reduction and only then will losses be reduced, that means our focus should be variability reduction.

So, if the variability is less the loss is less and if the loss is less the quality is more any deviation from the customer target will not yield the fullest possible customer satisfaction, losses may arise there are many instances of losses or many examples of losses like say lost if you have a loss then you bring in different kinds of problems like lost opportunities, voluntary cost, customer complaint costs and other tangible and intangible cost so it is loss should be minimum.

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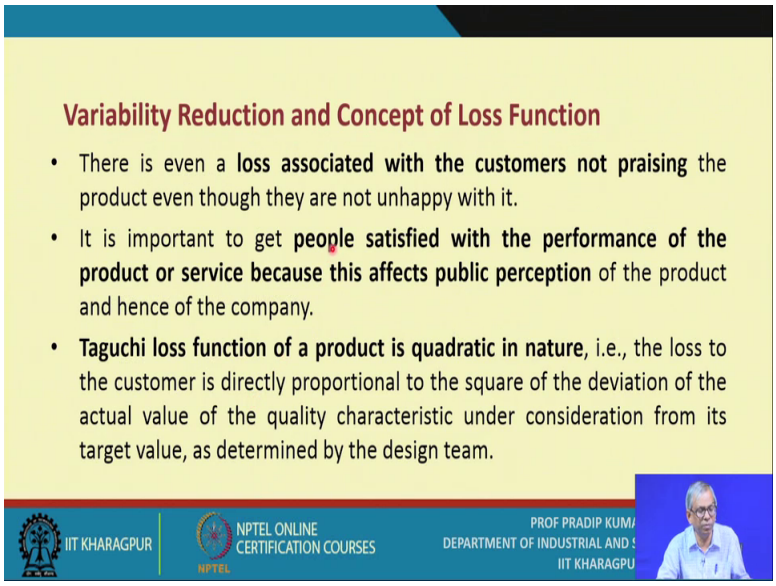

Now, even there is a loss associated with the customers not praising the product even though they are not unhappy with it is so this is this is the ultimate test in fact, so you have to be very care full about you enough that was is this actual you know the customers opinion regarding the performance of your product, regarding the quality of your product it is important to get people satisfied with the performance of the product or the service we have been emphasizing all through because these affects probably perception of the product and hence of the company, because the you know these days you know if the quality is consistently good ultimately you will find that it will have a bearing on the public perceptions about the products is it and it may lead to you know the branding of your product and that is your ultimate goal.

So, only thorough implementing you know a very powerful quality a engineering systems in your organizations and subsequently quality management systems, you can you can brand your product or ultimately you know the branding of your product is possible, Taguchi loss function of a product is quadratic in nature I have already the mentioned that that means the loss to the customer is directly proportional to the square of the deviation of the actual value of the quality characteristics under consideration from it is target value.

Now, this is to be looked into that means the loss to the customer is directly proportional to the square of the deviation of the actual value from it is target value as determined by the design team is it ok.

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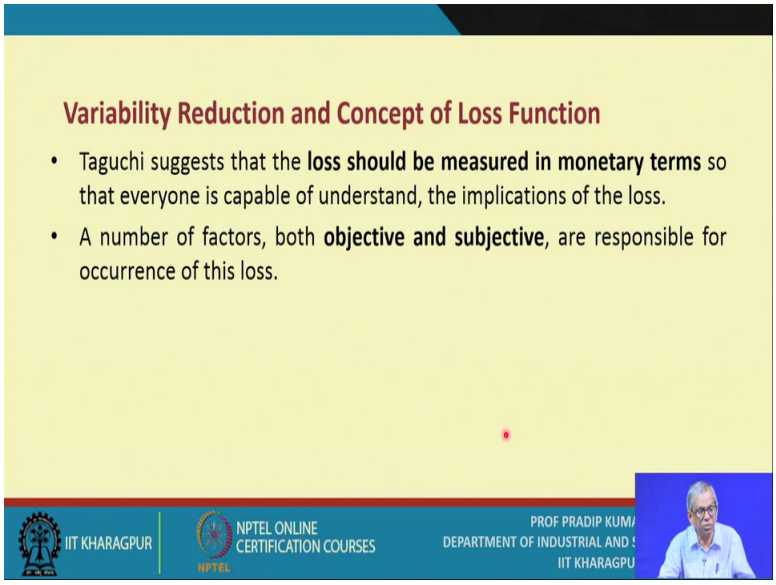

