Total Quality Management - I
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Lecture - 03
History of Quality Control

Welcome back my friends. I am Raghunandan Sengupta, teaching this total quality management course and welcome to this third lecture; each lecture being of half an hour and this is a total 20 hours program. Again to recap; even though the concept I have already mentioned; so, they would be after each week they would be assignments; so, they will be total of 8 assignments and 1 final semester examination.

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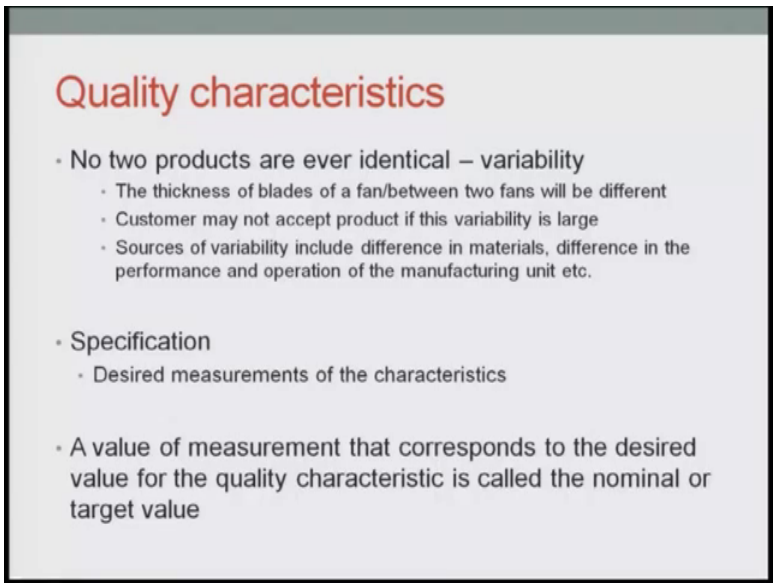

So, containing the discussion is quality its matrix and characteristics. So, this is now in the discussion we will take place about the characteristics of quality. So, no two products are ever identical so; obviously, they would be variability like say for example, if we consider a group of human beings. So, the heights are different; so, there would be variability, if they which you are considering they would be variability.

Obviously, it does not have any implication for the quality as such in general, but I am giving these example. So, say for example, if jam bottles are being manufactured or sauce bottles are being manufacturer or say for example, you are filling up teens of Amul; taaza milk or we are trying basically trying to fill up Tropicana juice; tetra packs.

So; obviously, they would be variability in the weights. So, whatever characteristics you are trying to measure in the quantitative sense for quality would have a level of variability; whether the variability is very high or low that is a different question, but they would be variability.

Consider this examples which I gave and when I added to that consider these examples. The thickness of blade of a fan between two flans would be different; the orientation of the blades of the fan maybe different. Because; obviously, they are all manufacturing processes they would be mechanical machines being utilized, they would be human errors, they may be machine errors white noises whatever they are.

So, for all these reasons they would be variability. Customers may not accept products if the variability is very large. So, if you remember; if the variability is very large it basically has an adverse effect or negative correlation with quality; which means quality would go down hence the customers would not be satisfied with the level of quality for that product or the service.

Sources of variability include difference in the materials, type of materials which are being used, the type of manufacturing process which you are using, the difference in the performance and the operations in the manufacture unit which are been manufactured; it maybe de depending on the temperature, it may be depend on the color, it may depend on the humidity or say for example, many things will basically may affect the variability and make it large; such that it will have an adverse effect on the quality. Quality characteristics are also related to specifications which are the desired measurements of the characteristics whether they have been met.

If you are trying to basically build coming back to the example of the tie rod or the transmission line; if the actual length should be 12.5 feet; obviously, it would mean that until this is 12.5 that tie rod can have utilized in the mechanical sense for basically passing on the transmission power from the engine onto the gear system of the truck or the LCV or the car or whatever you are manufacturing.

A value of measurements and that correspond to the desired value for the quality of the characteristics is called the nominal or the target value. So, if you remember the example which you are talking about the products of the transmissions of being supplied by

customer 1; which was the US company and customer 2, which was the Japanese company.

And this was the example we consider in lecture number 2. So, in that case; obviously, as mentioned by the last point of Jack Wells; which means that even if the characteristics of the quality implication which you are trying to measure in both the cases was same; here the variability for the Japanese product which was customer 2 watch much more less with respect to customer 1 which was the US company; such that if the which would basically have an implication in the variability and again coming back to the same point variability being high would mean quality level characteristics are much low.

