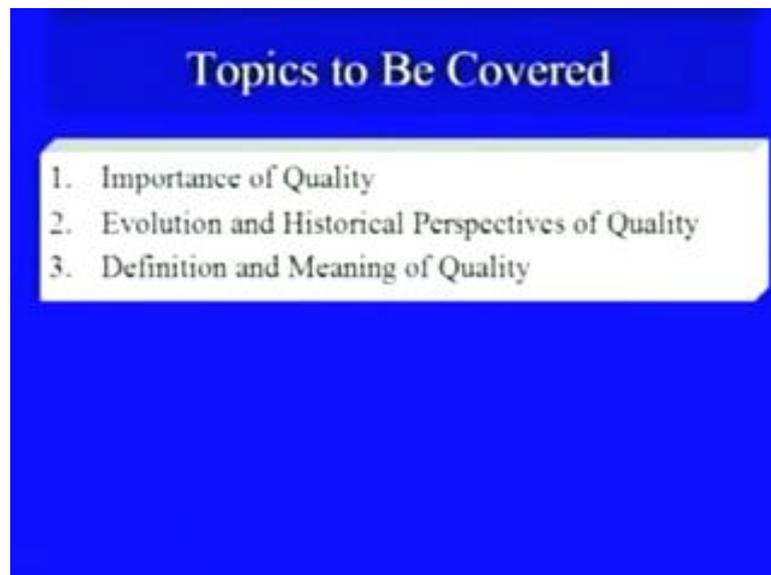


Industrial Engineering
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Module - 2
Lecture - 1
Statistical Process Control Part – 1

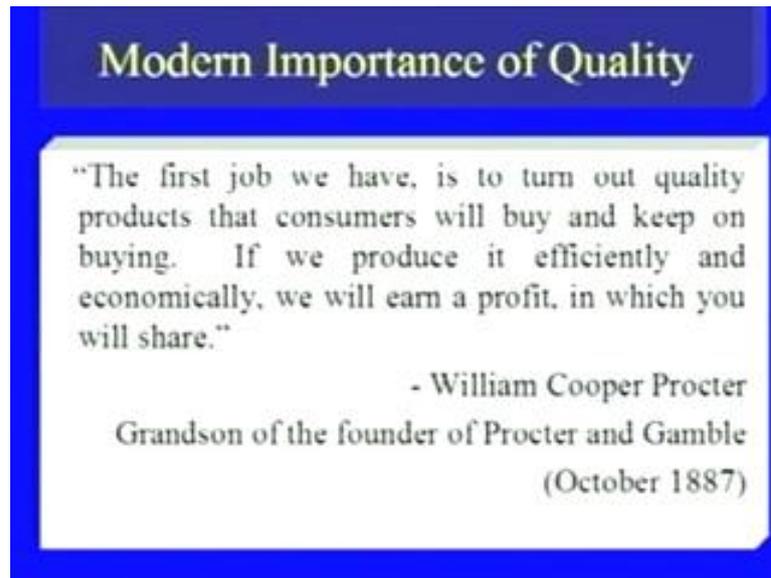
Dear viewers, the present lecture series will include the various topics on the Industrial Engineering, the topics that we will cover in this series are Statistical Process Control, basic seven quality control tools, new seven quality control tools, process capability analysis, facilities design etcetera. Today in the first lecture, we will cover the statistical process control, before we jump in to the mathematics and the concept part of the statistical process control. I would like to give you the idea of the importance of the quality, the cost of the quality evolution and historical perspectives of the quality, as well as the variability issues of the quality.

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The topics, that as I all ready I mentioned, that we will cover includes importance of the quality, evolution and historical perspective of quality, definition and meaning of quality.

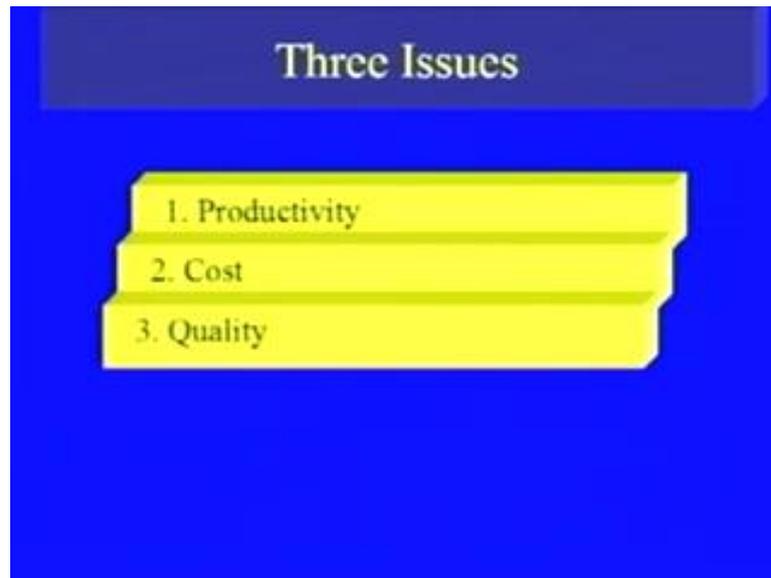
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The modern importance of quality that the saying has been given by the William Copper Procter, who is the grandson of the founder of Procter and Gamble and this saying he has given in October 1887. The saying is like this, the first job we have, is to turn out quality products that consumers will buy and keep on buying. If we produce it efficiently and economically, we will earn a profit, in which you will share, this is a comprehensive importance or this definition is the comprehensive importance of the quality.

