Industrial Engineering
Prof. Inderdeep Singh
Department of Mechanical and Industrial Engineering
Indian Institute of Technology, Roorkee

Module - 4
Lecture - 16
Quality Concepts

A very warm welcome to all of you in this lecture on quality concepts in the series of lectures on industrial engineering we have been discussing varied aspects of industrial engineering. We have already covered inventory management material handling facility layout design as well as some other important topics related to industrial engineering. Quality also plays a very important role in industrial engineering. Let us take a very basic example of manufacturing a very basic product. We have to first select the vendors from where we are going to procure the raw material.

Once the procurement of raw material is done we have to check the quality of the raw material that whether, whatever we want we have achieved or we have got or not. Once the raw material is according to our satisfaction, then we would like to convert this raw material and we would be subjecting it to a series of manufacturing processes to get the final product. Now, in these manufacturing process is also we would have to find out that whether, the process is performing according to our desired levels or not. If the process is not converting the raw material into the final product properly we may have to find tune the manufacturing process.

So, there also the concept of quality comes into picture Now, once the product has been manufactured we have to check that whether, this product is according to the desired specifications or not. So, whatever we wanted we have achieved we have got the product according to our requirements or not. We would be checking it using number of different techniques. Now, once the product is ready we have found out that this is according to the quality requirements. We have to dispatch the product to the respective retail market.

There also in distribution we need to have quality if the customer goes to the shop and our product is not available on the shelf; we are losing the market share. So, in distribution also we have to have a very good quality. So, that whenever the customer requires a product our product should always be available to him. In today's competitive market distribution also plays a very important role because there are so many other

players in the market. If we are not able to satisfy the demand of the customer at his particular requirement when he wants the product he is going to switch his loyalty to some other company and buy the competitor's product.

So, quality in distribution is also equally important So, we have just seen a very simple diagram in which a raw material is procured it is manufactured using a series of manufacturing processes. A final product is got, we check the quality of the final product and then we distribute in the market. At each and every step we have to have a quality. Similarly, in service sector also we have so many different industries in service sector like hospitality. We have hospitals also we have restaurants also so all these service centers also need to have the quality.

Today's scenario or the global scenario is such that only those companies which have a policy of the quality or quality improvement or total quality management will only survive in the market. Those companies who do not put adequate focus on the quality will not be able to last in the market for a long time. So, by the examples that we have taken we can very easily conclude that quality is not only important in manufacturing sector. It is also important in the service sector. So, it is important for us to understand that quality is an important issue and we should know the basics of quality concepts.

There are so many tools and techniques developed for implementation of quality concept within the industry. But, we are not going to go into detail of each and every concept we are just going to have an overview that, what quality means. What is the basic definition of quality? What is quality of conformance? What is quality of design and related issues? We are also going to consider the Juran's trilogy in which we are going to see that what he has recommended. So, let's now start the discussion on the various quality concepts.

(Refer Slide Time: 05:24)

So, let us start with the introduction. The rapidly increasing global competition over the past decade as led to the emergence of new scenarios for most of the industrial sectors. The competitiveness of a company is mostly dependent on its ability to perform well in dimension such as: cost, quality, delivery, dependability and speed moreover, innovation and flexibility to adapt itself to variations in demand. So, this slide sums up the today's business scenario. We can very easily see on your slide I will just like to repeat a few words again.

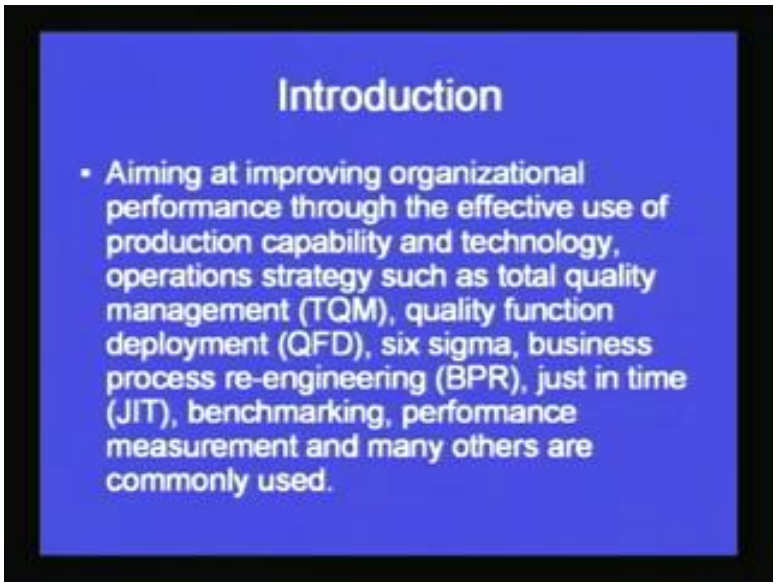
The success of the industry depends upon the cost, the quality, the delivery, the dependability and speed moreover, hour is that always we have to innovate always we have to be flexible always we have to change according to the demands in the market And our focus should always be to provide the best quality product with the minimum possible cost. So, in today's competitive market we are seeing that prize wars are taking place. Different companies are reducing the prizes of their products in order to gather more market share.

So, the need of the hour is to be competitive in the market and to be competitive in the market we need to produce at a very economical phase as well as economical rates as well as we have to take into account the quality issue. If we are providing a product which is very, very cheap as compare to the competitors product. But it is no of the adequate quality nobody is going to buy our product. We have to take into account that

quality is the best possible alternative, which every company should choose in order to be competitive in the market.

So, there are other things as well that we have to be dependable our delivery should be good, but all these thing fall under the broad umbrella of quality. If we are able to incorporate, the concept of quality at each and every step of the business process, then the company is surely bound to be competitive in the business environment.

(Refer Slide Time: 07:53)



Aiming at improving organizational performance through the effective use of production capacity and technology operations strategy; such as I have already told you total quality, management, quality function deployment, six sigma, business process re-engineering, just in time, benchmarking performance measurement and many others are commonly used. Now, basically each and every company wants to improve their organizational performance.

