Quality Design and Control
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Lecture – 06
Management of Quality- I

During the second week for the course quality design and control, I intend to cover the following topics.

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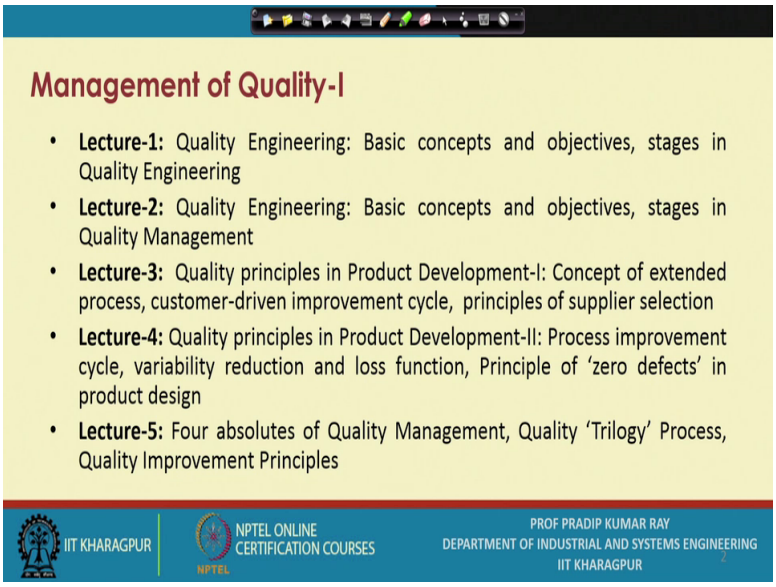

There will be 5 lectures and essentially during the second week I will be talking about some basic issues related to management of quality and on management of quality there will be 2 parts. So, the second week I will be talking about the management of quality part 1 and in the subsequent week during the third week, I will be discussing the second part of management of quality. As you have might have noticed by this time that the management of quality when we talk about when we discuss it covers a large number of topics. In fact, and I intend to cover all these topics in a systematic manner.

During this week there will be 5 lectures; on lecture-1, I will be discussing the quality engineering: the basic concepts and objectives, stages in quality engineering, what steps you need to follow if you want to apply quality engineering based tools and techniques and lecture-2: I will be talking about basically this is on the quality management aspects, basic

concepts and objective and the stages in quality management and lecture-3 quality principles in product development, concept of extended process customer-driven improvement cycle, principles of supplier selection, these are the specific topics I am going to cover.

Lecture-4: quality principles in product development part-2: process improvement cycle, variability reduction and loss function principle of 'zero defects' in product design and in lecture-5; I will be covering 4 absolutes of quality management quality trilogy process and quality improvement principle. So, this will be the broad coverage under management of quality part 1.

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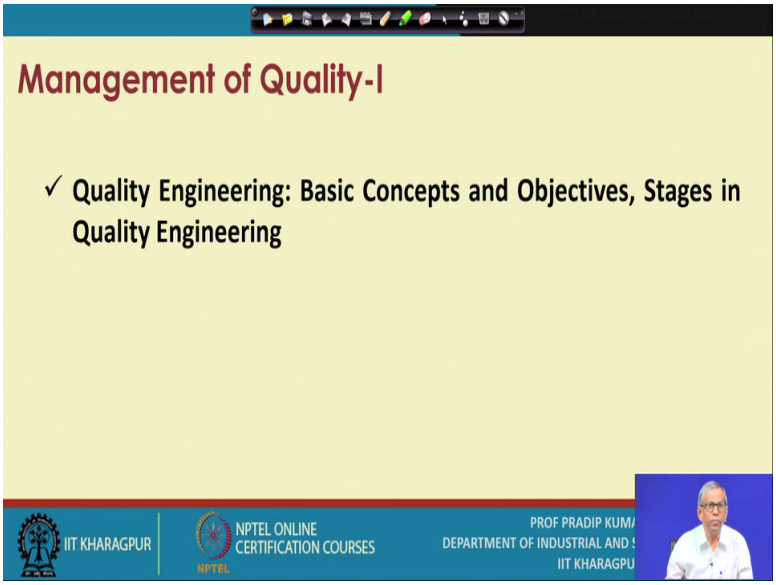

Now, let me first discuss the quality engineering, its basic concepts and objective and what are the stages in quality engineering that you come across.

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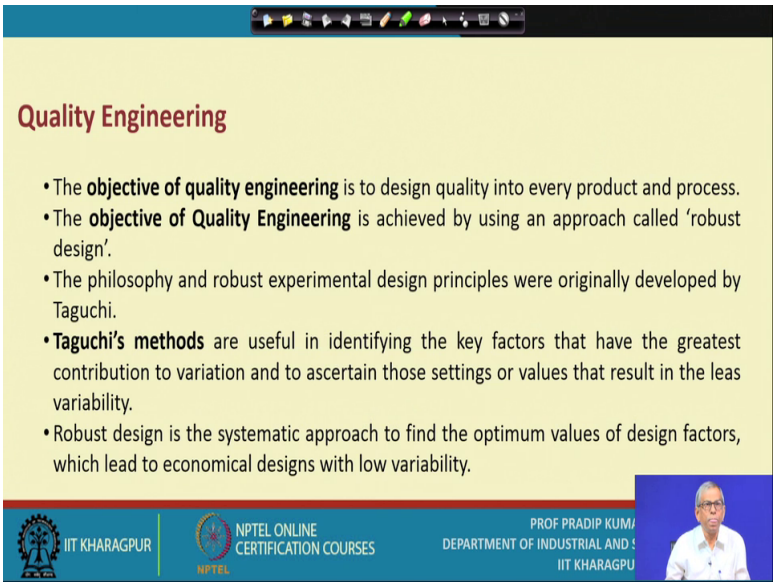

These days we have been using the term called quality engineering and there should be very clear ideas about what actually it is and what actually it does; obviously, the main objective of quality engineering is to design quality into a brief product and process.