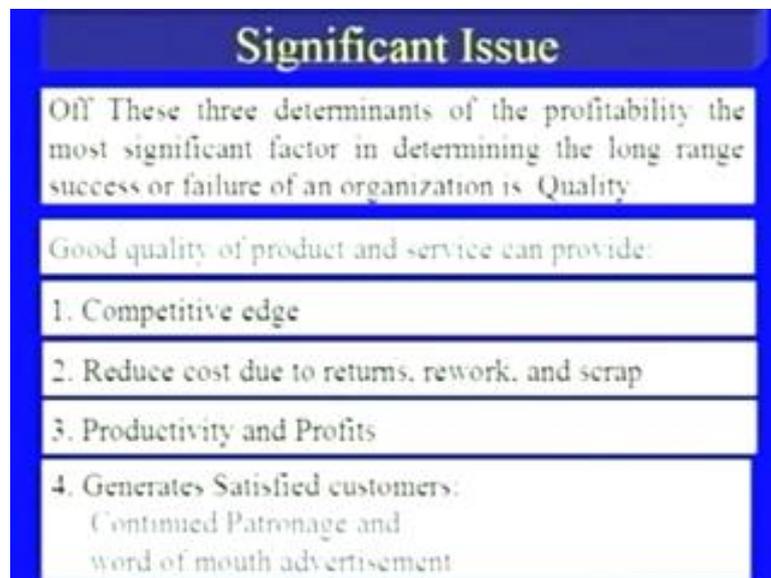
If you see that first this saying says about the quality, then it says that the consumer will buy and keeping on buying, that keep on buying basically means that company is producing the product that directly indicates regarding the productivity of the company. Also it says about efficiency and economical aspects means, it talks about the cost and in turn, talks about the profit, So, this definition gives four aspects, that three are the independent aspect and fourth is the dependent aspect.

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The three aspects or the three issues that this definition gives it includes the productivity, Second aspect or the second issue that this saying says about the cost. And the third aspect, this saying focuses on the quality. Out of these three aspects the most important or the significant aspect or the most significant issue is the quality.

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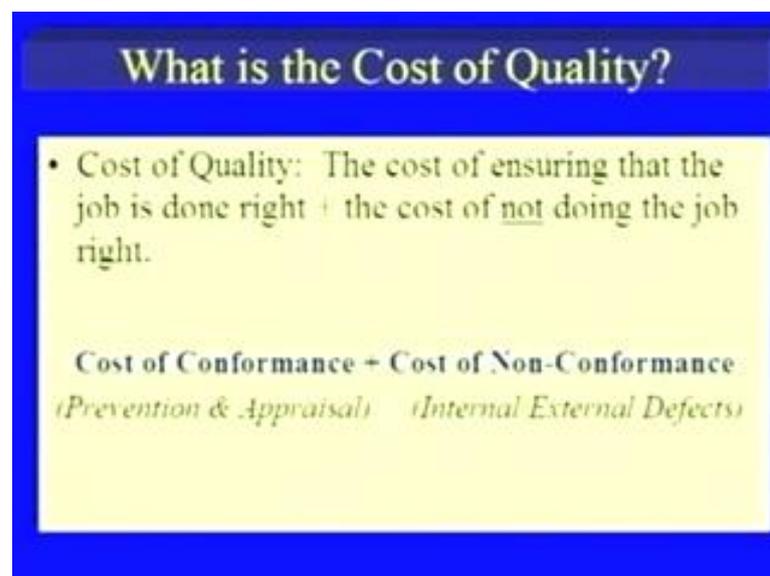
As it is mention in the slide of these three determinants of the profitability, the most significant factor in determining the long range success or the failure of an organization is quality.

Several benefits from the quality products or the quality services can be listed down, and some of the benefits of a good quality of the product and the services are given here. The first benefits is that if we are having or if we are producing a quality product or if we are delivering a quality service, the first benefit is the competitive edge that the companies or the organization can have. Second benefit that we can get from the quality of the product or the service that we deliver is the reduced cost due to returns, rework and scrap.

The third benefit that is mentioned here is the productivity and profit, this is basically, it is the outcome of the first and the second, that once the cost due to returns, rework and the scrap is reduced. Or the company is not producing any product that there is a need of rework or there is entirely that product is becoming a scrap. Or the customer is not retaining the product certainly the productivity as well as the profit of the company will enhance.

Finally, that if we are producing a quality product or we are delivering a good quality service, we are generating satisfied customer and satisfied customer, the benefit of a satisfied customer is that we will have the continued backing, get continued patronage as well as the word of mouth advertisement. Not only that we earn the profit, but this basically gives the goodwill to the company.

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The cost of the quality, when we are talking about the first issue that we have talked about the quality and we also had some points, that are related with the benefits of the quality. The second issue from the William Copper saying was the cost the cost of the

quality includes, the cost of ensuring that the job is done right plus the cost of not doing the job right, most of the companies their focus is on the first aspect that they always calculate the cost of ensuring that the job is done, right.

They go do the processes, they have the process checks, they go for the inspection, but most of the organization and most of the companies they do not count the cost of not doing the job right. Once the job is not done right they just either go for the rework or they just scrap the product, so but when we calculate or when we evaluate the total cost of the quality, we need to consider both portion that is the cost of ensuring the job is done right as well as the cost of not doing the job right.

The cost of conformance and the cost of non-conformance, the above definition basically if we summarize, the first part of cost of quality says cost of conformance and the second part says cost of non-conformance. The component of the cost of conformance and the cost of non-conformance are like this. Cost of conformance includes prevention and appraisal cost. Cost of non-conformance includes internal as well as external defect cost. The definition of all these four components of the cost of quality, they are here.

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Four Cost Categories Related to Quality	
• Prevention cost:	Cost of planning and executing a project so it is error-free or within an acceptable error range.
• Appraisal cost:	Cost of evaluating processes and their outputs to ensure quality.
• Internal failure cost:	Cost incurred to correct an identified defect before the customer receives the product.
• External failure cost:	Cost that relates to all errors not detected and corrected before delivery to the customer.

The first is the prevention cost, cost of planning and executing a project, so it is error free or within an acceptable error range. The second component of the cost of quality is appraisal cost that is the cost of evaluating processes and their output to ensure quality. Third portion of the cost of quality is internal failure cost, cost incurred to correct an identified defect before the customer receives the product.

The important factor in this definition regarding the internal failure cost is that we need to be very careful in deciding the cost, which is related to the internal failure cost that cost incurred to correct an identified defect, means once we are saying identified defect, this means that we are doing some inspection and we are finding that defect. So, not only we should find the defect, but we need to correct it. And, whatever the cost that we are saying that these are the internal cost, these cost basically are the cost that is counted before the customer receives the product.