Now, there are various facets of organizational performance. Some companies want to improve the quantity that they are producing. Some companies want to improve the quality that they are producing. Some companies want to minimize the wastage that is being done during the manufacturing process. Some companies want to be more competitive by adjusting to the economic environment that is prevailing. So, when the when the economy is down they would like to reduce the prizes of their product. Or

some times when the boom is there in the market they would like to increase the prizes of their product.

So similarly, there are so many different things that have to be taken into account. And there are so many tools which have been used for enhancing the organizational performance. Now, what are these tools? These tools are total quality management or we can say continuously looking for improving the services and the processes within the company. Quality function deployment usually called QFD, Six sigma, business process re-engineering, just in time, benchmarking, performance measurement and there are many other tools and techniques.

So, but why we are using this tooled as tools and techniques because, always there is a thrust towards competitiveness. Every company wants to make as much profit as possible. If there are infinite resources available with each and every company then there is no need to go for all these tools and techniques. But that is not the scenario; always there is a limitation on the type of resources that are available within the organization. Sometimes there are constraints on the money that is available with the company. Sometime there are constraints on the man power. Sometimes there are constraints on the technology. Sometime there are constraints on the infrastructure.

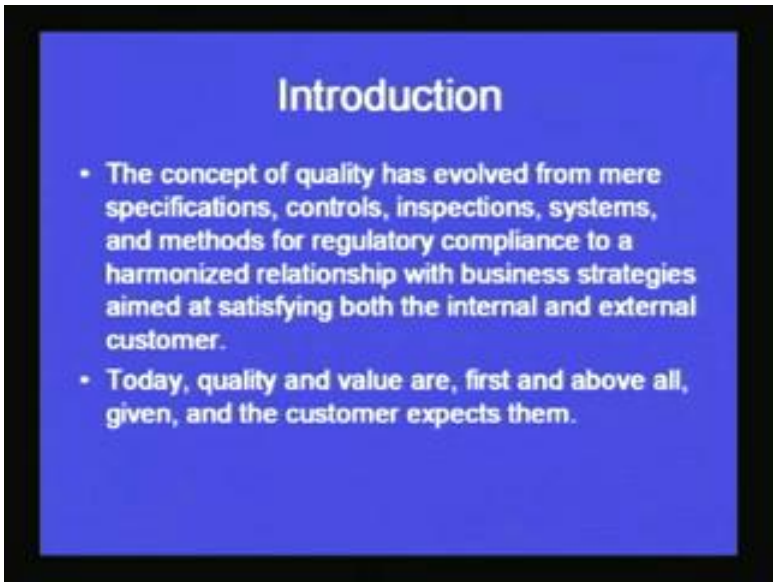
So, always the company is operating within certain constraints. And in order to get the optimal solution within these constraints we need to understand these tools and techniques. Now, all the time we have to provide a quality product within all these constraints. Sometimes the technology that is there that is available can produce a high quality product. But, the technology is very costly we cannot go and buy the technology. Therefore we have to think that this technology now is not available with us.

We have to get to that quality, but with some other particular operation or some other particular process. Now, process x can generate quality y. We want to generate quality y, but we do not have the process x available with us. Now, we have to find out within these constraints we have to work that, how to get quality y without having process x. So, can we redesign process x or can be duplicate process x so that, we are able to get the same quality.

So always there are constraints and within the constraints we are operating. And in order to operate successfully in order to provide quality products we have to always think of

such tools and techniques like total quality management, Six sigma, business process re-engineering, quality function deployment, benchmarking and so on and so forth. So, in today's business environment or business scenario we can say that the due to competition in the global scenario or global environment. All the times the companies have to learn these tools and techniques in order to produce the products at a relatively lower cost but at a relatively or we can say at a very high quality.

(Refer Slide Time: 12:15)



The concept of quality has evolved from mere specifications controls inspections systems and methods for regulatory compliance to a harmonized relationship with business strategies. Aimed at satisfying both the internal and external customer. So, initially the focus was mere specifications or controls. So, in order to get the quality what was done was that there was a quality control department; which would always be focusing on reducing the error or the mistakes.

So, each and every product that is produced would be checked according to certain specifications or certain pre defined quality standards. And then it would be found out that whether it is of adequate quality or not. But, these days quality has attained a much higher significance as compare to what it was initially designed for. So, the concept of quality has evolved from mere specifications, controls, inspections, systems and methods for regulatory compliance.

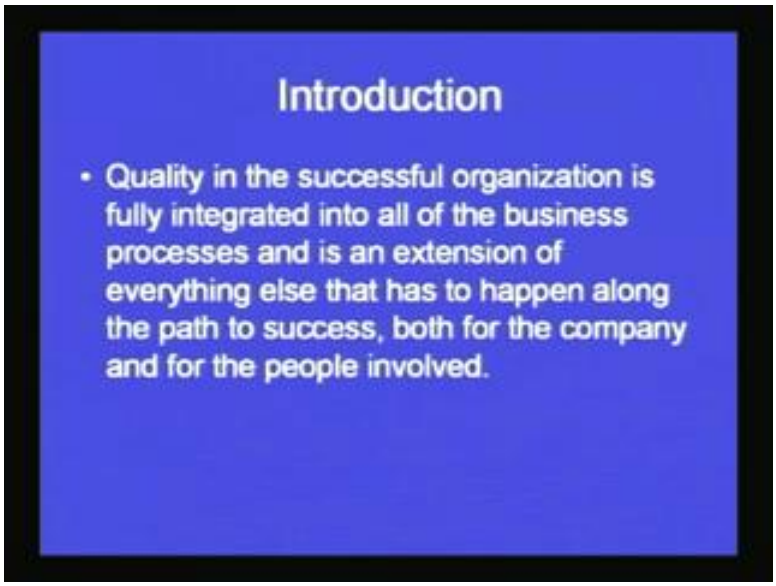
So initially, we have seen we have observed that the quality basically was conformance; conformance to a predefined quality level. So, we have fixed of this is the quality level we have to adhere to this. Now, we are putting a control on the process or on the material and we are trying to achieve that level. So, that was basically a regulatory compliance. So, there was a predefined standard and we have to achieve that standard, but nowadays a harmonized relationship with business strategies aimed at satisfying both the internal and external customer.