So, this is the core objective of quality engineering; that means, as simply designing a product is not enough you have to follow a separate you know the approach for building quality into the product during the design stage mostly. Now, the objective of quality engineering is achieved by using an approach called robust design; that means, whenever someone says that he is working on quality engineering, you may assume that he is he or she is trying to design a product and which is essentially robust in nature.

So, with the help of quality engineering based tools and techniques and approaches the product is designed such a way that it becomes robust. Later on we will define what is this robust this and all the robust. The philosophy and the robust experimental design principles where originally developed by Taguchi. In fact, this particular term quality engineering was the coined by him Taguchi and while he proposes an approach for creating a robust product he emphasizes on using experimental design during prototype stages; that means, he is essentially focusing on the offline quality control technique.

Taguchi's methods are useful in identifying the key factors that have the greatest contribution to variation and to ascertain those settings or values that result in least variability. So, that is very important. In fact, like as I have been telling all the time and in any exercise and quality

is essentially an exercise on variability and you design a product in such a way that the performance variability should be under control and this performance variability should be as minimum as possible. So, Taguchi methods actually focusing on this particular aspect and hence robust design is considered to be a systematic approach what actually he proposes to find the optimal values of the design factors leading to economical designs with low variability; that means, the quality is to be maximized, but at what cost. So, make sure that the cost is also at the minimum level and so, also the variability in the product performance.

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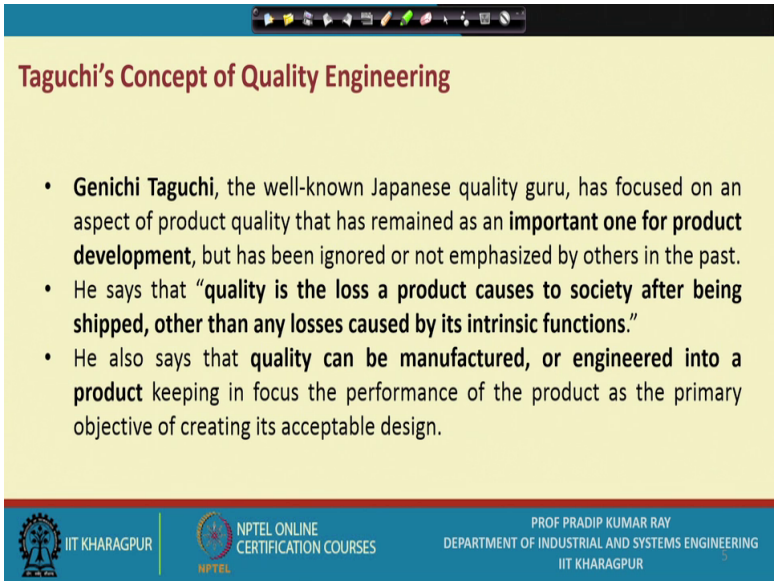

Now, Genichi Taguchi the well known Japanese quality guru has focused on an aspect of product quality that has remained as an important one for product development and this is the part of product development, but has been ignored or non emphasized by others in the past and when he introduced the concept in 50's, initially there was lot of problem, but he stood firm and he says that you know your objective should be to create a robust product.

Now, what is a robust product; that means, the product performance may be affected by the several kinds of external noise factors. Now, obviously, you know you have to search for ways and means with which you know the effect of such noise factors on the performance of the product should be made as minimum as possible and in that condition the product is referred to as a robust product.

Now, he says that quality is a loss a product causes to society after being shipped, other than any losses caused by its intrinsic functions; that means, as I have already mentioned during the first week that there are different definitions of quality and the definition given by Taguchi is a unique one, in the sense, that he relates quality with the loss and he calls it as a societal loss. So, if against a particular product which you have designed if you can measure its loss and that you have to do and you say that I have designed a product, the loss is minimum and that is why the quality is acceptable or the quality is very high. So, this is the basic issue.

Now, he says that quality can be manufactured or engineered into a product and that is why he refers this concept as quality engineering, keeping in focus, the performance of the product as the primary objective of creating acceptance acceptable design. So, the design means what? Means you create a design so that, the performance of the product is guaranteed.

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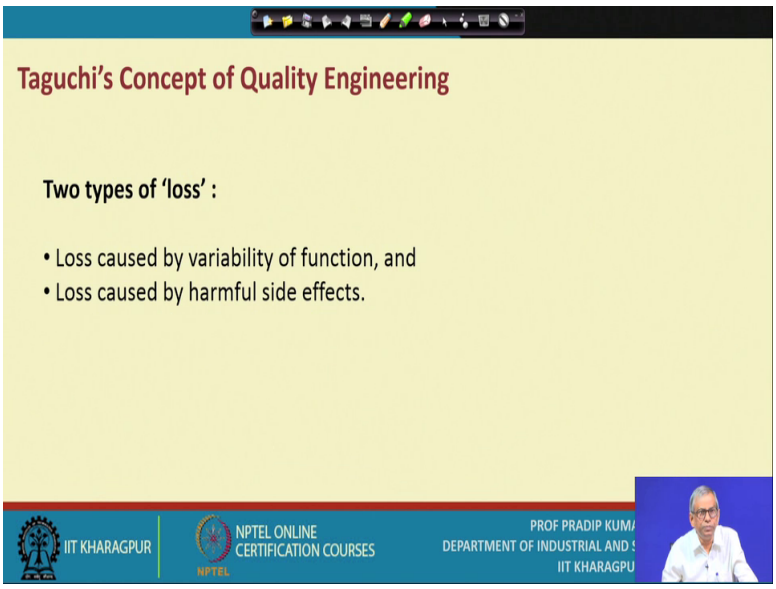

Now, when he refers to the loss, there are 2 types of losses. Normally, we come across loss caused by the variability of function that is obvious in fact. And the second type of loss caused by harmful side effects. Now, there could be several examples, later on we will highlight those examples in the subsequent lecture classes. So, there are 2 types of loss; the first loss is caused by the variability of the function and the second loss is caused by the harmful side effects.