The external failure cost, basically is the cost when the product has been shift to the customer, so when the customer starts using it and if he finds that there is some problem in the product, then the whatever the cost he basically spends that basically comes the cost comes in the category of external failure cost. That is the cost that relates to all error non detected and corrected before delivery to the customer.

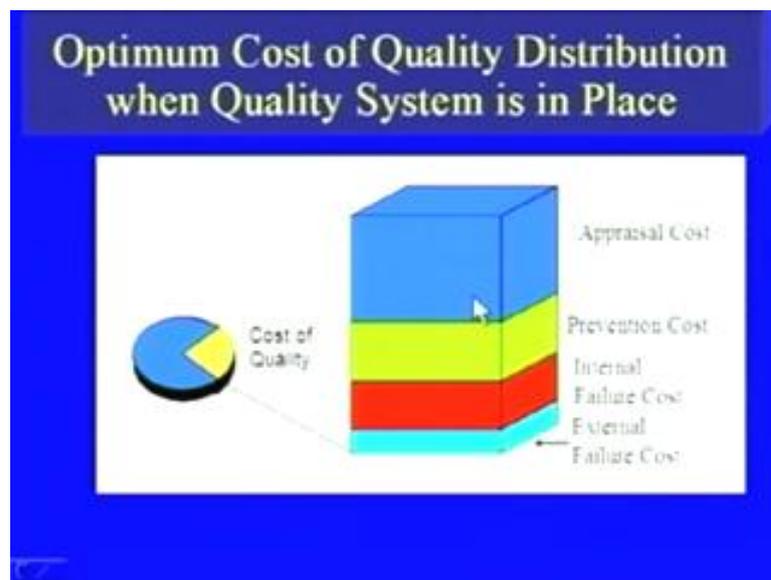
This basically cost, this has the multiple effect not only the product is coming back to the organization for rework or whatever it is, but it is basically spoiling the image or spoiling the goodwill of the company. So, the internal and the external failure cost need to be carefully ascertained apart from the prevention and appraisal cost. This basically shows, that normal cost of the quality distribution when quality system is not in place. This means a company which is not having or any quality processes or any quality concepts or any quality system in place that the four component that I mentioned prevention, appraisal, internal and external failure cost. This basically slide shows all those aspects.

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That if you see, that the cost of quality, the whatever the cost of the quality component is there the company is spending a very little amount in the appraisal cost and a lit bit more than the appraisal cost is prevention cost. So, this total appraisal and prevention cost that is the cost of conformance, the spending is very less as a result internal failure cost and external failure cost are very high. So, when internal failure cost and external failure cost are very high, that this says that the company goodwill, company product goodwill or company itself goodwill is not good.

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The another figure that we will see, that this is the optimum cost of quality distribution when a company is having quality system in place that. If you see that appraisal cost and the prevention cost that has been increased company focusing more on prevention and more on appraisal, the result of these two basically is the reduction in the internal and the external failure cost. Once internal and external failure cost have been reduced, this will focuses on three issues that I mentioned in the beginning of the lecture, that is the productivity cost and the quality.

So, once your scrap rework etc is reduced, certainly your productivity is improved quality, quality because these costs are just reducing because of the better quality. So, once better quality is there, productivity is there, certainly the profit the company that will earn is much higher than the company, which is not having the quality system in place. With the background of understanding of cost quality and productivity, let us talk about the evolution of the quality.

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Evolution of Quality

During the early days of manufacturing, an operative's work was inspected and a decision made whether to accept or reject it. The focus was just to accept or reject the products based on the specification. No effort was made on defect prevention.

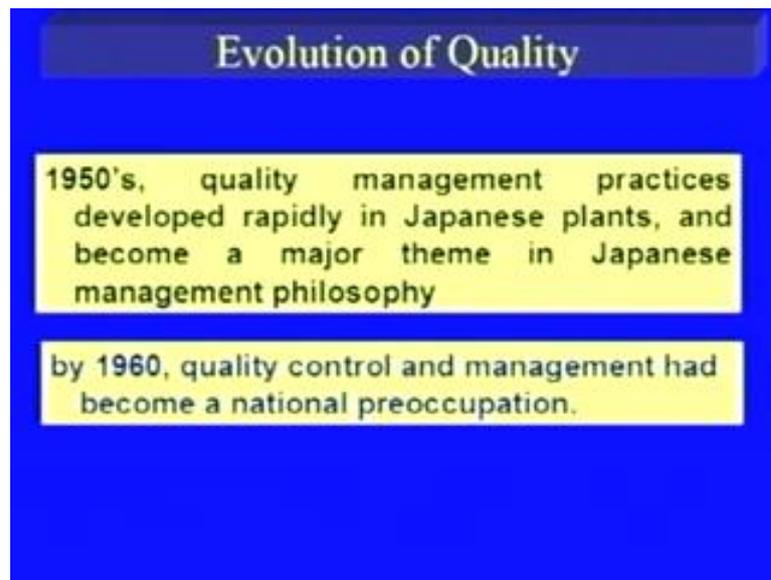
1920's statistical theory began to be applied effectively to quality control.

1924 Shewhart made the first attempt of a modern control chart. However, there was little use of these techniques in manufacturing companies until the late 1940's.

During the early days of manufacturing, an operating work was inspected and a decision made whether to accept or reject it. The focus was just to accept or reject the products based on the specification no effort was made on the defect prevention; that means, that total scenario was or the total productivity or the total output was based on the inspection. Inspection basically is an audit tool, it is not in building the quality into the product, it is just auditing good or bad.

So, the when the product is produced, the product inspector used to inspect it and they say it, it is good or bad, so bad product are sent back to the manufacturing whether for the rework or for the scrap and the good product was delivered to the customer. And there was no effort in putting, but was the causes that for creating the bad products, that is why its mention that there was no effort on the defect prevention. In 1921, the statistical theories began to be applied effectively to the quality control. And Shewhart in 1924, he made a first attempt of modern control charts; however, there was little use of these techniques in manufacturing companies until the late 1940.