So, it would not be wrong if I say that customer is the king today. Each and every company is focusing their business strategies towards the customer satisfaction. Each and every company is trying to satisfy the customer because; he is basically the king. He has. so much of variety available with him. And he is going to choose the product which is going to provide him the best value for his money. So, basically the initially it was there that only control and specifications and for regulatory compliance quality standards were followed, but now it has gained a much more wider meaning.

It means that it has to be incorporated into all the business strategies and it has to be incorporated at each and every level. So, quality is not just of the product that we are producing; it is of the service also that we are providing. It is of the reusability. It is quality has also to be associated with the service that we are providing after the sales. Once the product has been sold, what is the after sale service we are providing a quality has to be establish there also. Quality has to be established when we are procuring the raw material from the vendors.

So, it has got greater dimensions now as compare to what it what some years back. So basically, the major issue is the satisfaction of the customer. Today quality and value are first and above all given and the customer expects them. Already whatever we have been discussing till now, that a customer is the king we have to manufacture the product we have to provide the service what the customer wants. If we are not able to satisfy the customer the brand loyalty is may change and the cost customer may switch to some other competitor company. That we do not want. So, basically quality and value has to be given and the customer is expecting that particular quality. If we are not able to do, so we would not be there in the market for a long time.

(Refer Slide Time: 16:09)



Quality is the successful organization is fully integrated into all the business processes. This I have already told that it is not particularly it will it be focused on a particular product that this product has to be made within these specifications. And if we are able to satisfy the specifications we will say that your quality is good. The quality has to be incorporated into each and every business process on your screen, you can see in the very first line. Quality is the successful organization is fully integrated into all of the business processes.

So, a quality in the successful organization, so if the quality is incorporated into all the business process the organization would itself become successful. So, our quality in the successful organization is fully integrated into all the business processes. I think it is very clear now. And is an extension of everything else that has to happen along the path to success both for the company and for the people involved.

So, quality now has got a very diversified domain, it has got a global domain; it is not just focused on one particular element that is the product. It has to be spread into each and every process which is somehow related to the manufacturing of the product or the launch of the product. Now, one example comes to me that is of a team that is performing for a particular country. Say a football team.

Now, in a football team if all the players perform their roles satisfactorily it would result into the success of the team. But suppose, there are some players who are lagging in the

sportsman sprit or who are not fit and they are not performing according to the desired level. Then the whole team is going to lose it is not those four individuals who are going to lose, but the whole is going to lose. Similarly, if we are incorporating the quality concepts in whole processes or in all the processes that are associated with our product or with our service we may be successful. But, if some or a part of the processes or a part of the cycle is not a qualitative or is not taking care of the quality concepts.

Then the whole product may lose it shine or the whole product may not be able to do as well as it is expected to do in the market. So, quality is in the in the successful organization is fully integrated into all the business processes. And is an extension of everything else that has to happen along the path to success. Both for the company and for the people involved. So, by now we have seen if we summarize whatever we have discussed till now. We have found out that quality is very important we have seen so many examples. Where we have seen that, if we are able to produce the quality our product would be successful in the market.

We have seen that in globally competitive market, if they are not able to provide value to the customer for the money he is spending then he is going to switch to some other product; which is providing him good quality at relatively low prize. So, each and every company has always to focus on the development of products which are of high quality and similar at the same time they should be of low cost. Now, let's come on to the basic definitions of quality. We have made a very good build up to the discussion related to quality concept.

We have seen that quality is important, nobody can say that quality is not important. We have established the importance of quality till now, and now we want to see that what quality exactly means.

(Refer Slide Time: 20:10)

So, quality basic definition is quality is fitness for use which has been given by Juran. So, fitness for use means, that if I am buying a product for one particular application or for one particular requirement. If a particular product is satisfying that requirement or satisfying that use we will say yes; it is of adequate quality. Let us take an example of the gears. Gears are used in so many diverse applications. Even in mechanical watches we use gears.

So, the quality of those gears which we are using in the wrist watch may be substantially different from the quality of the gears that are being used at some other low and application. But, if the gears are performing the function or they are being used satisfactorily we will say yes, the quality of the gear for this particular use of this particular application is good. So, from here on we can say that yes quality is relative for wrist watch the quality of the gears required is very high. Or we can say the specifications set for the gears for wrist watch is are different from the specifications that are set for the gears that are used for some other low and application.

So, quality is fitness for use. So, if the use is getting satisfied or we are getting the quality according to our requirement, we will say yes this is the good quality product. Now, coming on to the second definition, quality is conformance to requirements. So, we have certain requirements and we are buying a product or a service. And if our requirements are being met easily we will say yes this is what the quality product should

do. That it is conforming to the requirements for which we have brought the product or which we have brought the product.