So, this target value is basically the value which you want to achieve, when you are trying to manufacturing this product. So, considering the example of the tie rod; the actual target value is 12.5 meters; what I mentioned or 12.5 feet; whatever it is. The values which I mentioning may not have any actual practical examples, but the values in the numeric sense would give you an idea that what are the target values and the characteristics of the overall product would be to basic be added to the other than both the numerical characteristics of shape, size, scale, color whatever it is; based on which I am trying to utilize that product.

Or say for example, if the quality of the cloth which I have purchased or the quality of the garment which I have purchased and if it is woolen garment; if basically the quality of the wool is of poor quality; obviously, it mean that with very few washes that the level of the quality or the level of usage of the woolen garment would basically decrease which means; the durability is very low which means the variability would have a huge implication and a negative implication on the concept of quality for that product.

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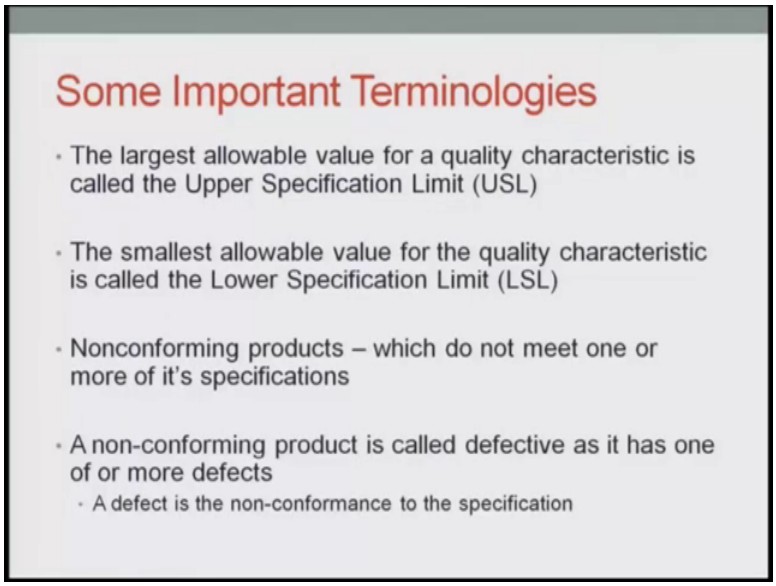

Now, we will be utilizing and meeting for the first time few characteristics in the quantitative sense and you will see these characteristics in the quantity sense would be appearing time and again when we discuss the quality control charts; the X bar charts, the P charts the art charts and so, on and so, forth. So, let us at least spend some time in understanding these quantitative concepts; in a qualitative frame works such that when we actually do the problems; they would become much clearer to you.

So, again I am saying that with a notion that we will first consider the qualitative aspect of the quantitative terms and then later on when will see that as we solve the problems; will be able to understand them in a much better sense. Now, as far as I can recollect in figure 1.2; that is where we consider the target value, the variability and we measured what was the metric along the X axis and along the Y axis; if you may remember we measured the relative frequency of the probability.

Now, they were if you go back to the slides or go back to the lecture; they were two other vertical lines on to the right and to the left of the target value. They were basically given as terms and names as UCL and LCL; which is basically the upper control limit and the lower control limit to which we will now discuss and make it much clear for the audience to appreciate what actually UCL and LCL means. So, UCL or USL which basically means the upper specification limit also. So, these words would be utilized interchangeably so do not worry about that.

So, UCL also would mean USL which is the Upper Specification Limit; it means the largest allowable value for a quality characteristics what we can measure and what we are allowed to basically measure and basically see to that that the characteristics of the quality being measured in the quantitative sense does not over exceed that would be known as the USL.

And the counterpart on the left hand side; that means, if you looking on the graph with the middle value being the target one and as you go on to the right hand side of yours; the value still keeps increasing and if you go to onto the values or to the left, the values decrease. So; obviously, the value of LSL which or LCL which is the lowest specification limit or lower control value would be on the left hand side. So, the second point means; the smallest allowable value for the quality characteristics is called the lower specification limit, which would be on the left hand side and try to recapitulate it figure 1.2.

Non-conforming products would be the products which do not meet one or more of its specification for which it has been designed or made. Consider this; if the heater is not able to heat the room or if the AC is basically were not able to cool the room; obviously, it means it is not able to function as per is normal standards. So; obviously, they would be non conforming products based on the characteristics for which the products are have been built a designed and have been made.