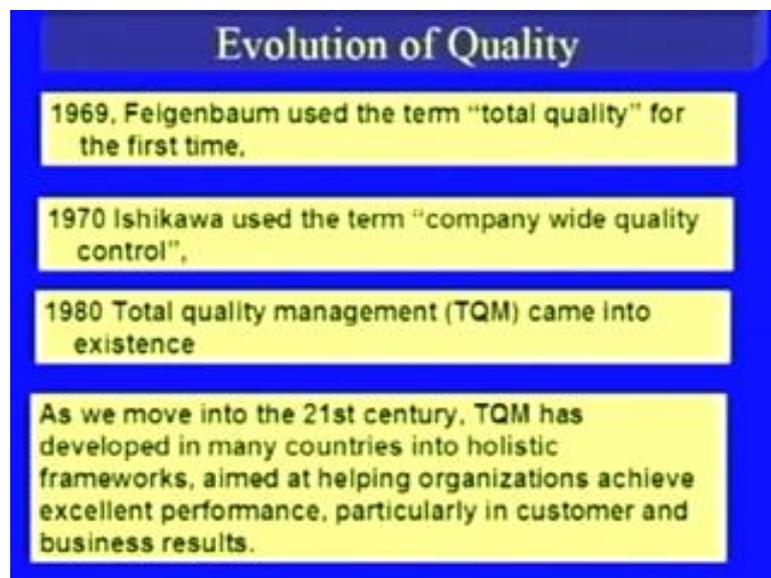
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The slide is titled "Evolution of Quality" in a dark blue header. Below the header, there are two yellow text boxes with black text. The first box contains the text: "1950's, quality management practices developed rapidly in Japanese plants, and become a major theme in Japanese management philosophy". The second box contains the text: "by 1960, quality control and management had become a national preoccupation."

In 1950, the quality management practices developed rapidly in Japanese plants and become a major theme in Japanese management philosophy. By 1960 quality control and management had become a national preoccupation.

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The slide is titled "Evolution of Quality" in a dark blue header. Below the header, there are four yellow text boxes with black text. The first box contains the text: "1969, Feigenbaum used the term 'total quality' for the first time,". The second box contains the text: "1970 Ishikawa used the term 'company wide quality control'," . The third box contains the text: "1980 Total quality management (TQM) came into existence". The fourth box contains the text: "As we move into the 21st century, TQM has developed in many countries into holistic frameworks, aimed at helping organizations achieve excellent performance, particularly in customer and business results."

In 1969 Feigenbaum used the term total quality for the first time and in 1970 Ishikawa used the term companywide quality control. In 1980 the total quality management came in to existence. And as we move in to the 21st first century, TQM has developed in many countries into holistic framework, aimed at helping the organization achieve excellent performance, particularly in customer and business result.

These evolution of the quality, if we see in the historical perspective, that this particular table if you see that it has been divided into the four part.

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Historical Perspective of Quality				
	Primary Concern	View of Quality	Emphasis	Methods
Inspection	Detection	A problem to be solved	Product uniformity	Gauging & measuring
Statistical Quality Control	Control	A problem to be solved	Product uniformity with fewer inspections	Statistical tools
Quality Assurance	Coordination	Proactively solve problem	Production chain designed to prevent failures	Programs and systems
Strategic Quality Management	Strategic Impact	Competitive opportunity	Market and consumer needs	Strategic planning, goal setting

First as I mentioned that initially in the early days of the manufacturing, the focus was on the inspection. There was no effort was put in to maintain the quality of the product regarding the prevention of the defect, second period or second row is the statistical quality control, third is the quality assurance, fourth one is the strategic quality management. And all these focus is basically, where seen with a different concern, primary concern view of the quality, what was emphasis and what were the methods used there.

If, we see the inspection, so during the early stage of the manufacturing in the inspection stages the primary concern was the detection, detection of the scrap, detection of the defective product or detection of the defect. Although there was no effort, on the prevention aspect as I all ready earlier mentioned and the view of quality during that period was that a problem to be solved and emphasis was productive uniformity that every product that is going in the hand of the customer should be uniform in all the aspects, means it should be perfect.

Methods that they used gauges and the different measuring instrument and based upon the gauges, calipers and measuring instrument they used to check whether the product has been made as per the specification and focus was the specification not the quality in

to the design of the product. The statistical quality control although, it is started the in modern quality control chart.

But up to nineteen forty, there was nothing there in the historic aspect that people are not utilizing the modern quality control charts in their manufacturing. Although during the second world war, these techniques were utilized for the preventing or to finding the defects as well as to go for the corrective action. That is why you see, the primary concern was control, means to inspect it as well as to find the reason of why the product is getting fail or why that we are producing the defective products.

So, the primary concern from detection, it has to change to the control, the view of quality was the same there problem to be solved and emphasis was productive uniformity with fewer inspections. The focus was that there should be consistency in the quality of the product as well as the inspection should be as low as possible. And the tools that they used in maintaining the quality of the product were the statistical tools. The third stages was the quality assurance and the primary concern was the coordination.

Earlier in the inspection and in the statistical quality control the focus was totally on the manufacturing side, means what is happening before the manufacturing and what is happening once the product has gone in the hand of the customer that focus was gone. So, they in the quality assurance stages, they tied to integrate the different aspects of the manufacturing, not only the manufacturing, but manufacturing, engineering, purchasing design section and install, field installation and commencing of the product.

So, they try to coordinate all the activities of the product life cycle and what was the view of the quality, proactively solve the problem. Emphasis was production chain design to prevent failures that production chain basically, the any manufacturing activity or manufacturing cycle that starts from the design. So, once you are not able to put the right quality into the design, you cannot put any effort to bring back the quality into the product.

So, earlier people were saying that once it has, once it is manufacturing stage they do the inspection and they check the specification, if they meet as per standard otherwise no. So, they tried to integrate the production chain that is designed to prevent failure method was programs and the systems. People were made aware, but the benefit of the quality is, what are the different features of the quality is by using tools, techniques and the awareness programs.

Finally, the present stage that is strategic quality management stage, primary concerned is that strategic impact, it is not only that we are talking about the good quality or the bad quality of the product. But what is the strategic long term impact of the product on the company not only on the profit, but on the goodwill of the company. The view of the quality, in the strategic quality management stage is the competitive opportunity. So, there is a lot of competition going on and just to survive in the competitive market, they basically the focus was the strategic impact, emphasis was market and its consumer need.