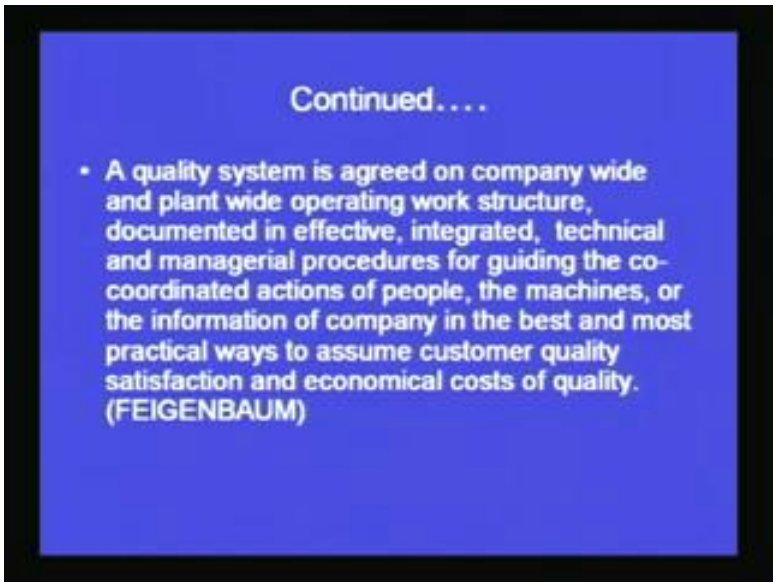
Similarly, the efficient production of the quality that the market expects there is another definition. Now, this is related to manufacturing one very simile example I have a given towards the start of today's lecture. That right from the procurement of the raw material converting it into the final product and then supplying it into the market through the retail segments. Each at each and every step we have to adhere to the quality standards. Through the efficient production of the quality; that the market expects.

Now, the market basically is nothing but the customer each and every customer expects some quality form the manufacture. Sometimes there are some brand qualities also. Each and every brand has established itself and the customer when he is buying a product he or she is buying a product of that particular company. He expects a certain degree of quality yes; that this companies product is going to be of high quality.

So, the market accepts quality and the efficient production of that quality we can say that yes, if the customer is satisfied then the quality is good. Now, the last definition on your screen you can see quality is what the customer says; it is. So, if the customer says that yes, this is what I want and we are able to satisfy his demand. We are very we can very easily say that yes this is what the quality is. So, we have seen that basically quality is something which is driven by the customer demands and it also depends on what we are producing.

So, if you are producing a product which is able to satisfy the demand of the customer. We can very easily conclude that yes, we are able to justify the quality requirements of the customer. But if we are not able to satisfy the specifications that or the requirements or the use value set by the customer. Then we can say that yes our component or our product is lacking in quality. It is not confirming to the requirements set by the customer. So, the important point to note here is; that quality is relative and quality has to be incorporated into each and every aspect of the business process.

(Refer Slide Time: 24:22)



A quality system is a agreed on company wide and plant wide operating work structure, documented in effective integrated technical and managerial procedures; for guiding the coordinated actions of people, the machines or the information of company in the best and most practical way to assume customer quality, satisfaction and economical costs of quality. So, the definition or this particular discussion seems to be very long, but let us take it step by step. A quality system is agreed on company wide and plant wide.

So, a quality system is not local it is global. So, it is agreed on company wide and plant wide operating work structure. So, it has to be incorporated throughout the company throughout the plant Documented in effective. So, documented means that yes it has to be put in black and white or it has to be documented properly. Integrated technical and managerial procedure; so for achieving the quality we have to follow certain set of procedures. For guiding the co coordinated actions of people, the machines or the information of company in the best and most practical ways.

So, basically we are going to coordinate the efforts of the machines and the people with the specified or led out procedures for achieving the quality. And we have to coordinate the actions of machines and people in the best and most practical ways to assume customer quality satisfaction and economical costs of quality. So, basically customer quality satisfaction or the customer quality satisfaction means that the quality requirements of the customer are getting satisfied.

So, basically it is global it there are certain procedures which are well documented which have to be adopted. And when we adopt these procedures we are going to satisfy the customer with the quality requirements. Now, let us see what are the dimensions of product quality here we are focusing on the product quality . We would also be seeing the service quality a product is something tangible. We are having suppose, this mouse; this is a product we are having a laptop this is a product. We are having a television set it is a product. So, what are the dimensions of product quality, how we can say that it is good quality or bad quality or what is the criteria on the bases of which we can make a decision like whether this product is of good quality or of poor quality.

(Refer Slide Time: 27:07)

So, these are the dimensions on your screen. Let me first read this dimensions and then we would see that how these dimensions are considered when we see the product quality, performance, reliability, durability, serviceability, aesthetics, features, perceived qualities. So, these are the dimensions or the criteria on the basis of which we say whether the product quality is good or it is poor. Now, performance means, that we have designed the product for performing an intended function.

So, if the product is performing the intended functions satisfactorily we will say yes the performance is good. Similarly, reliability whenever we want to rely on the product or whenever the product is called upon to perform it is able to perform or not. If it is able to perform we will say yes this is a reliable product. But, if it is not able to perform when it

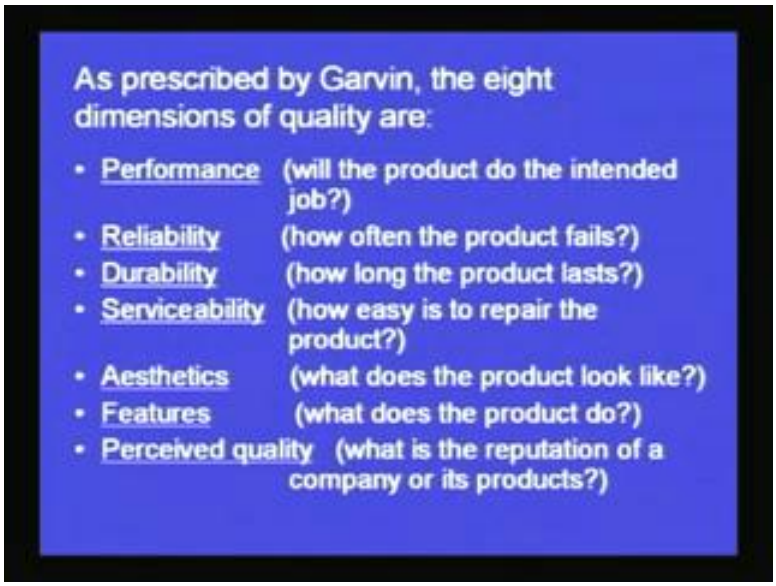
has been called upon to perform then we will say no, this is not a reliable product. For example, we take example of a match stick. We take out a match stick and try to burn it. If it is burning we will yes the reliability is good. If it is not burning we will say if so many match sticks are failures we will say no this is company is not reliable company because, most of the match sticks are not burning so the product has to be reliable.