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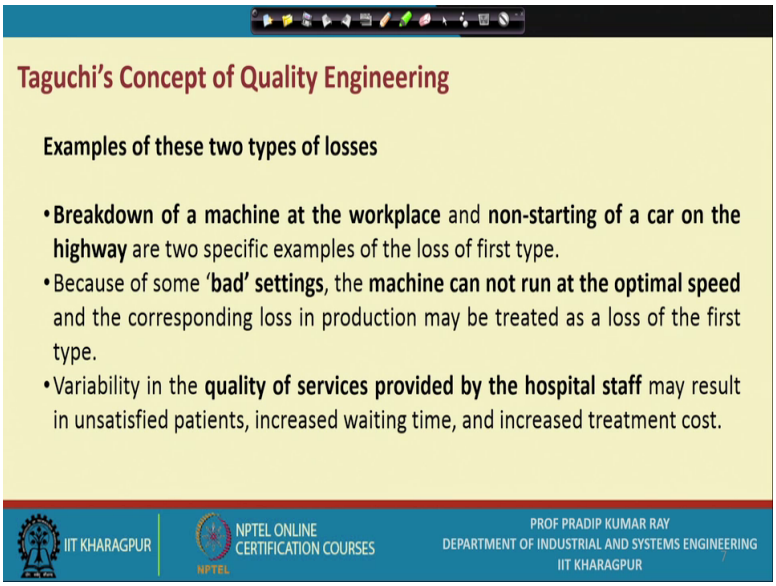

So, now there could be the several examples of these 2 types of losses; for example, break down of a machine at the work place and non-starting of a car on the high way, are 2 specific examples of the loss of the first type. So, this is always we come across because of some bad settings; that means, you know as I have already mentioned at that when you design a product and you try to produce it that means, we by a process. So, with respect to that process you must be able to identify the process parameters with which you know these process parameters you set such a value that you get all the design of the product manufactured as per the specifications.

So, because of some bad settings, process settings essentially the machine cannot run at the optimal speed and the corresponding loss in production may be treated at a loss of the first type. So, this always happens in fact. So, any machine is installed and when you start using that machine for producing a particular component so obviously, with respect to the component design specifications and you need to set the process parameters at the required the values.

So, this whole exercise is essentially known as the process setting. Now, if the process setting is wrong; obviously, what you may find that there will be a loss; that means, we will be producing a component which may not be able to confirm to the specifications and if you start using that particular component at the part or the product; obviously, you know the entire system it just cannot run at the best possible you know the manner.

So, that is why there will be always the loss. So, variability in the quality of services provided by the hospital staff may result in unsatisfied patients, increased waiting time and increased treatment costs. So, these are another example of the societal loss or loss in general, in respect of a service function or service activity.

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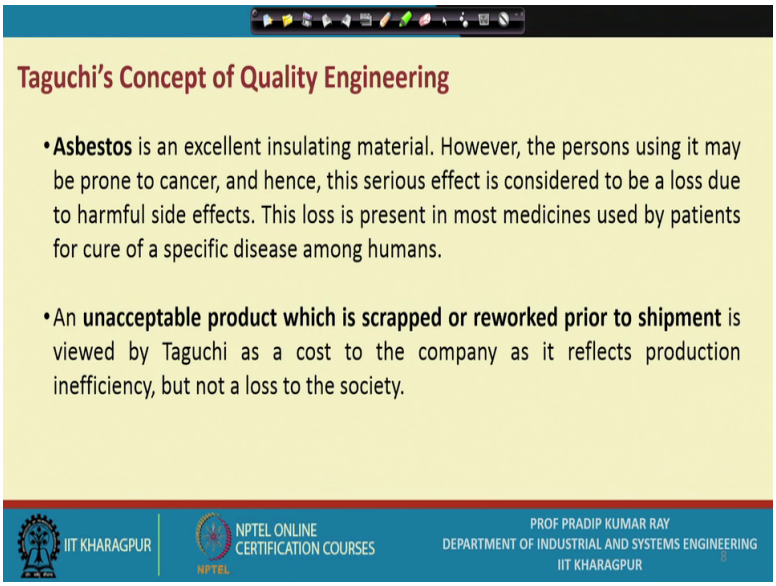

Asbestos is an excellent insulating material, now what you can deny this; however, the persons using it may be prone to cancer and hence, this serious effect is considered to be a loss due to harmful side effects. This loss is present in most medicines used by patients for cure of a specific disease among humans. Can you know this is the serious concern; that means, for a particular treatment definitely medicine you can use, but always there may be harmful side effects.

So, these harmful side effect is referred to as loss and if you can reduce this harmful side effect we say that the quality of the product has increased and unacceptable product which is scrapped or reworked prior to shipment is viewed by Taguchi as a cost to the company as it reflects production inefficiency, but not a loss to the society now. So, may be, that means, it assumes that whatever inefficiency you have in the manufacturing systems you should control them and later on you might say that I do not have any the production inefficiency that is the goal. And, obviously, you know these are the there could be many internal factors contributing to this production inefficiency and you should be aware of you should be able to

identify this factors and in course of time you must be able to remove those factors from the system.