The Taylor made solutions, nowadays are coming up, people were basically driven by the customer earlier, the people whatever the products are available the customer used to take depending upon their requirement. But now the demand is basically driven from the customer, methods they use the strategic planning and goal set. So, this is an overview of the historical prospects in the evolution of the quality, starting from the inspection to the strategic quality management with different concerns from primary concerns to the methods.

Dimensions of the quality, whatever we are saying about the dimension of the quality or about the quality, that let us see what we think of the quality. There are various way we can think of the quality as the Garvin as mentioned the eight, he has given the eight dimensions of the quality that different people see that quality in different way.

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The Eight Dimensions of Quality	
1. Performance	(will the product do the intended job?)
2. Reliability	(how often the product fails?)
3. Durability	(how long the product lasts?)
4. Serviceability	(how easy is to repair the product?)
5. Aesthetics	(what does the product look like?)
6. Features	(what does the product do?)
7. Conformance to Standards	(Whether the product meet the specifications)
8. Perceived quality	(what is the reputation of a company or its products?)

Now, we can just see the Garvin as mentioned the performance as one of aspect or one of the quality characteristics that a person can see, only that depending upon the customer,

where he is maybe thinking of the quality, he may be thinking about the aesthetics different points are there. Some people think about the specification, some people only focus that the product should perform well. So, the first dimension, that the Garvin has given that the performance.

And the question that we can ask, will the product that we are getting it or will the product that we are manufacturing it, will the product do the intending job or the required job. The second is dimension is the reliability, sometime not only we talk about the performance of the product, but we also talk about the reliability, how often the product fails. Also sometimes we go for in congestion, where performance reliability and durability that how long the product last means the life of the product.

Serviceability how easy is to repair the product, in case there is small or little failures, aesthetic what does the product look like, features what does the product do. Sometime not only the performances reliability, durability there are different similar products are available in the market some products are having few features, some products are having some additional feature. That additional, whatever the additional we are getting that basically appeals to us.

Conformance to the standards, whether the product meet the specification, sometime customer provides that the product age should be have that much tolerance or that much specification, this much strength etc. So, whether the product that the customer ordered or customer thought, initially that whether the product meets the specification as he has specified. And the eight dimension is the perceived quality, the perceived quality means what is the reputation of a company or its product that is the goodwill.

Sometime we have in our mind that whatever the product that we are buying, that is having the good quality or the company's image basically goes with the product. So, these are eight dimensions that that depends upon the customer, that depends upon the person whether he is looking for one dimension, two dimension or all the eight dimensions of the product that he is equally satisfied with the performance. He is equally satisfied that the reliability, durability, serviceability etc.

Maybe, sometime some person go for only one or two dimensions that performance and the perceived quality, he is only looking that the company should be have the good quality as well as the product should perform well, the person may not bother about that how long the product last. So, depending upon the requirement, a person can have the

different dimensions of the quality. And coming to the definition of the quality, there are five different stages or different we can define the quality in five different way.

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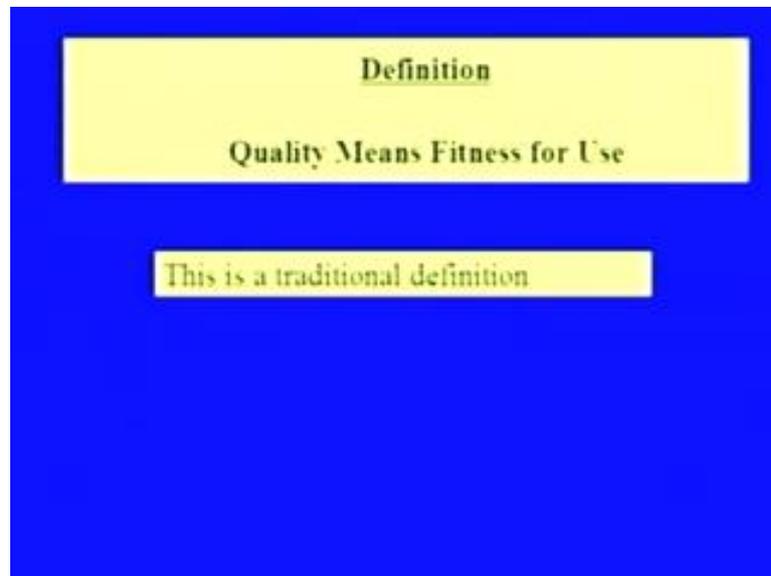
The first way is the transcendent definition that everything that is the excellence, transcendent means excellence. Everything that excellence in all the aspects that I mentioned you that there are eight dimension and when we go for the transcendent definition, we say excellence. The second definition maybe the product based definition quantities of the product attributes. The product maybe having one attribute, two attribute, three attribute depending upon the customer requirement, if customer is looking for more attributes, so then other definition maybe there.

Third, phase of the definition or the third type of definition, basically user based definition that fitness for use fitness for the requirement whatever I am intending for whether the product is fit for my use. Fourth is value based definition, sometime we take, we go for the product not only we check the quality, but also we go for the prices, if the prices are low and we try to make the tradeoff between quality and price.

Sometime, we have the good features, good quality, good performance, but cost are high in such cases that we go for the some because if the price is the prime concern, so we have to think of another product. So, there is some people, then they can go for the value based. And the fifth is the manufacturing based definition that earlier people used to have that is conformance to the specification, that whether the product that the is being manufactured meets the specification provided by the designer.