A non conforming product is also called a defective one as it has one or more defects based on the level of quality characteristics which are going to study or which we intend to study for the product; for which it has been designed. So, the defect is the non confirmations to this specifications, it may be related to color, it may be related length, it may be related to weight, it may be related to height, it may related to texture, it may be related to say for example, pH scale.

Consider you have you have trying to basically manufacturer a chemical. So, on the chemical and consider as a fertilizer and you want the pH scale to be absolute neutral in that case; obviously, if the characteristics of fertilizer is not as per the pH scale is basically more acidic or alkaline, it would mean the actual characteristics would be as per the non conformance of the product for each has been designed and it would be called as a defective product.

Or say for example, you have purchased a cloth and to be used during the summers and you thought that you could basically be able to really give you the comfort; considering with; if the very high humidity or high temperature it is and if the type of the cloth is of terylene type of terry cotton type; so; obviously, mean it would not be able to soak the overall the sweat of your body and it would not meet the actual quality characteristics for which you have purchased the products, so; obviously, it mean a non defective product or non conformity product.

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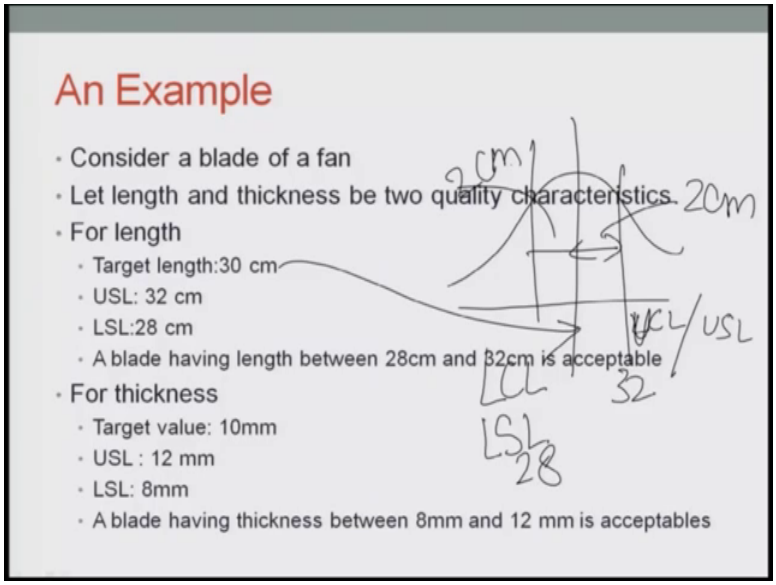

Examples to continue this; would be consider the blade of the fan; so, let the length and the thickness be of two quantity; which we are trying to measure for the length. Say for example, the target 1; which is the middle line or say for example, considering this is the normal distribution; the mean, median and mode whatever we say; it is 30 centimeters and if you consider the normal distribution to be true; which may not be true in many of the examples, but we will try to utilize the normal distribution for our general our studies.

So; obviously, it would mean the USL and the LSL or the UCL or the LCL which are corresponding to the upper limit and the lower limit are equally disposed on to the right and the left, because it is a normal distribution. So; obviously, you have to mean that if USL or UCL is 32 centimeters; where the target value is 30 centimeters, then the corresponding value of LCL or LSL would be 28. So, if I draw this curve in a very

simplistic way; with the mean value being the target. So, this is the normal distribution; the mean value being 30 which we have measured. The LCL or the USL; this is the UCL sorry UCL or USL being 32 and the lower control limit or the lower support level; whatever it is; it is 28, which means the differences are 2 centimeters here; 2 centimeters here.

So; obviously, this 2 centimeters which you are considering as the LSL and this USL need not be plus 2 or minus 2; it can be say for example, plus 4 and minus 4, but the level of difference from the central value or the target value; would depend on what you are considering is a variability or the actual dispersion of the distribution based on which you are measuring; I will come to that later or. So, it would mean considering the example we have considered of a target value of 30; upper value 32, lower value 28.

A blade having length between 28 centimeters and 32 centimeters is unacceptable. Say for example, if you consider the actual HP of a motor it is rated say for example, 200 HP and the overall utilizes in such that if the motor is between the value of 210; say for example, of 190 HP; you will basically consider that motors as conforming to the actual quality characteristics.