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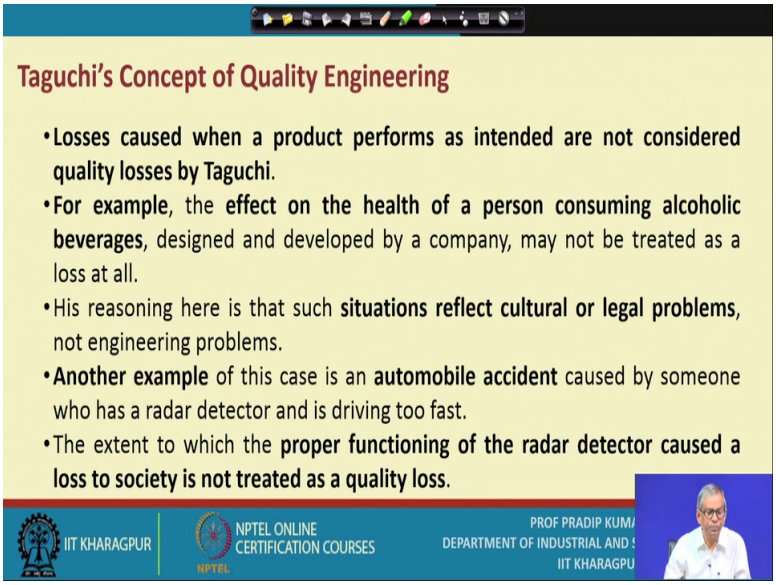

Losses caused when a product performs as intended are not considered quality losses by Taguchi. So, this is plays the important point to be noted. For example, the effect on the health of a person consuming alcoholic beverages, designed and developed by a company may not be treated as a loss at all. So, you know this is a controversial the topic in respect of a particular product. He is reasoning here is that the such situation reflect cultural or legal problems not engineering problems; means, the legal issues or the cultural issues must not be brought in or a ethical issues must not be brought in.

So, our focus is on engineering problems and related to the engineering design, related to the engineering systems we will be identifying the loss. This is the boundary line we must create otherwise you know this product may be treated as a loss to the society is it. So, wrong it is the state is allowing it to produce. So, obviously, while we quantify the loss we must treat it as an engineering problem.

Another example of this case is an automobile accident caused by someone who has a radar detector and it is driving too fast. The extent to which the proper functioning of the radar detector caused a loss to the society is not treated as a quality loss. So, you should be very

careful that under what context this quality loss has been defined. This is very important and you must set a boundary line while you deal with such problems.

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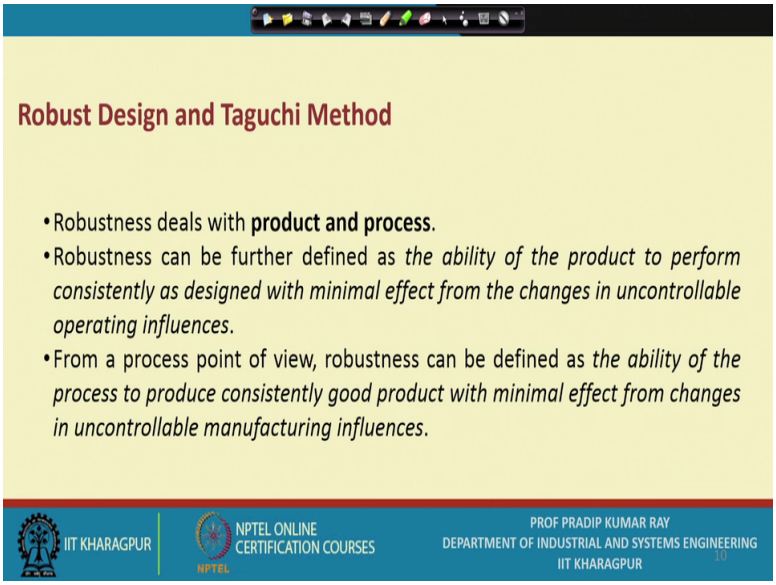

Now, I have already mentioned that you know ultimately if you intend to use quality engineering based tools and techniques with respect to a product, the main objective is to create a robust product. And so the robust product you can create only when you are aware of the characteristics of a robust design; that means the robustness deals with the products and the process both. It is not only you know you say that the product is robust, you also must say that by the machine which I am using it that the process I am using that is also robust.

Robustness can be further defined as the ability of the product to perform consistently as designed with minimum effect from the changes in uncontrollable operating influences; that means, always there will be you know the existence of uncontrollable noise factors like a humidity, like say you know the temperature, like say you know the dust, fumes, working environment or say the skills of a particular person, the variation in the skills is it ok. So, you cannot avoid that and how to minimize the effect of uncontrollable noise factors on the performance of a product. So, that is the key issue while you create a robust or design for a product.

From a process point of view, robustness can be defined as the ability of the process to produce consistently good product with minimum effect from changes in uncontrollable

manufacturing influences. So, this way robustness has been defined with respect to a product with respect to a process.

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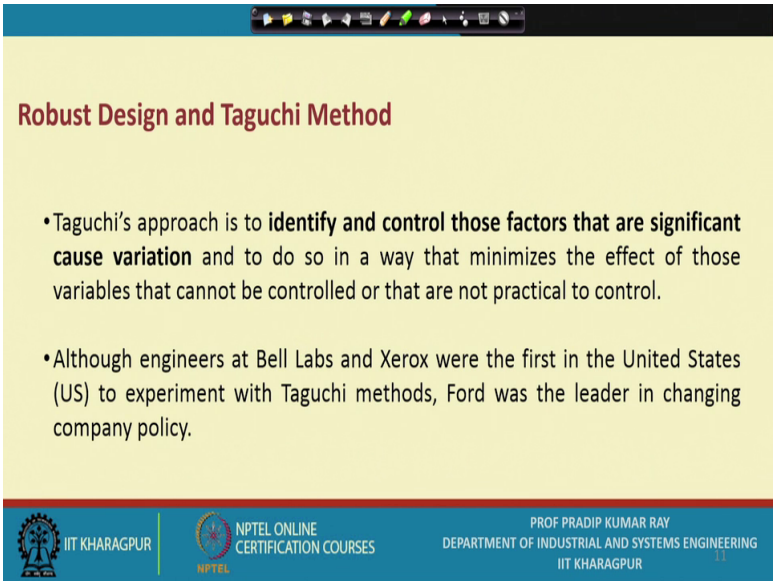

Now, the Taguchi's approach is to identify and control those factors that are significantly cause variation and to do so in a way that minimizes the effect of those variables that cannot be controlled or that are not practical to control. So, this is the point to be noted. So, although engineers at Bell labs and Xerox were the first in the United States to experiment with the Taguchi methods; so, they are the pioneers in fact; Ford was the leader in changing company policy; that means, the companies like Ford are many such companies in the subsequent years of second period they have adapted the Taguchi's robust design approach in designing as well as in manufacturing their products. So, it is a well known technique.