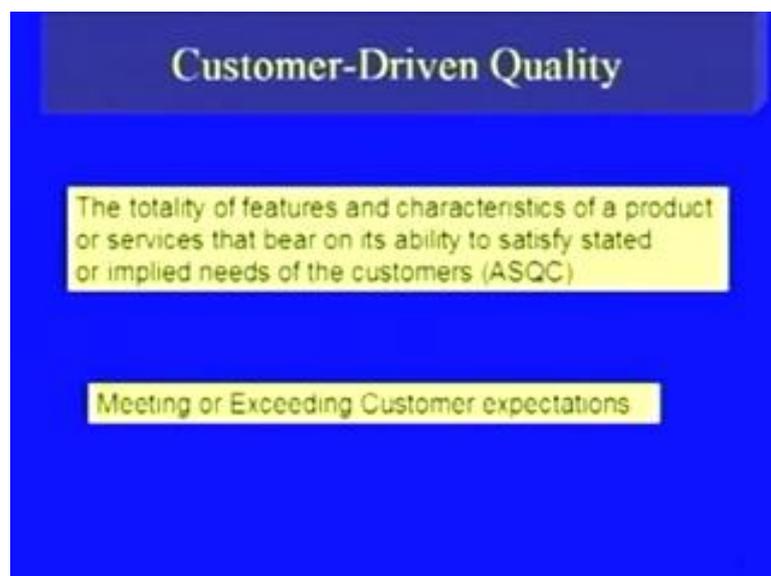
So, that this is the five different way, that we can define the quality. And all these definitions are because there is no unique definition, I earlier mentioned that is it is the individual perceptive, how he looks at the quality.

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This is a traditional definition that quality means fitness for use, this is given by the Joseph Juran.

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The customer driven quality, the as per the American society of quality control, that is ASQC. The totality of features and characteristics of a product or services that bear on its ability to satisfy, stated or implied needs of the customer. This means meeting or

exceeding customer expectation, there are different companies they just focus on the meeting the customer expectation. Customer is satisfied, but when you give some additional features something etc that customer was not expecting and you are giving some additional features, something extra means wow quality.

So, there is difference between meeting and the exceeding customer expectation, so when the customer buys a product and is satisfied with the product means he is the satisfied customer. But once you give the product with additional features, addition thing that the customer was not expecting; that means, basically the customer delight, customer feels delighted in buying and using the product.

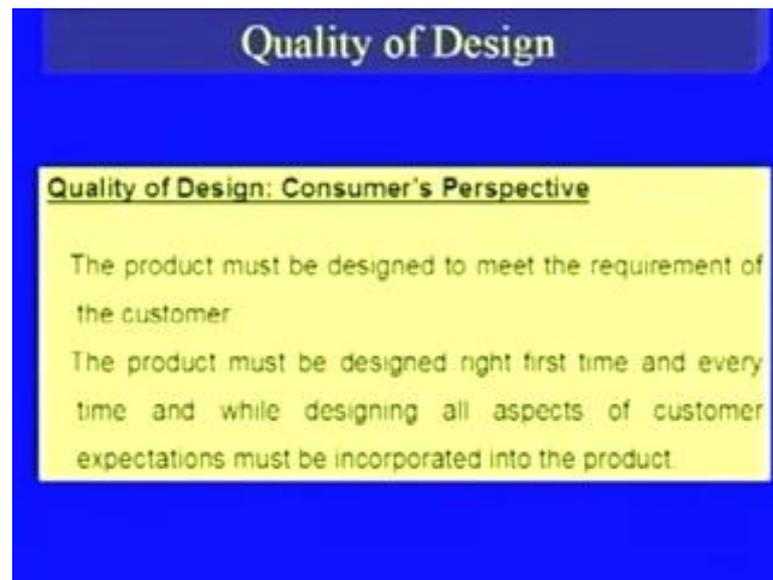
Three aspects of quality, I earlier mentioned that some of the product inspection stages, in some of during the evolution of the quality I mentioned that focus was on the inspection. Also in the definition I mentioned manufacturing based definition, when the focus was meeting or confirming to the specification.

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The three aspects of the quality in this link I say that all the quality aspects basically are a linked with the quality of conformance, quality of design and quality of performance.

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Quality of design is basically the consumers perspective, the product must be designed to meet the requirement of the customer. The product must be designed right first time and every time and while designing all aspects of customer expectation must be incorporated into the product. This definition basically that basically changes the focus earlier people were only concerned about the manufacturing, now people think that instead of looking at the downstream that is the manufacturing and the subsequent stages, we should look upstream.

When we look upstream, the focus should be on the design that the marketing person, from the market when they meet, go for the survey they contact the customer, they try to capture what the customer want. They try to capture the voice of the customer and they take, there are various means they go for the survey, they go for the warranty records, they go for the individual meeting of the customer.

So, when they meet it the customer tells them what they want, these marketing people then they understand what actually customer is requiring then they inform, then they give the entire detail to the designer, to the to the product design section or the designer. So, when product design persons they design the product, so it is there responsibility, if suppose as a designer, if I am a designing a product and if I am thinking that I am expert in all the areas, I cannot manufacture the right product.

Suppose, if I produce any product or if I try to design a product, I think that since the customer is asking for a very high strength, then I will suggest that this product whatever

the product I am designing. And I will suggest a certain material that is very good that basically delivers or that is having very high toughness and high strength etc. Then when this my design goes during the manufacturing, the manufacturing people may say that the material that you are specifying, that we do not have any machine to machine that particular material, the machining of that material is not possible.

Maybe the possibility is there, whatever the material the designer is suggesting that the purchasing department may think that they cannot buy the material, the material is not available, so this is basically a mistake, great mistake I should say, that the designer usually do. So, instead of designing the all aspects of manufacturing, they should involve the people from the subsequent or downstream section like purchasing, like manufacturing engineering, like manufacturing inspection all the stages when the product is in the design stage.

So, when the product is in the design stage, then whatever they are designing maybe at that time, at that time purchasing department or purchasing person function or purchasing manager may say, that this product or the material that we are suggesting will not be available in the market. Maybe the manufacturing person may say, that the tolerances that you are providing, our existing machine cannot deliver the same tolerances.

So, the focus basically is that we cannot put the quality, right quality back into the product in the subsequent stages. We should design the quality right into the product that is why, it is mentioned here the product must be design to meet the requirement of the customer, the product must be design right first time and every time. So, first time and every time, every time basically indicates the consistency of our delivery. And while designing, all aspects of the customer expectations must be incorporated into the product.

All aspects of the customer expectations means that I mentioned the eight dimensions of the product, maybe customer is looking for the performance as well as the reliability, durability. Whatever the aspect the customer has specified, all the expectation or all the aspects that the customer is expecting must be incorporated into the product. The factors need to consider while designing the product are.

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The type of the product, the cost, profit policy of the company, demand and the availability of the parts, so when a designer designs the product, he need to focus what type of product he is designing, he should have also the aspect of the cost that what is the cost that a customer is willing to pay. He should also need that I mentioned in while reading the slide, that he should also need to know what is the profit policy of the company.