Or say for example, you are basically making a special type of paint; to be utilizing in painting a room and the grade of pink; if for example, between plus and minus whatever level of value of utilization; or measurement of paint you are utilizing; if it is basically confirming to that, you will utilize that in painting in that room. Or see for example, you are trying to basically utilize as coming back to the example of the fertilizer.

If the pH scale actual target value is neutral which is 7 and if the values between which you can utilize is 7.5 and on the other side 6.5; then you if all the fertilizers are within that range of 6.5 to 7.5; you will say that they confirm to the characteristics of the overall utilization of the fertilizer and use them as not as confirming products and the other products which are over 7.5 and below 6.5; you used like say they are actually non conforming to the products.

To consider this the example further; for thickness of the blades we consider the target value of 10 mm; again consider the central value to be 10 mm; the USL or the UCL is plus 2 with 10; which is 12 millimeters and the LCL or the LSL is 10 minus 2 which basically becomes to 8 mm. So, all the products which are within this range of 8 to 12

are acceptable and considered as confirming to the level of quality characteristics; which we have assigned to them.

So, this value of LSL, USL or the upper value and the lower value may change. See for example, it may become 14 in the second example and the lower value may becomes 6 which means 10 plus 4 is 14 and 10 minus 4 is 6. So, in that case they may conform to the characteristics depending on what you have pre set or the values or the upper control limit and the lower control limit; that would depend on the level of quality which you want that product to confirm.

So, in that case all the products which are outside this range of 14 on to the right of 14 and to the left of 6 would; obviously, consider as defective product and not confirming to the characteristics of qualities which you have assigned find yourself to measure.

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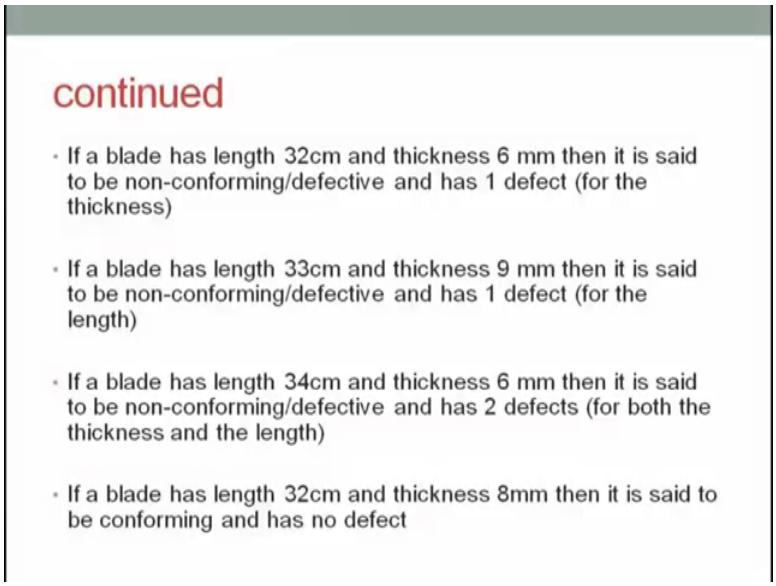

Consider the examples further on; if a blade has length 32 centimeters and thickness 6 millimeters then it is set. So, if you match with the length and the thickness. So, continuing with that; if a blade has length 32 centimeters and thickness 6 millimeters; then it is said to be non conforming defective and as one defect for the thickness. So; obviously, it means the characteristics of the length, but there is defect in the thickness; so, there is one level of defectiveness. So, consider the second bullet point as measured here if it a blade has length 33 centimeters and thickness 9 millimeters; then it is said to

be non conforming or defective or has one defect and the defect is with respect to the length.

Because if you remember; the length target value was 30 plus value was 32, minus values was 28. So, this value 33; 33 is the above the upper control value, but this 9 millimeter was within the range. So, it basically means that characteristics from the thickness point of view.

Considering the third bullet point; if a blade has s length 34 centimeters and thickness 6 centimeters so; obviously, 30 more means 34 means; it is not conforming to the length; 6 means it is not confirming to the breath or the thickness. Hence it is said that it is non conforming or defective an account for both that affects, because it does not added to the properties of thickness and length; based on the upper value and the lower value for this example.

Consider the last bullet point; if a blade is length 32 centimeters and thickness 6 millimeters; then it is said to be conforming to both the account of length and breadth. Hence it is not defective and it basically meets both the criterias; not to the same level, but basically level what I am utilizing it before but I will come to that concept that what is the overall concert of level to confirmers later on as we do the problem. But in this example, we see the fourth bullet point; it basically means that it adders to both length and thickness; hence it is not a defective product.