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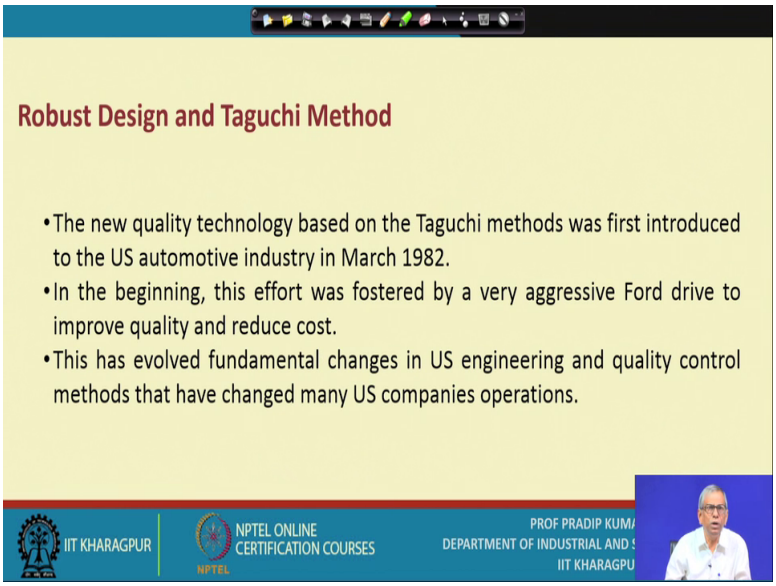

So, this is sometimes this is referred to as the quality technology. So, this the quality engineering based or the quality technology based the techniques as proposed by Taguchi was first introduced to the US automotive industry in March, 1982. In the beginning this effort was fostered by a very aggressive Ford drive to improve quality and reduce cost. As I have already mentioned that you have to improve quality all the time of a product and you have to reduce the cost at the same point or you know concurrently you have to do that. This has evolved fundamental changes in US engineering and quality control methods that have changed many US companies operations. So, this is the background.

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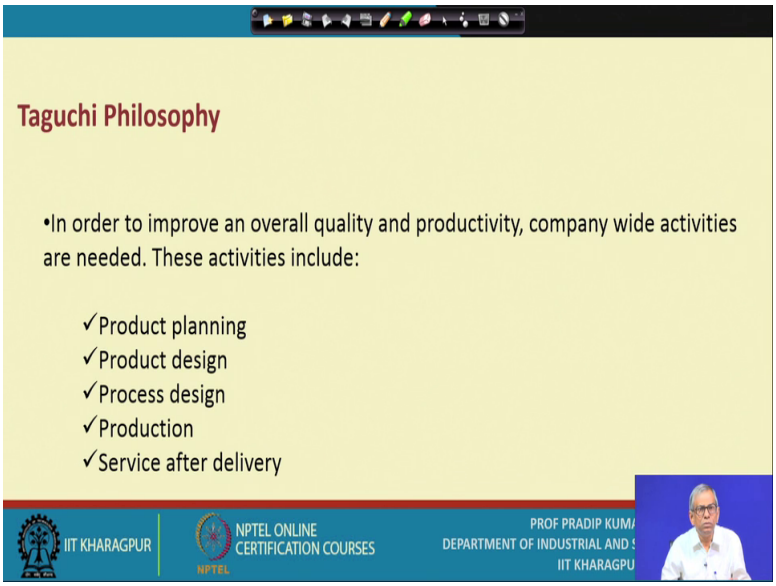

Now, whenever sometimes the Taguchi's method is referred to as the Taguchi philosophy; that means, when you adapt this particular the methods your mindset must change and you really you know the change your attitudes to for quality improvement in production processes. So, there is some fundamental changes in the attitudes. So, that is why sometimes these Taguchi methods are referred to as a Taguchi philosophy.

So, in order to improve an overall quality and productivity, you will definitely improve will always try to improve the quality, but you also make sure that the performance of the productivity of the systems or the performance of the productivity of the products concerned must also improve. So, the company to achieve this; that means, both quality improvement as well as productivity or performance improvement, company there you have to you know engage yourself in several types of activities.

So, these are obviously, this is the responsibility of the company and the main activities are the company's activities in this context is; product planning, product design, process design, then you production, opt for production and the last one is the service after delivery. So, these are very important and when you look at all these activities you will find that essentially we are trying to give importance to all the dimensions of quality.

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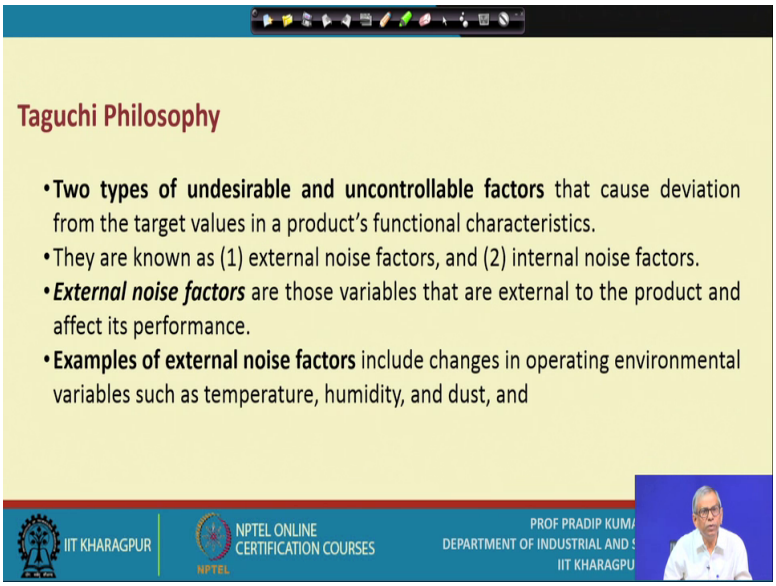