Similarly a product has to be durable. So, durability is related with time, that today if I buy a product and I feel that it is durable. Then it should be durable for certain amount of time may be 6 months, may be 1 year, 1 and half years, 2 years, 5 years, 10 years. So, durably is related to time. So, product quality can be measured in terms of performance, it can be measured in terms of reliability, it can be measured in terms of durability.

Similarly, serviceability aesthetics is also one of the most important points which is gaining significance these days. Initially, products were designed keeping into the count the functional requirements as the foremost requirement for the shape of the product. So, products for usually designed and the shaped was dictated by the functional requirements of the product. But, today that is not the scenario. So, many products are there in which the functionality is also incorporated, but the aesthetics is also taken into the account.

So, aesthetic or the eye appeal of the product is also factor which has to be considered in product quality. If the aesthetics are very poor we can say no the not very good quality product, but certainly if functionality or the performance is measure criteria. Aesthetics may come at lower down in the hierarchy. Then features perceived quality that how do you see the quality of that particular company. There can be a perceived rank and there can be actual rank; perceived is like according to my perception and actual is according to the data and the statistics. Let us see in 1 line that what does these dimensions mean in terms of product quality?

(Refer Slide Time: 30:27)



So, as prescribed by Garvin, the eight dimensions of quality are performance will the product do the intended job for which is a it has been brought or it has been designed. Now, designed by the designer the designer designs the product for a particular intended function the customer buys the product for performing some job. So, we can say the performance is good if the product do the intended job satisfactorily or the performance can be poor if the product is not able to do the intended job satisfactorily.

So, it is very clearly mentioned on your screen. Second point is of reliability how often the product fails I have already given you an example, in which the match stick failure can be related to the quality of the product. So, if it fails quite often we can say not the product is not very reliable. If it does not fail over a period of time we can say yes it is a very reliable product. Similarly, coming on to durability, how long the product lasts.

If the product lasts for its designed life, let us take an example of a bridge. Over bridge has been constructed and its life has been estimated to be 20 years. If the bridge lasts for more than 20 years we will say the quality of the bridge was very good because, it was designed for 20 years. But it has it has been able to perform its functions function satisfactorily beyond 20 years. So, we can say the product is very durable or the bridge is very durable. Similarly, serviceability how easy is to repair the product.

So, if it is easily serviceable we will say yes, we can it is a very good product. If it is not easily serviceable we will say no, not very good product. Similarly aesthetics, what does

the product look like taking into account the features we have to take into account what does the product do. What are the functions the product is performing if the product is performing all the functions that the customer wants, then we can say it is a good product. Now, repeatedly I am using the word good because now I am going to come to another important word that is quality which is the main important focus of today's lecture.

The last point on your screen is the perceived quality. What is the reputation of a company or its products? So, every customer will have a perceived quality that yes, if I am buying a product of such and such company my quality or my requirements or my specifications would be met. If I am buying a product of xyz company I may not be able to get a very good quality product or my expectations, my requirements, my specifications might not be met.

So, each and every customer will have a perceived quality related to the brand image or the brand name of the product. Now, in this screen we sum up everything that we have discussed till now. That if of product provides a very good performance it is performing its function for which it has been design to. It is durable, it is reliable, the serviceability conditions are good. Aesthetically it is very good looking it is having given us a very good eye appeal all the features for which it has been designed are according to the customer requirements.

The perceive quality of the company for which has produce this particular product is very good or the customer has a very good image of the company of the product. In such a scenario it can be concluded that such of product is a good quality product. So, the all the dimensions of quality are being justified. All the dimensions of quality have been addressed and if all the dimensions are satisfied according to the customer's requirement. We can very easily conclude that yes the quality of the product is good. Similarly, there is a quality in the services also.

(Refer Slide Time: 34:46)

Now, let us see that, what are the dimensions of quality in the service sector? Dimensions of service quality, so what we were discussing till now were the dimensions in product quality. Now, we are seeing what are the dimensions in service quality, so reliability same as product quality responsiveness. Now, whenever we are providing a service your responsiveness is also very important. For example, in hospital we receive a call that yes there has been accident in such and such place.

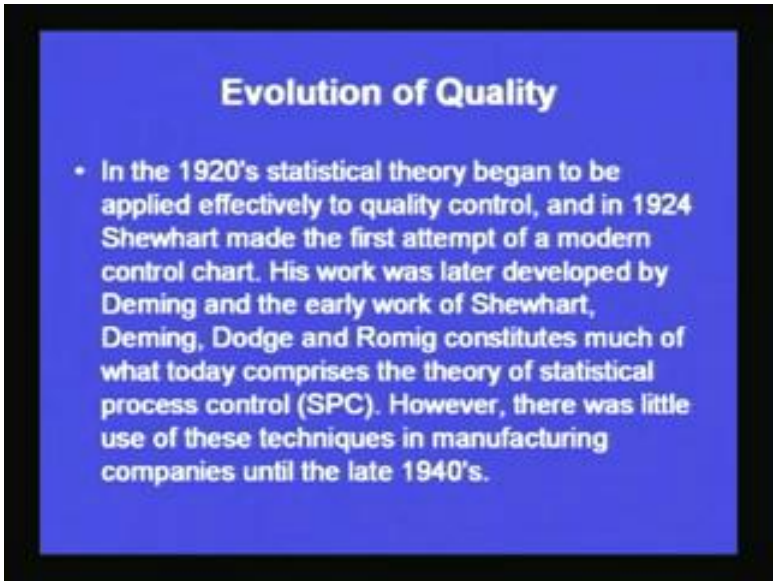
If we are responsive we are reaching the spot at the earliest who knows that we are saving so many human lives. So, the responsiveness is also an important factor. Similarly, competence in the hospital if we have very good doctors, in the hotels we have very good chefs in the restaurant we have very good people for service. Similarly, courtesy communication: now if we go to a restaurant where we are not able to communicate with the people who are there at the desk.