So, now with all the discussions about quality and what we mean by quality; the different dimensions of quality, what are the different type of characteristics of a quality? How do you measure quality? What is mentioned as the target value? What is upper control value? Lower control value and what you see as the defective items. So, having mentioned that we will basically go out through e brief sequence of history of quality; so, I would not be discussing much of quality as from the historical perspective.

But give you the main milestone based on which quality has taken some jumps in those time period; such that we can really say that the concept of quality and the level of quality and in the study of quality has really taken a front street at those milestone such that quality has become as more and more integral part of our life; as days have gone by.

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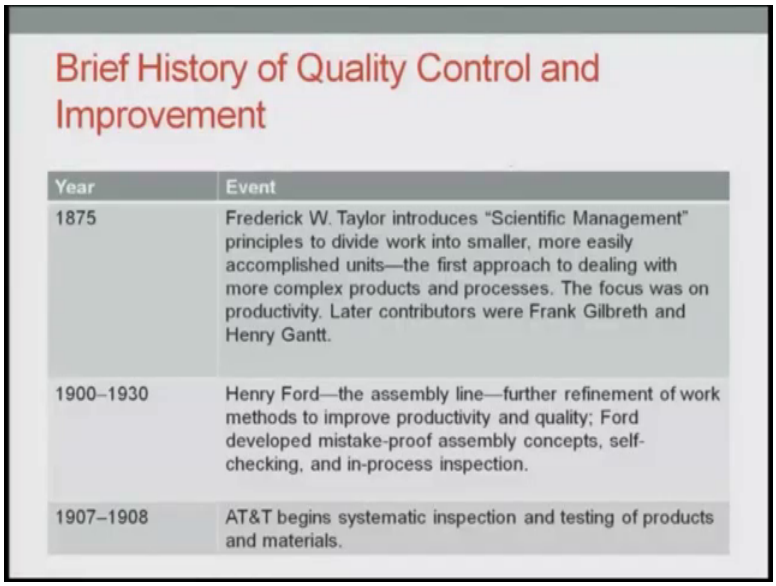

So, consider this chart; I have made it in the very simple chart so that you can understand the year and what was the actually event which happened; which you can basically say that has have a great implications in trying to basically bring quality as the main focal point for the discussion for total quality management which we are studying here. So, in year 1875; Frederick W Taylor introduced the concept of scientific management principles to divide the work into small concepts of works; into smaller most units to easily accomplish units.

The first approach to dealing with this more compressed products and processes was basically done in this year and in and around that. The focus was more on productivity, how works could be broken down into smaller units such that you can increase the productivity. Later the contributions which came from Fraqnk Gilbreth and Henry Gantt; so Gantt was basically the person who proposed the concept of Gantt charts and so, on and so forth.

So, then later part in the 1900 to 1930's after the works of Frederick Taylor, Frank Gilbreth and Henry Gantt; Henry Ford came up with his great concept of trying to produce; manufacture car for the masses. So, basically Henry Ford was the main person who came with the concept of the assembly line; for the refinement of the work methods to improve productivity and quality and basically to improve the throughput. Ford developed mistake proofs assembly concepts; self checking an in process inspection, but

the problem was that because the demand of product was so high; people were even willing to accept; not good qualities or products which are not conformed into quality.

But Henry Ford can be considered a pioneer in this field because in that is quality was there in the scenario, but the level of sophistication of quality was not to that level which we now see; now a days after the work of say for examples Jiran and Dabbing; which will consider later on.

In the 1907 and 1908 AT&T began systematic inspection and testing of products and materials to find out whether they are basically conforming to quality or not.