Now, 2 types of undesirable and uncontrollable factors you have not yet discussed in detail or we have not yet classified the various kinds of uncontrollable noise factors. So, there are essentially there are 2 types of undesirable and uncontrollable factors that may cause deviation from the target values in a products functional characteristics. A product may have different quality characteristics. Now, in each quality characteristic you have to identify the best possible, you know the nominal value or the desired value is it and you target to achieve this desired value.

So, it is not the mean value, it is basically the target value you want to achieve and when you start using the Taguchi method for quality engineering. So, the target values must be known. They are known as, now this 2 types of factors uncontrollable noise factors are classified as external noise factors and internal noise factors. Now, external noise factors are those variables that are external to the product and affect its performance. So, that is the external noise factors. So, what are the examples of external noise factors; like changes in operating environmental variables, such as temperature, humidity and dust; that means, they are existing external to your systems to your boundary line, but definitely they may affect the performance of the product. So, these are external noise factors.

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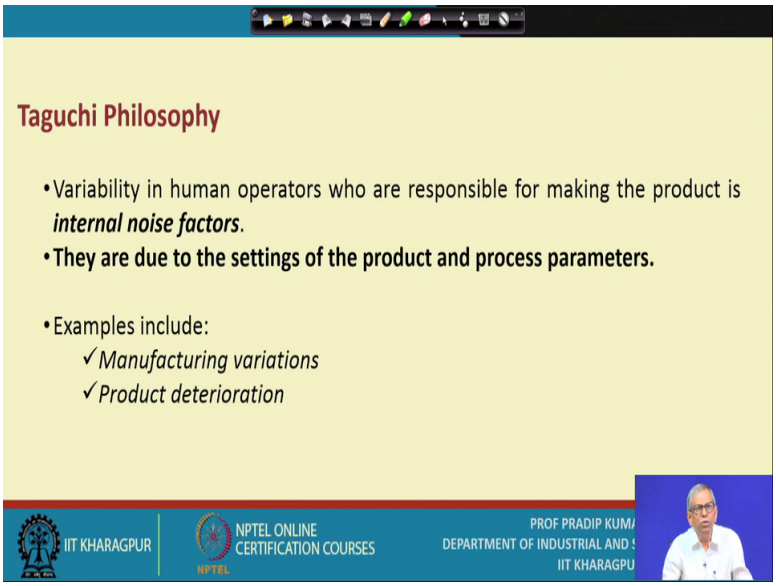

You have also internal noise factors. So, the variability in human operators, who are responsible for making the product, is internal noise factors which are unavoidable. If suppose, you engage the 3 persons for producing or manufacturing component or the product, so obviously, there will be differences in their skill levels and these variability is unavailable. So, this is considered as one example of internal noise factors. Now, they are due to the settings of the product and the process parameters.

So, sometimes what happens, you know if you engage person A, he will they set the machines in one manner. If you engage say another person say person B, on the same machine now he might set the machines in a different manner. So, obviously, you set the parameters of the machines in such a way that you can handle it you can handle the machines properly as per your skills. So, individual to individual there will be variation and this is referred to as one example of internal noise factors.

Now, under internal noise factors, there are 2 specific examples; one is the manufacturing variations, which are unavoidable and the second one is the product deterioration. Say, like say due to warranty or and there could be many factors which are dynamic in nature.

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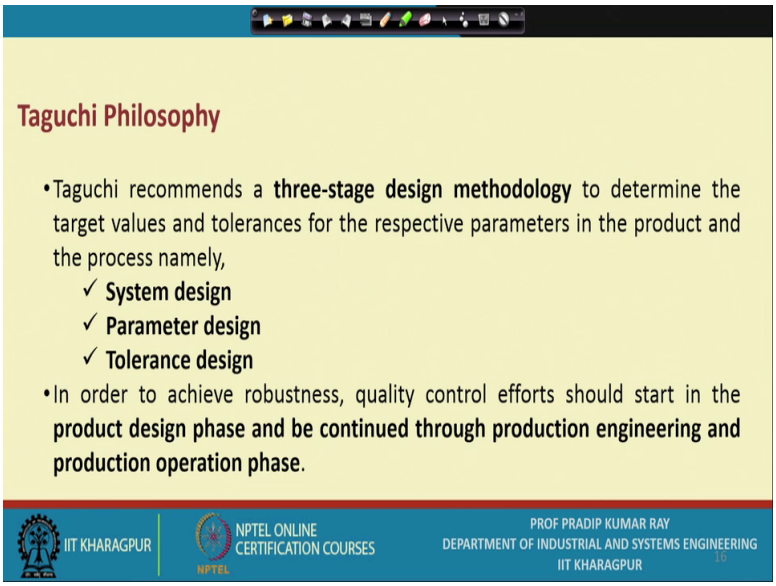

So, Taguchi, while he proposes a robust design approach to create a robust product he recommends us three-stage design methodology to determine the target values and tolerances for the respective parameters in the product and the process namely, system design, parameter design and tolerance design. So, these are the 3 steps. Now, in order to achieve robustness, quality control efforts should start in the product design phase and be continued through production engineering and production operation phase. So, this is very important.