What is the demand, whether it is one of type or a continuous demand type of product, whether whatever he is designing and whatever the parts or the component he is recommending, whether those component or parts are available in the market or not. It is not only restricted to the parts as I earlier I had mentioned that the material that the designer is suggesting, that material is available in the nearby market or available in the country. Also apart from all these five aspects that designer must also consider the process capability of the manufacturing machines.

That sometime what happens, the designer gives the tolerance say for example, plus minus point zero, zero three, means up to the three place after the decimal. But when the product or the component goes into the manufacturing, they think that or that machines the available right in the manufacturing area is not capable to produce the part with the tolerance that is having the dimension or that he is having the tolerance or that can give the tolerance back accuracy up to the three place after the decimal.

So, there is a to and fro moment of the product and the component they are blaming, because when the machines are not available that are capable to produce the tolerances up to the three place after the decimal. Then, the product is bound to be rejected because it is not meeting the customer requirement. So, these factors, the designer should consider while designing the product. The next aspect of the quality is the quality of conformance.

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The quality of conformance, basically it is the manufacturers prospective the earlier aspect that I talked about the quality of design that was the consumer prospective, so in this manufacturers prospective that we look, what the designer has given to the manufacturing section. And whatever, the bill of material what are the specifications that as been designed at the designed product design stage that basically comes through the manufacturing engineering section to the finally, manufacturing section.

The product at this stage must be manufactured exactly as designed, the activities involved at this stage include defect finding, defect prevention, defect analysis and rectificaton. So, as per as the manufacturers his focus should be that whatever the specifications has been been provided in the design, stage the manufacturing people should provide exactly the same way.

So, if not, if any how because of any reason the tolerance or the specification as not meeting as per the specifications, the first step in the analysis should be the defect finding. That careful finding of the defect why this is not happening, so once you know

that what are different type of defects there, then the control phenomena that how to prevent these defect. So, then we need to find out the reasons first, then we need to try out, try to find out where the control mechanism is there and we try to prevent all these defect and this is possible unless until we go for the defect analysis.

So, once we go find the defect, we analyze the defect then only we can prevent it and not only our purpose is to prevent the defect, but the rectification in the processes. So, that the process performance, the steps all the steps necessary to produce the product in a right way, first time and every time. Quality of conformance in continuation.

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That some of time, the difficulties encountered at the manufacturing stage must be conveyed to the designer. As earlier, I mentioned about that sometime it is possible that the designer is recommending the tolerance that plus minus point zero, zero three means up to three places after the decimal. And the manufacturing section does not have the capable machines that can produce or that can deliver such tolerances, so there is a communication between the manufacturer and the designer.

So, this two way communication, it is not it is not a one way communication, it is a two way communication between the conformance, quality of conformance sections to the quality of the designing sections or manufacturing to the design section. As mentioned here, the two way communication between designer and the manufacturing may help to improve to the quality of the product. If you look back the diagram of the three aspects of the quality that, this is quality of the designing section or you can say that designer

section, this is the manufacturing section. There is a two way communication, this way and that way, two way communication is there, the third aspect that now we are going to discuss is the quality of the performance.

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The product must function as per the expectations of the customer, this is basically the definition part of the quality I all ready mentioned, here the communication lies between the designer and the customer is the key to have a quality product. If we again, I am showing that diagram that if you see here, that there is only one way that once the product has been designed then it goes to manufacturing. Manufacturing people see for the conformance, here the communication lies both the end means designer to the manufacture and manufacture to the designer.

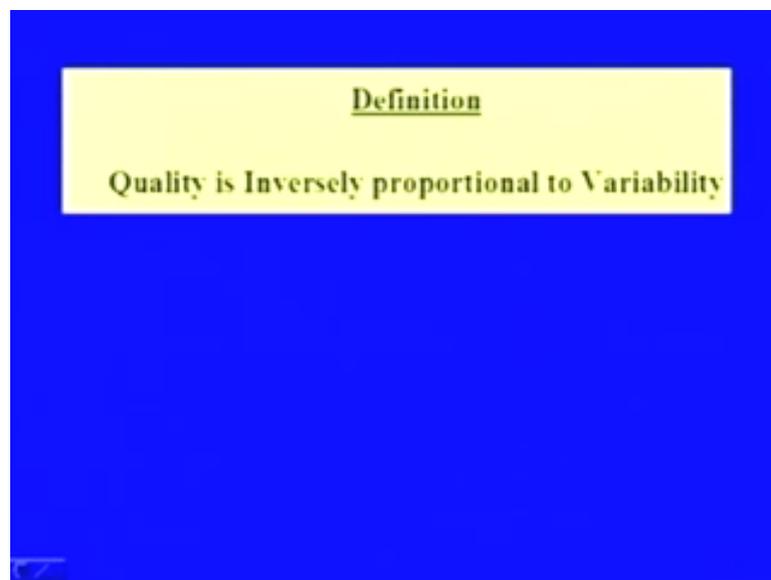
Then, whatever the product has been produced that goes in the hand of the customer and the performance quality, quality of the product performance is measured here. But whatever wrongs maybe the product is not performing well then instead of going back through the section that through the marketing persons that there is a two way communications between the designer and the customer. So, designer and customer they basically deliver the things deliver what the customer want, what they can what they can provide.

So, this is a two way commutation that is if of prime importance at this stage, so once we have all these three aspects quality of design, quality of conformance and the quality of performance. In all the cases, that we need one hundred percent perfection that our

design should be one hundred percent right our conformance with the specification should be one hundred percent right and the quality of performance should be one hundred percent right.

That is, that we should get ten out of ten, ten out of ten and ten out of ten in all the three aspects of the quality, then only we say that yes that our product meets the expectation of the customer. The other definition of the quality, we have talked about two definition earlier that quality is fitness for use, quality is what the customer wants or exceeding the customer requirement.