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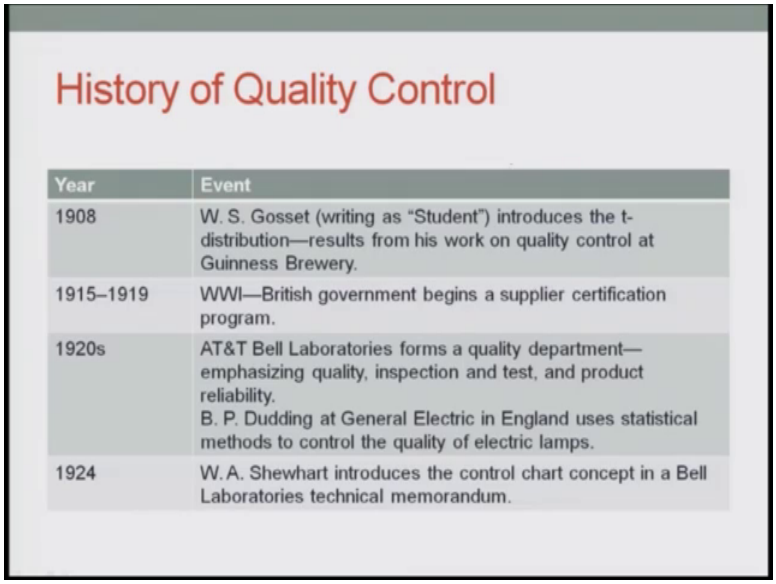

This I am giving as a sequence with are going to the details of discussion. In 1908 Gosset; who basically wrote his used (Refer Time: 21:52) student proposed the introduction of t-distribution; t-distribution is one of that is main distribution which comes out as an of astute for the normal distribution. Those f distribution, chi square distribution and t distribution; we will study t distribution later on; that is t tests and all these things. So, introduced the t distribution that the person by the name of W. S. Gosset results from his work on quality control and gunnies bravery; that means, the bravery with basically manufacturers beer.

In 1915 to 1919 during World War 1; British Government begins of supplier certification program basically to added the quality characteristics of the products, which are being

supplied to the armed forces and to the industry in Great Britain. In 1920's AT&T Bell Laboratories again forms a quality department emphasizing quality, inspection test and product reliability and product been confirming to the quality level.

During at general electric in England uses a statistical methods to control the quality of the electric lamps and test whether they will basically adhering to the level of qualities or level of satisfaction for which the products were been build; so, here the products for the electric lamps.

In 1924; Shewhart introduced the concept of quality control charts in a Bell Laboratories. So, based on the work of 1920's where they were being utilized to check how good or bad the products which were the electrical lamps; which are being manufactured, Shewhart came with the control quality charts; such that they could be actually utilized such that the concept of statistics could be brought out in a very simple way such that could be utilized to understand; how the process was going on, whether the process was adhering to the quality characteristics and if there was not adhering to the characteristics of quality; which they were supposed to do.

How things could be looked into in details to understand where the problem was. In 1928; acceptance sampling methodology was developed and was defined by Dodge and Roamig in Bell Labs.

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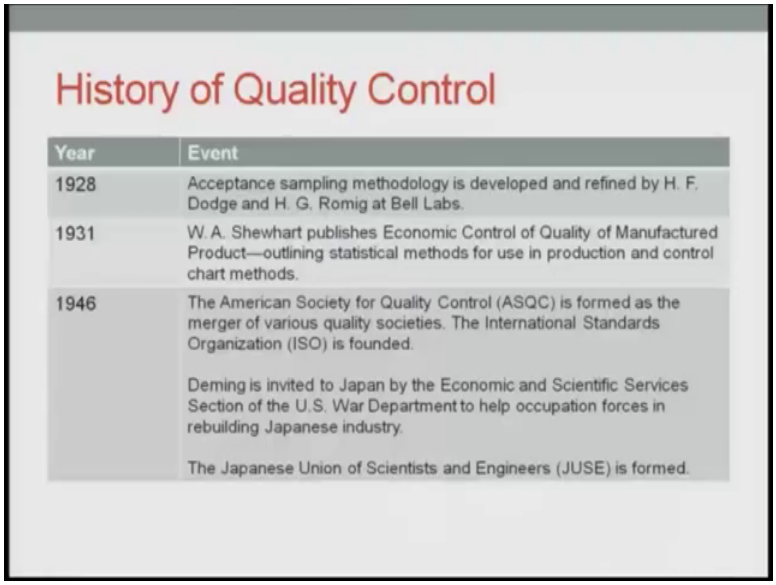

So, if somebody at all is interested to understand the concept of supply chain and how sampling was done; Dodge and Romig came with the multistage concepts of two stage sampling and so, on and so, forth such that you can at least have a better look at the quality and such that the products for which the quality inspection what been done could monitored in a much better way. So, there is a Dodge Romig plan and based on that; for the interest of the people who are in statistics, this caused the sequential sampling and sampling based on different type of levels of sample size was also done later on.