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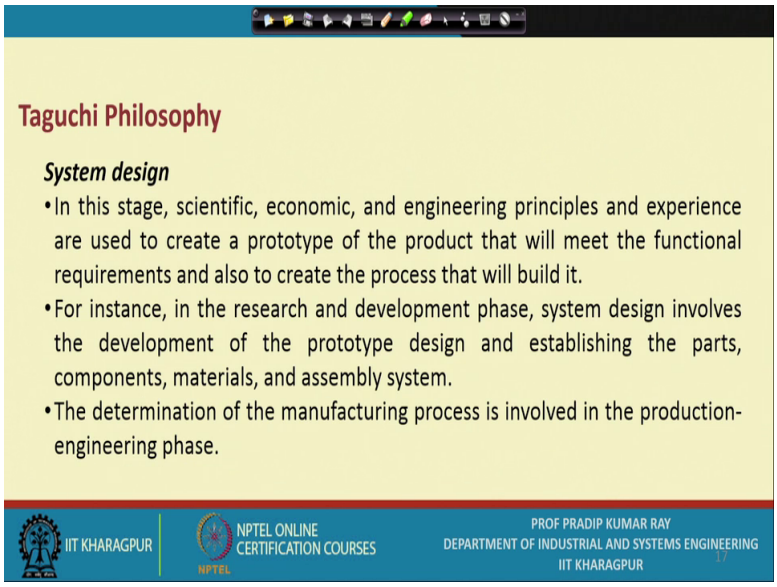

So, what is the system design? Now, in this stage, scientific, economic and engineering principles and experience are used to create a prototype of the product that will meet the functional requirements and also to create that the process that will build it. You know, essentially, during the prototyping stage or when you create the prototype, you follow these rules. For instance in the research and development phase R and D, system design involves the development of the prototype design and establishing the parts, components, materials and assembly system. So, and the determination of the manufacturing process is involved in the production engineering phase. So, this is the one.

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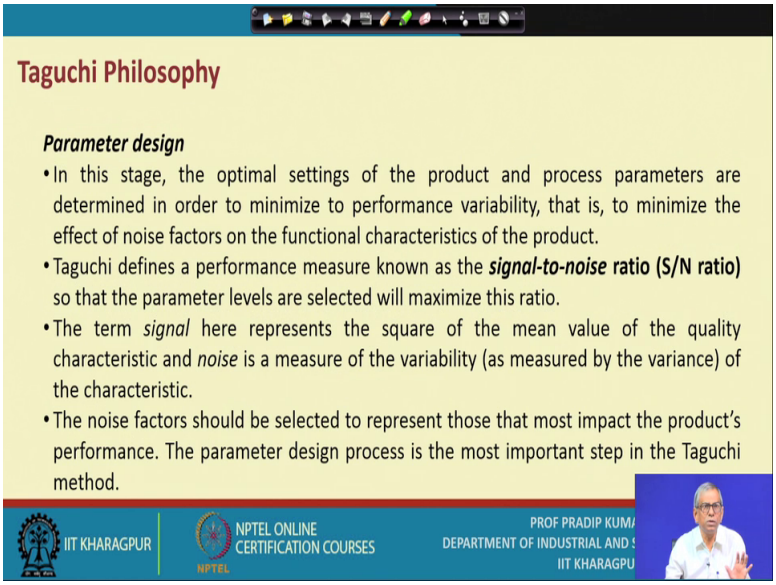

Next, we go to the parameter design. Now, here what you try to do; that means, you too you try to have the optimal settings of the product and the process parameters, this is the first 2; in such a way that you minimize the performance you will be able to minimize the performance variability. This is the first part you do and the in this context Taguchi defines a performance measure known as the signal-to-noise ratio.

So, we will be discussing this part later on in detail. So, this is the signal; that means, that is you know positive part of the performance, the desirable part of the performance whereas, you know you also have an undesirable say the part in the performance that is referred to as the noise. If the desirable aspect you improve and on the noise aspects you know you try you can minimize the noise, obviously, the performance is going to improve. So, he uses a particular performance measure known as signal to noise ratio.

Now, there are different measures. There different ways you can measure the signal; one way to measure it this is just get the square of the mean value of the quality characteristics and similarly, the noise factors should be selected to represents those that most impact the products performance. The parameter design process is the most important step in the Taguchi method.

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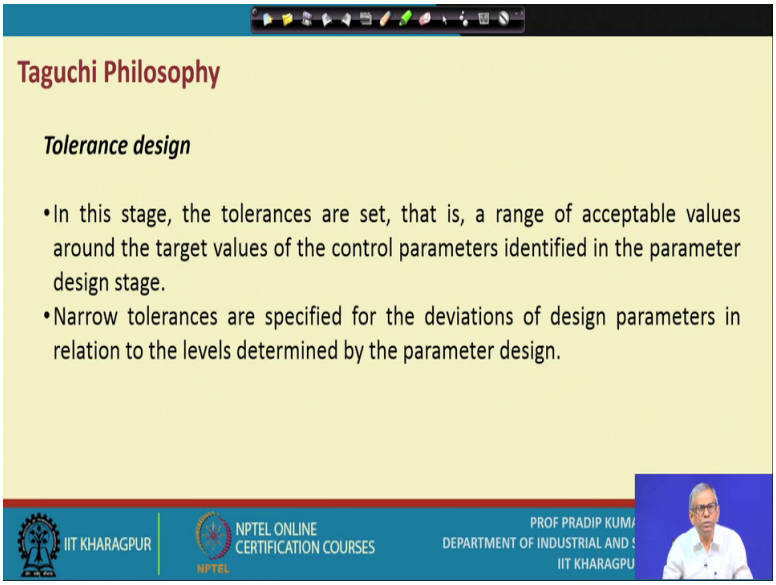

And then you go for the tolerance design. So, here, the tolerances are set, that means, a range of the acceptable values you must be able to determine around the target values of the control parameters. And narrow tolerances are specified for the deviation of design parameters. So, this is your objective narrow. So, if the narrow tolerances you are able to specify then you assume or you have created a design in such a way that close control of the process parameters is possible.