It is not going to providing us a very good quality service. Why because the communication factor is lacking. Similarly, credibility in banks or other services financial institutions credibility is also very important. As well as the security if we are going and staying in a hotel; then is a security arrangements are not that good you may not feel safe. So, you would say that yes the quality of the hotel is not that good, because of the dimension of security in which is going to dictate the quality of the services being provided by the hotel.

So, let's now summarized it what are the dimensions in the service quality, we have already seen the dimensions of product quality in service quality. There are some new things that have been added like: responsiveness, competence, courtesy, communication, credibility, security and reliability is common in service quality. Also as well as in product quality so whenever we are trying or we are planning or we are designing a particular service provider company or service provider thing.

We have to take into account that yes we have to provide a very good service and on the contrary we can very easily say that, we have to provide a very good quality service. Now, good quality would be in terms of the reliability it would be in terms of responsiveness, it would be in terms of competence, courtesy, communication, creditability and security. If all these dimensions are met satisfactorily according to the customers requirement we can very easily say that, we are providing or that particular company is providing a very good quality service.

(Refer Slide Time: 37:40)

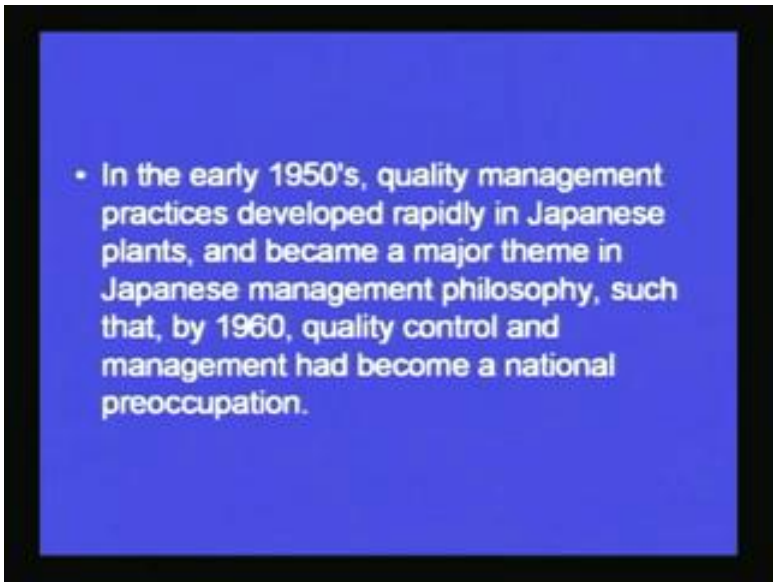


Now, let us go to a brief evaluation of quality in the 1920s statistical theory began to be applied effectively to quality control. Which we have already seen that how quality has evolved, initially the focus was on quality control. Some compliance that we have already seen we have already used the word compliance or the regulatory compliance; if you remember in today's lecture itself. So, initially it was regulatory compliance and in 1924 Shewhart made the first attempt of a modern control chart.

So, control charts were developed his work was later developed by Deming and the early work of Shewhart Deming Dodge and Romig constitutes much of what today comprises the theory of statistical process control. However, there was little use of these techniques in manufacturing company until the late nineteen 40s. So, this is just telling us that initially the focus of quality control was to dedicated towards the product quality only.

So, it was not having a global domain it was only having a local domain and the technique that was developed was of the statistical process control. So, the major attention or major point of attention was the process and all the efforts were put on the process and control charts were developed. So, that the process does not go heaver or the process does not go beyond the permissible limits. Means the product that this process is producing is within certain control limits. So, the focus was on process.

(Refer Slide Time: 39:22)

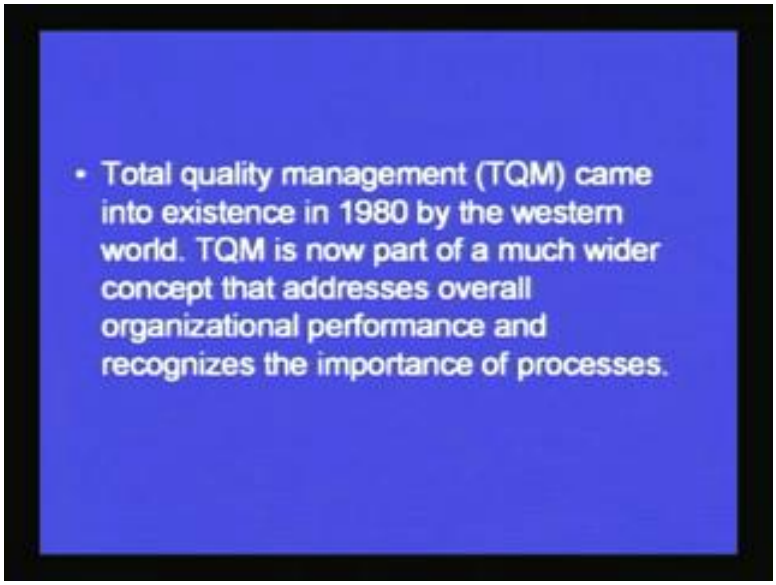


In the early 1950s quality management practices developed rapidly in Japanese plants. So, Japanese people have been said as the front runners in the field of quality. And became a major theme in Japanese management: philosophy such that by 1960 quality control and management had become a national preoccupation.

So, if everyone, if the whole country or the whole environment or the whole business people who are working for a particular company have a philosophy of quality in their minds always the product is going to be good and the company is going to make profit. But if the quality philosophy is missing then the company may not be able to last in the

market for a long time. So, global dimensions of quality or the global domain of quality was established after the 1960s.