In 1931; Shewhart publishes; the Economic Control of Quality of manufacture products outlining statistical methods for used in production and control charts. In the 1946 and later on the American society of quality control is formed as the merger of various quality societies. The national standards organization; the ISO was formed; Deming is basically invited to Japan by Economic and Scientific Services of the U.S War Department to help the occupation of forces in rebuilding Japanese industries.

The Japanese Union and Scientists and Engineers; JUSE is formed and the last point which basically I mention in Deming; it happened in such a way that the person who was sent from US; basically build up the Japanese industry. The Japanese learn the tricks came back after few 10 or 30 years; say for example, in the 1970's and see that what has happened to the overall Japanese companies; how they have captured the American market.

Be in car, be it in electronics equipment and if you see the same thing has happened for the shield industry. And as obviously, there are other reasons of cost so and so forth. But the concept of quality was brought in by the Japanese in such a big way; by Toyota or by Honda; that all the American cars were really all most wiped out from the American market and the Japanese slowly took control of the automobile sector in USA.

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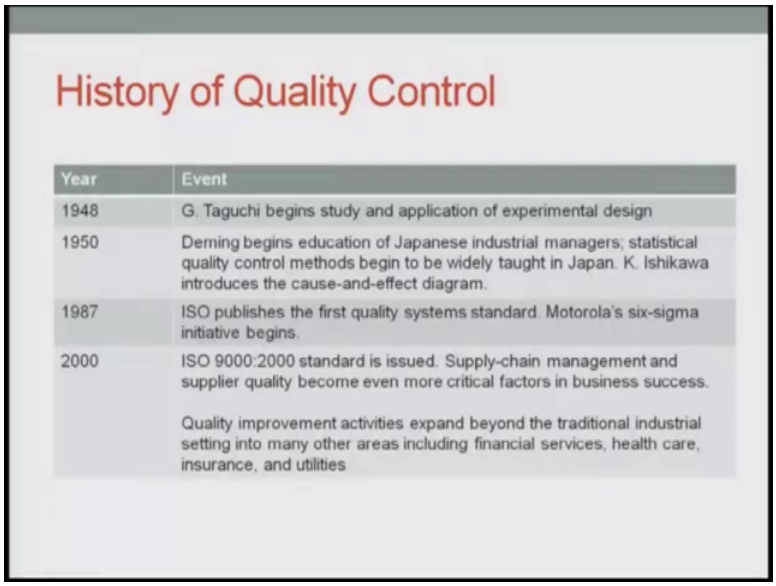

In 1948 Taguchi began the study and application of experimental design and we all know the Taguchi loss functions which were utilized and utilized in such a way that somebody could understand the concept of design of experiments and how they can be utilized, in the study of quality and process quality control charts. In the 1950's; Deming begins education of Japanese industrial managers, statistical quality controls are brought in a very big way in Japanese industry and they are widely talk to Japan.

Ishikawa introduced the cost and effect diagram so that based on these concept of Deming; which has taught in the Japanese industries. Ishikawa they were utilized in a very big way to increase the productivity and the quality of the Japanese industries in a very big way.

In 1987; ISO publishes the international organization, if you remember in the last slide. Publishes the first quality systems standard Motorola's six-sigma initiative begins. So; obviously, if you read later on and we will discuss later on Motorola was the company which basically introduced the concept of six-sigma and how the concept of six-sigma utilized in a very big way basically to reduce the level of non conformity in the products and increase the level of quality.

In 2000, ISO 9000 and 2000 standards were issued. Supply chain management and supplier quality became even more critical in business successes. And quality improvement activities expanded beyond the traditional industries setting into force

many of the use of the quality concepts in areas like financial services, health's; if you remember; I did mentioned the health services like hospitals and so and doctors and so on and so forth.

It also came up in a very big way; in insurances and utilities as the services sector expanded and industry utilization of the products and the services basically took of forefront in time to deliver the products to its customers. So, with this I will end the third lecture and continue with the discussion of our total quality concept and how the concept which we are going to study; really make sense to all the 3 lectures we have already studied.

And I even tried to give in a very qualitative feel of what is quality? Or what are the dimensions of quality? What are the metrics of quality? What do you mean by quality? What is robustness and so on and so, forth; such that we can slowly utilize the concept of both qualitative plus quantitative in a much better line to and appreciate that how quality can be brought into the picture; both in the production segment as well as a service segment to improve and understand that how things can be improved in a very big way in all the fronts.

Thank you and have a nice day.