So, this is basically you must be able to compute in a given in a given situation for a particular product, that means the expected value of the loss by assuming quadratic loss function it will be able to calculate and for that data collection is a must so you collect data and then with the given data later on we will have exercise on this when we discuss in detail the Taguchi method, we will find that the against the values which you get or the product with respect to it is quality characteristics what you need to do you need to determine the loss and while you determine the loss you assume that the that the loss function is a quadratic loss function as per Taguchi method. So, Taguchi suggest that the loss should be measured in monetary terms this is an important point to be noted.

So, that everyone is capable of understanding the implications of the loss this is very important in fact, and because you know the loss can be interpreted in 100 ways from different perspectives, but whatever may be your perspective it must be converted into monetary you know the monetary term so that everyone get you know the real meaning of the loss in the in the same language a number of factors both objective and subjective are responsible for occurrence of this loss.

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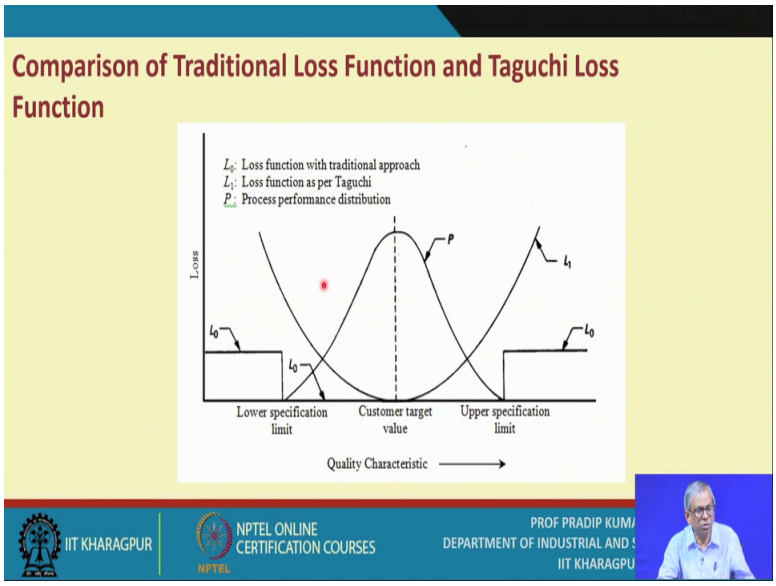

So, this is you know the traditional loss functions and this particular figure depicts the difference between the traditional loss function and Taguchi loss functions. So, here what you have basically for the given quality characteristics you have the upper specification limit and you have the lower specification limit; that means it is two sided specification the limits case and this is the customer target value usually unless otherwise specified it is the midpoint between the upper specification limit or the lower specification limit is it ok.

Now, this target value you have to achieve, now in the traditional approach you know any value you get anywhere between in this range, that means the range specified by the upper specification limit and the lower specification limit. They will have they will consider not to have any kinds of loss but as soon as you get a value less than lower specification limit then the loss jumps to this level L zone or just it crosses the value crosses the upper specification limit you know that this is a there is a is the step function and you say the loss is very high, that means this is an unacceptable zone this is also an unacceptable zone.

So, but the Taguchi loss function it is says that my target is the nominal value or it is referred to as the target. If I get a value which is different from the target obviously you I am I am incurring a loss, so this way the loss function is depicted this is 1 and that is why it is the loss function as per the Taguchi that is L 1 this is the entire loss function that is a

quadratic loss functions and what do you find that this your performance is it that means suppose you have produced some 10000 units and you get a distribution of 10000 units, that means unit to unit there is a variation and these variation is due to some random causes not assignable causes ok.

So, you will have this distribution what you will find that may be, if this is the performance and you believe in you know the achieving the target may be 70 percent of the components or the 70 percent of the units the you are getting and within plus minus 5 percent or plus minus 10 percent from the target. So, this is obviously it is indicative of improvement performance so this is your this is your traditional loss function this is not acceptable it is theoretically not correct, whereas you believe in you know the Taguchi loss function you can explain these loss function scientifically.