(Refer Slide Time: 40:21)



Total quality management came into existence in 1980 by the western world. TQM is now a part of much wider concept that addresses overall organizational performance and recognize the importance of processes. So, importance of processes is still there, but overall organizational performance is the focus area. This was initially a local area; which was related to the process. So, some years back the focus was on local area improving the quality of that particular local process or local area, but today the dimensions are very global.

The focus area is very wide starting from one end to the other end or starting from north to south east to west within the company the focus is on improving the quality of the products. The services as well as any other aspect related to converting the material from raw material to the final product.

(Refer Slide Time: 41:25)

So, we have been discussing the historical aspects of quality. And we would now see what Edward Deming has done. He has postulated statistical quality control principles which we have already seen which are very important in managing the quality of the process. Similarly, he postulated 14 points of management which have been successfully used by the Japanese manufactures. So, by using these quality principles the Japanese manufactures have got a huge amount of profit.

Similarly, Williams Crosby emphasized humanistic behavior aspects of quality improvement. So, quality improvement is not only focused on the processes and the manufacturing facilities. It is also focused on the humanistic or the behavioral aspects of the people who are associated with these manufacturing processes or with these tools and techniques. So, initially the focus was on the processes on the manufacturing on the production, but today the focus has shifted.

The focus is still on the manufacturing as well as on the process is, but the focus is also now on the humanistic behavior. And William Crosby has emphasized humanistic behavioral aspects of quality improvement. That he has quality can be improved if the humanistic behavioral aspects are improved. So, this is becoming more important now which I have already told for initially the focus was process. Now, the focus is process plus a large number of other factors which are associated with the process.

(Refer Slide Time: 43:11)

So, other things in historical aspects are the Joseph Juran's quality trilogy. So, Joseph Juran has given a quality trilogy. He has divided into 2 important aspects: so first was the quality planning, set of quality goes set plans for operations based on these goals. So, we have to set the quality goals that yes this is the quality that we want to achieve. So, the goal has to be very clear. Then we have to do the planning we have to set the plans for operations based on these goals.

Now, we know this is the quality that we want we have to move in that direction and we have to plan our path that guess we are going to move at such and such phase and these would be the problem areas we have to do the planning accordingly. Then once the path is very clear we have identified that we are going to move on this path and this is our goal. Here we have to reach this is the quality standard we have to achiever we start our process.

So, planning is done the next step is the execution. The second point or the second important facets of Juran's trilogy or the Juran's quality trilogy is the quality control. That is there on your screen, responsible for meeting quality goal. Now, we have already established the quality goals. We have to meet these quality goals, so quality control is important in meeting those goals. Now, prevent adverse changes set and observe performance measures compare with industry standards and benchmarking.

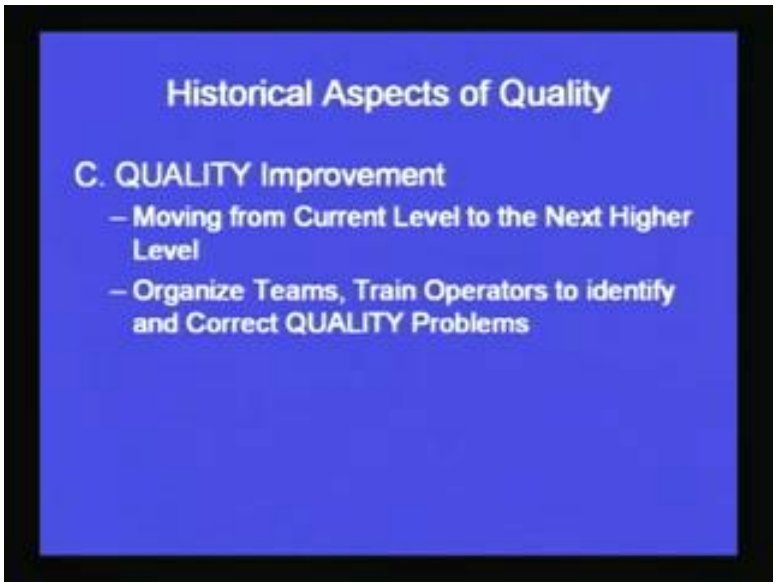
Now, to put all these things with the help of an example and to put these things in a very straight forward and clear manner let's say that we have already fixed a goal. We have done all the planning we know that this is the path we have to follow and we are going to achieve our goal of a particular quality standard. Now, if we are going in a wrong direction we are adopting some other path or we are digressing from the path or the plan that we decided at the very beginning.

It means that, some control exercise is required there should be somebody who should bring us on the path which we have set in the planning stage to achieve our target. So, what are these, these are the control measures. So, these are performance measures we would be seeing that what whether we are performing according to the planned path or not. If you are not performing according to the planned path and the quality control measures would be required.

Similarly, we can compare the performance with the other industry standards. Now, suppose any particular company is making a product of quality x. We can compare our product with the quality x that whether; our product is of more quality or of less quality. Similarly, we can do the benchmarking also so 2 important facets Juran's trilogy has been explained. That the first 1 is the quality planning we have to plan, we have set objective, we have to set a goal. We have to do all the planning how to achieve that goal.

At what particular step what particular efforts would be required and the second step is the quality control. If we are digressing any way from the path that we have set to achieve that goal, then we have to execute or then we have to compare our performance with the performance measures or we have to do benchmarking.

(Refer Slide Time: 46:48)



Now, the last facet of Juran's trilogy is there on your screen now. So, this is quality improvement moving from current level to the next higher level. For this what we need to do, we need to organize teams train operators to identify and correct quality problems. So, initially once we have achieved a quality we have to go for further improvement. We have to go for quality improvement. So, continuous improvement is the measure focus of quality improvement.

That all the time we should keep a focus that whatever we have achieved there is something or there is there are certain things which are beyond this particular level which we have already achieved. So, try to plug in the defects try to find out the mistakes and then we can work towards quality improvement. So, three different facets of Juran's trilogy have been given and these are very important quality concepts which every engineer should know.