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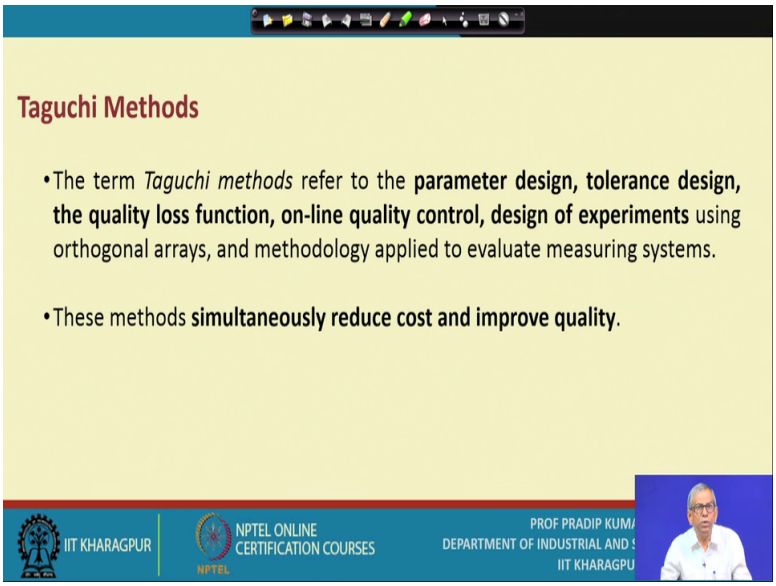

Now, so these are the 3 stages and this parameter design, tolerance design, the quality loss function, on-line quality control, design of experiments using orthogonal arrays the and methodology applied to evaluate measuring systems performance. These are all included in the Taguchi methods and these methods simultaneously reduce cost and improved quality.

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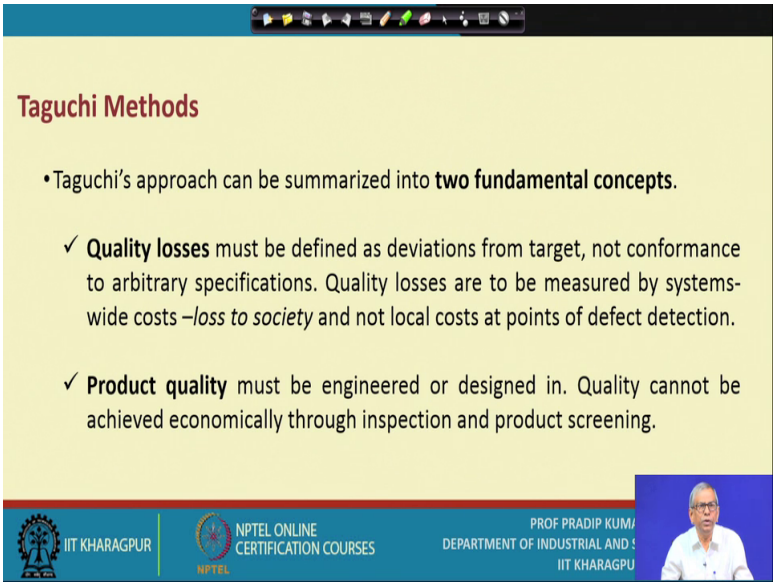

So, the quality losses you have 2 measures and as far as possible these quality losses must be measured in monetary terms and the product quality must be engineered or designed in. Quality cannot be achieved economically through inspection and products screening.

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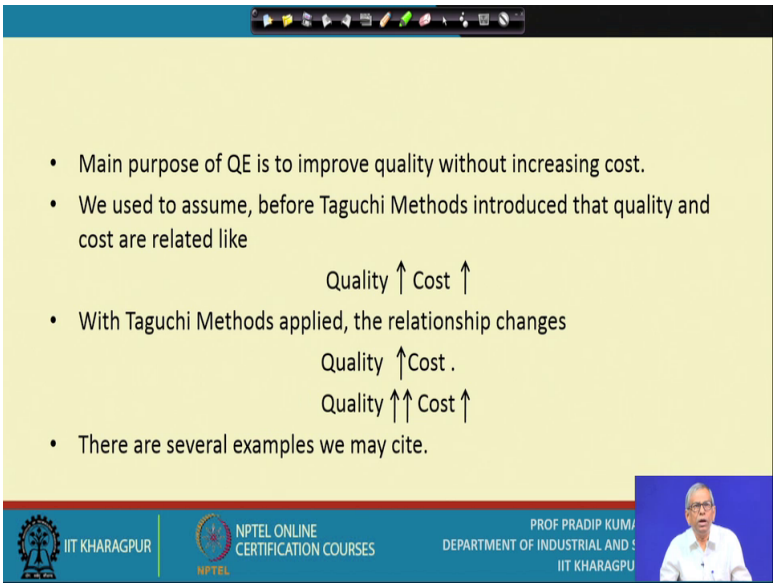

So, now I will conclude with this particular the concept, that is, what could be the relationship between the quality and cost? So, the main purpose of quality engineering is to improved quality without increasing cost. So, this has been the challenge. Before the Taguchi introduced the concept, his concept for designing a product, for manufacturing a product, we used to assume that if you want to increase the quality of the product, obviously, the cost also will increase.

So, we used to assume before Taguchi methods introduced that quality and cost are related like if the quality increases cost also increase. With Taguchi methods applied, the relationship changes to even if the quality say quality increases at a particular rate, where the cost may not increase or if suppose the quality increases at a faster rate the cost increases at a slower rate. So, obviously, there are several examples on this we may cite.

So, later on we will discuss this issues in details it is just. So, the introducing the concept of quality engineering and ultimately offline quality control, online quality control many tools and techniques you will learn and, but keep in mind that ultimately whatever you learn, those

tools and techniques methods methodologies you must be able to use to create a product, to create a system, to create a process, robust in nature.

Thank you.