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So, many companies they are adapting this Taguchi loss function and accordingly they are trying to the design the product, is it ok so that means it is it is a real challenge that means, there no deviations from the target is allowed. So, this is and then only you know you will find that your performance is such that that you hit at the target all the time is it ok, so the variability is at the minimum level and if the variability is at the minimum level consistently then obviously your production systems your process has high level of say conformance or your you know the quality of conformance is at very high level.

Now, the next the third one third principle I am going to discuss that is the principle of 0 defects in product design. Now a days the principle of 0 defects is known worldwide now what is this 0 defect, let us call that recall that you now many a time we say that how can you have a 0 say the defects obviously it is a production system and it is effected by several uncontrollable noise factors, so how can you have 0 defects even if say as a point 1 percent defective but you have to have point 1 percent defective.

Now, many years back in early in the early 60's the us department of defense they have developed a program with respect to their parsing missile project and they started calling it 0 defects program. For all types of products that organization design the ZD philosophy should be established across all functions and work units involved in the product development.

So, it is a total approach whenever one organization talks about the 0 defects that means a total systems approach is a must. The basic of any ZD program is to ensure an error free best performance from a designed and developed product, both quality of design and quality of conformance must guarantee the error free performance of the product. So, this is that means we are focusing on quality of design and quality of conformance.

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Now, originally introduced and implemented for the pershing missile project in the USA in the early 60's of the 20th century is it and exactly in the December 1961, typical ZD program calls for removal of errors of all types in the working of a product, now the

question is what are the possible causes of error there are three possible causes of errors first one is the inferior or bad quality of material parts or the components, second reason is the inferior or bad quality of equipment and facilities used in manufacturing and the third one is the human error occurring during manufacturing or while using the product.

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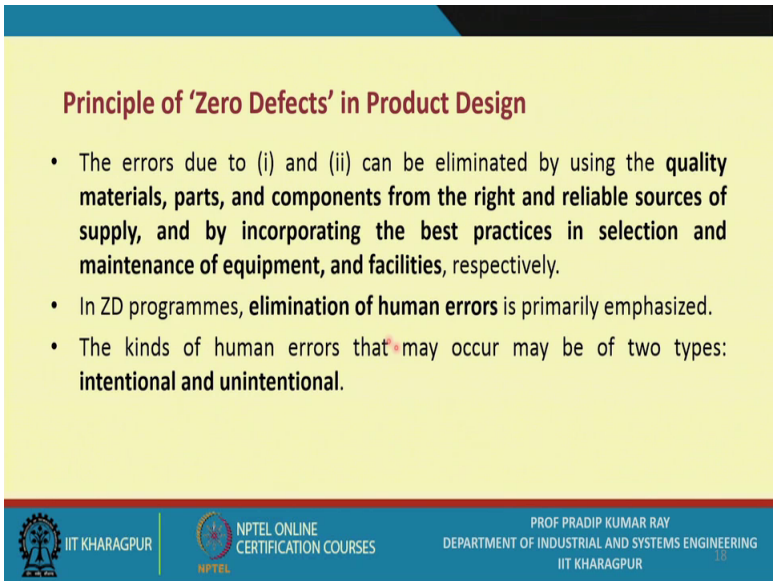

Now, the errors due to 1 and 2 this point is to be noted that the errors due to 1 and 2 that means due to materials or due to the equipment can be eliminated by using the quality materials parts and components from the right and reliable source of supply I have already mentioned the principles of supplier selection. So, if you follow those principles of supplier selection so obviously, it is possible to get right quality materials parts and components from the right and reliable sources of supply and by incorporating the best practices in selection and maintenance of equipment and facilities that means, it is possible that if you are if you if you wish to have the best possible you know the equipment in place you can do that, but in the ZD programs the main focus is elimination of human error and elimination of human error is not an easy task it is a most challenging assignments and this elimination of human error is primarily emphasized in any 0 defects program the kinds of human error that may occur may be of two types, one is intentional and the second one is unintentional.