(Refer Slide Time: 47:50)

The 3 aspects of quality and there linkages with each other have depicted in the figure. Now, there are 3 important quality aspects. So, you can see quality aspect 3 important aspects are quality of conformance, quality of design and quality of performance. So, all these 3 are interrelated There are three aspects of quality; quality of conformance, quality of design and quality of performance. And all these 3 are interrelated I have repeated twice what is there on the screen.

So, you can yourself imagine that for understanding the quality aspect, we need to understand the quality from three different aspects or three different points that is the design, conformance and the performance.

(Refer Slide Time: 48:41)

Now, what do we mean by these they are going to address each and every point in a individual perspective. Now, quality of design customer's perspective the product must be designed to meet the requirement of the customer this is what we have been discussing for the last one hour or so… The product must be design to meet the customer requirements; the product must be designed right first time and every time and while designing all aspects of customer expectations must be incorporated into the product.

The factor need to be considered while designing the product are: now, we are going to see that what factors have to be consider when considered when we are designing the product. But the summary of this slide is that we have to take care of the expectations, the requirements and the specifications of the customer. So, while designing all these things have to be incorporated into the product.

(Refer Slide Time: 49:38)

So, the factors that need to be considered while designing the product are the type of product. What is the type of the product? There again be different types of product we can see in our surroundings all the things that we see around us are different types of products. So, first point to decide is what type of product has to be design? What is going to be the cost? What is going to be the pricing? What is going to be the manufacturing cost? What is the going to be the material cost associated with the product?

Similarly, we have to see the profit policy of the company. Now, some companies may fix we are going to charge 2 percent or the 3 percent profit on the total cost that we are spending on manufacturing of the product. But some companies may have may like to put wide a profit margins. Now, some companies may have a company policy of producing large number of products or they might be focusing on the volume. Some companies may not go for volume they might lie to sell less number of products with the greater profit margin.

So, all these things have to be taken into account when we are designing a product. And this is what that is going to dictate the final quality of the product or the value of the product. Similarly, we have to take into the account the demand also now it demand has number of facets. Each and every customer would have his or her own requirements and these requirements have to be taken into account while designing the product.

If we are able to meet the requirements we can say yes we have been able to make a very good product. But, if we are not able to meet the requirements the specifications of the customer than the quality of the product according to the customer may not be good. Similarly, we have to check for the availability of the parts. So, first thing is the quality of design and from customers perspective we have to take into account all these points, if we want to generate a good quality design. Coming on to the quality of conformance; manufacturers perspective the first perspective was the customers perspective, second is the manufactures perspective.

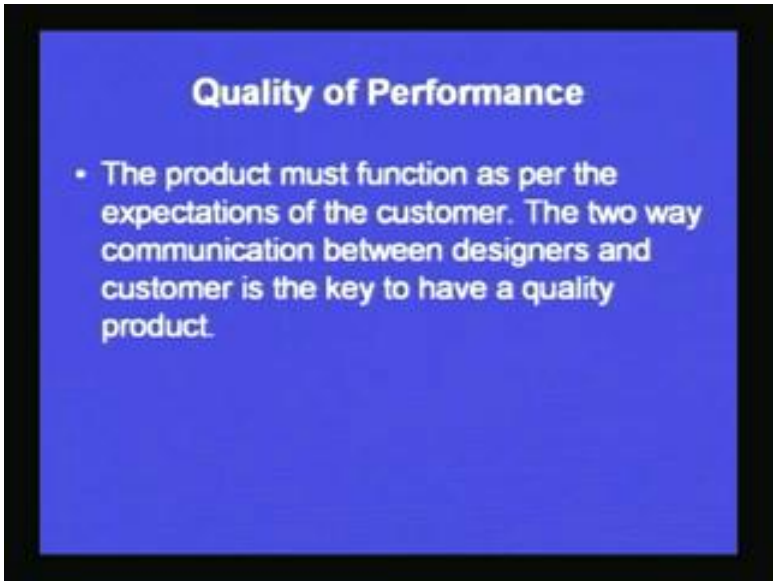
(Refer Slide Time: 51:41)

The product must be manufactured exactly as designed. Now, while designing we have taken into account all the quality aspects. Now, while manufacturing also we have to take into account those aspects. Like the design has taken care of the quality, the manufacturer also has to take care of the quality. The product must be manufactured exactly as designed. The activities involved at this stage include defect finding defect prevention defect analysis and rectification.

So, all these are the activities that are done at the manufacturers point or at the from the manufacturers perspective in order to improve the quality of the final product. The difficulties encountered at the manufacturing stage must be conveyed to the designers for modification in design, if any… The 2 way communication between the designer and the manufacturing may help to improve the quality of the product.

For this purpose only new branch of science and engineering is in place these days and is being widely taught to the students of engineering that is called as design for manufacturing. Even we can go a step further we can have a process or we can have a tool or technique which we can call as design for manufacturing and assembly. So, 2 way communication between: the designer and the manufacturer in order to remove all these defects. So, first point is the quality of design. Second point is the quality of conformance that whatever has been design whether, we are able to produce that according to the requirements or not or according to the specifications set at the design stage or not.

(Refer Slide Time: 53:21)



Similarly, last point is the quality of performance. The product must function as per the expectations of the customer. The 2 way communication between the designers and the customer is the key to have a quality product. So, if the designer is able to incorporate the requirements and the specifications set by the customer into the product. The product is surely going to be a good quality product also, if the quality of conformance has been incorporated all the defects and the mistakes has been rectified at the manufacturing stage.

So, let's summarize what we have covered today in today's lecture. We have gone through the basic aspects of quality we have establish the importance of quality as one of the most important aspects of industrial engineering. We have seen various definitions of

quality given by the experts in the field of quality. Then we have seen how the quality has evolved over a period of time. We have seen Juran's trilogy in which we have covered the 3 important facets of trilogy. And later on we have seen the quality of design the quality of conformance and the quality of performance. I feel that this lecture would introduce the learners into the very broad field of quality management.

Thank you.