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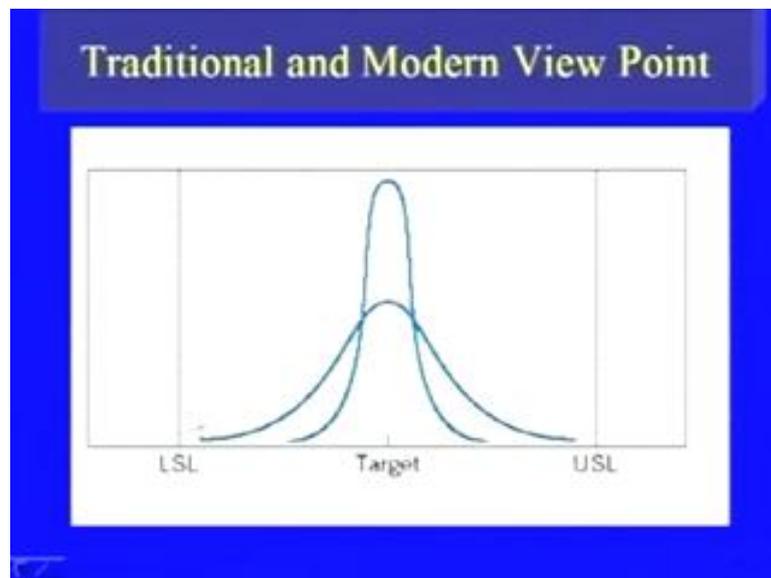
There is another definition that is the definition of the quality that quality is inversely proportional to the variability, this variability means the variation higher the variation poor the quality. So, this variation, basically is will be either from the processes or from the product. As far as the processes are concerned, we need to control the processes every process, ever machine, ever person they have the inherent variation and this inherent variation basically is the evil that is creating the problem.

The ISO 9000, basically ISO 9000 is the answer to it, the answer that ISO 9000 provides that it is a totally documented approach, and its focus is that whatever you do you document it and whatever you have documented that you do it and once you follow this, you follow it consistently. Now, the question arises that whatever we are documenting whether we are documenting right or wrong. If we have documented the wrong procedures that we are following the wrong procedure consistently.

So, that should not be the approach, that we should before documenting, we need to standardize the processes, we need to standardize the method, we should document only the right methods, right procedures. Once the procedures have been standardize, the total documentation should be there and whatever is documented we need to practice it. The focus in ISO 9000 was is basically that whatever irrespective of the person, irrespective of the system, whoever does the job that if he follows the documentation that the quality of the product will be exactly the same as was done before.

This concept of the quality that is it is inversely proportional to the variation is very well addressed through the ISO 9000. And ISO 9000 focuses, on the quality system approach and as well as the consistency of the processes.

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If you see, this traditional and modern view point of the quality in this diagram, if you see that this is the lower specification limit, this is the upper specification limit. And the traditional philosophy or traditional approach was that the customer has given two boundaries or two conditions that the product that we are manufacturing, it should be between lower specification limit and the upper specification limit.

Now, suppose if the product that we are manufacturing that comes near to the lower specification limit then if you buy this product after purchasing this product you start using it. And maybe after six month time because of the wear and tear or because of some problem this dimension whatever the dimension here or whatever characteristics

that product is specifying here, that characteristics goes beyond the lower specification limit.

Or the other way, if you purchase the product that is near to the upper specification limit that because of wear, tear and because of usage this characteristics of the product may go beyond the upper specification limit. So, then when this product go beyond this limit, either beyond the lower specification limit or beyond the upper specification limit, you need to do some maintenance or some rework on this particular characteristics of the product.

So, that it comes into the within the specified range that is the between lower specification limit and the upper specification limit, so that is the traditional way to look out look at the quality. Whenever, we put effort to bring the quality back between the lower and lower half and upper specification limit means we are putting extra effort, extra effort may in terms of money, in terms of human efforts. So, the modern view point, if you see this second curve that most of the products, this is the distribution of the products, this is the target value most of the products are just near the target.

And suppose, you buy the product that is towards the left hand side of this distribution or towards the left tail of this distribution, now by time due to wear and tear, due to the usage that it goes beyond the lower specification limit, the entire life of the product is over. Sometime, when we buy the product we say the life of the product is fifteen years, so if you even, if you buy this product here then the it will take more than fifteen years to go beyond this limit or if you buy this product, it will go more fifteen years to go beyond this limit.

So, this is the basically the difference in the view point, in the traditional and the modern view point, the traditional view point looks at the goal post philosophy that if even if it is closer to the lower specification limit you say pass or fail. But the modern view point says that we produce at the target and with a little variation around the target, so this is the concept. And this concept, clearly supports the definition that we are had all ready talked about the modern definition that quality is inversely proportional to the variation.

So, the lower the variation, better the quality is, and quality improvement basically is a continuous process, if we keep on reducing the variants, our quality will keep on

increase. So, here I am finishing my today's lecture and the same concept, variability concept, we will continue in the next lecture and we will build up the situation from the variability concepts. We will talk about the different quality control tools and techniques also we will talk about the basic seven quality control tools.

And, then we will talk about the all the control, statistical control charts ranging from variable to attribute type of charts. Today what we have discussed, I am just briefing what we have discussed in the today's lecture, that is that we initially we talked about the importance of the quality, then we have derived from that importance of the quality the different issues that is the cost, quality and productivity we have talked about.

Then, also we talked about the benefits, what the benefits of the quality is and after that, we had a little discussion on the cost of the quality that different factors, prevention of appraisal internal and external failure cost. Then, we have gone through the evolution of the quality and the historical prospective of the quality, in the historical perceive of the quality, we had divided the entire thing into the four stages that is the inspection stage, statistical, quality control stage, quality assurance stage and finally the strategic stage.

And all these stages, we have looked at in different view point the emphases was there the primary concern of the stage was there and the means and the method utilized in all the historical perspectives of the quality. And we, have seen that how the prospective changes from inspection to the strategic quality phenomena, then we talked about all the different definitions from the basic definition, from the traditional definition that quality is fitness for use to the modern definition of the quality, that quality is inversely proportional to the variation.

We have looked also the different aspects of the quality from the consumers prospective to the manufactures prospective. And we have try to drive the relationship between the all the three aspects that how the information is being shared between quality of conformance to the quality of design, from the quality of performance to the quality of design.

Thank you viewers.