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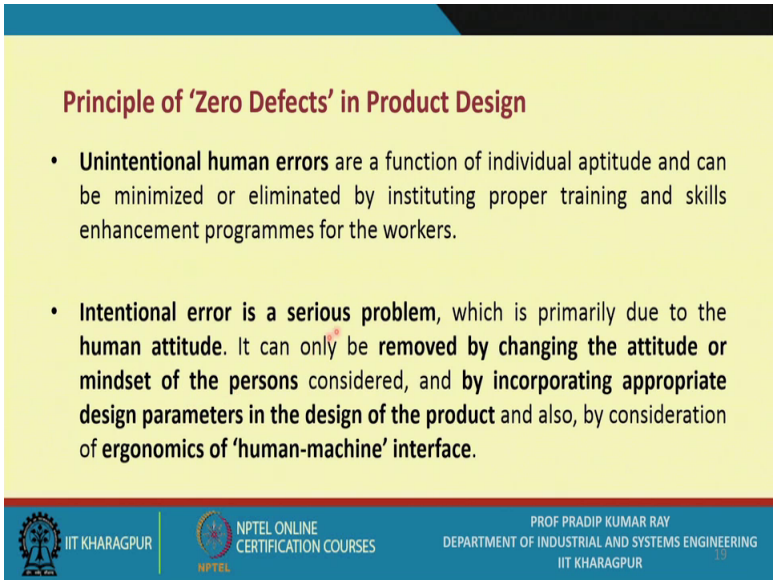

Unintentional human errors there will be unintentionally human errors, but these errors are a function of individual aptitude and can be minimized or eliminated by instituting proper training and skills enhancement program for the workers. So, this is this always any company they take up such programs for the workers so that you know unintentional they have the right kinds of skills and the aptitude and so that unintentional human errors come to almost you know the 0 level, but the main problem is how to eliminate the intentional human error.

So, this is a serious problem which is primarily due to human attitude it can only be removed by changing the attitude or the mindset of the persons considered and by incorporating appropriate design parameters in the design of the product and also by consideration of ergonomics of human machine interface.

So, this is very important this point is to be noted, that means in today's context while you design a system and the systems will have the human elements systems will have the you know the machine elements and while you produce something there is always an interface there is always an interaction and this is referred to as a many a time the human machine interface. So, the key you know the issue is that you will create a quality systems, but in today's context in while you develop a quality systems if it focus on how to create a quality human machine interphase is it ok.

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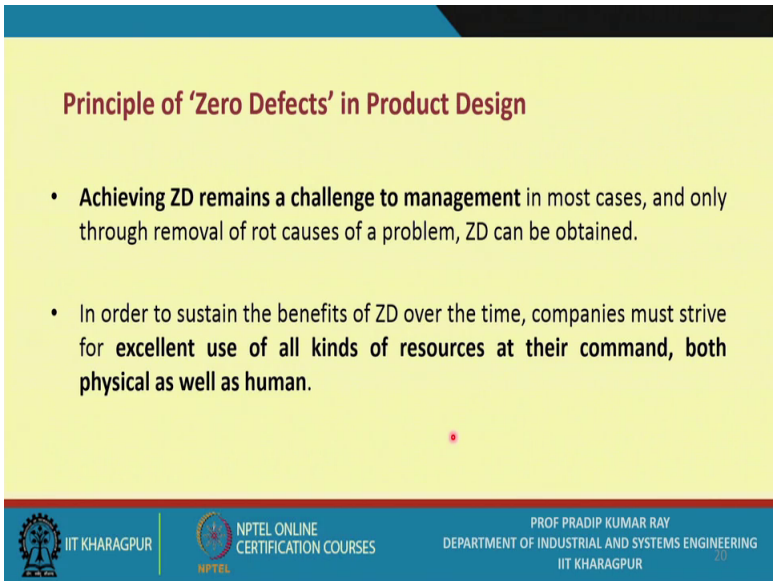

If there are cases, where the equipment is very equipment is very good the person is otherwise very good or you really do not know when the person is put on the machine whether the output which you get whether it will be of good quality or not.

So, the interphase design is the key an interface design is a challenging task. So, achieving ZD remains a challenge to management in most cases and only through removal of a rot causes of problem ZD can be obtained and in order to sustain the benefits of ZD over the time companies must try for excellent use of all kinds of resources at their command both physical as well as human.

So, here you know any ZD programs the emphasis on how to eliminate intentional human error and if you go through the what is go through the original ZD programs as it is documented you will find in detail that what sort of action steps you have to adapt or you have to take so that the intentional human error does not exist. So, this is the important principles almost you know a few important principles we have discussed and these have high relevance with respect to the product development with respect to the product quality.