

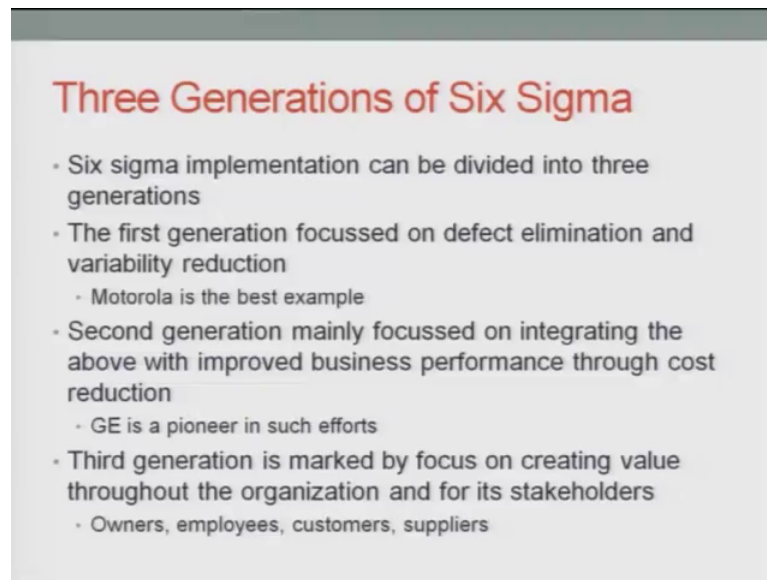
**Total Quality Management - I**  
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**Lecture - 10**  
**Quality Improvement**

Hello everybody, a very good morning, good afternoon; good evening to all of my friends who are taking this TQM, one which is total quality management. And I am Raghunandan Sengupta from the IEM department at IIT, Kanpur. So, if you remember we are discussing the different concepts of quality from the point of view of examples for DuPont and other cases, and how for a company considering that is that is a manufacturing one starting from the customers requirement. How the customer feels his or her requirement how the vendor selection is done how the project manage basically goes into the procurement of materials and then raises the will till the item is delivered.

So, that is the general process of flow; obviously, there would be changes here and there depending on whether it is actually a manufacturing unit, whether it is a service sector service sector can be say for example, a bank a restaurant a retail outlet for supermarket and so on and so forth. It can be hospital also. So, with this we will start the tenth lecture. So, technically we all know we have heard and many of you must have read and have a good understanding about the concept of 6 sigma. And what that six sigma concept means? And what are the relevance for total quality management and statistical process control, we will discuss that.

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### Three Generations of Six Sigma

- Six sigma implementation can be divided into three generations
- The first generation focussed on defect elimination and variability reduction
  - Motorola is the best example
- Second generation mainly focussed on integrating the above with improved business performance through cost reduction
  - GE is a pioneer in such efforts
- Third generation is marked by focus on creating value throughout the organization and for its stakeholders
  - Owners, employees, customers, suppliers

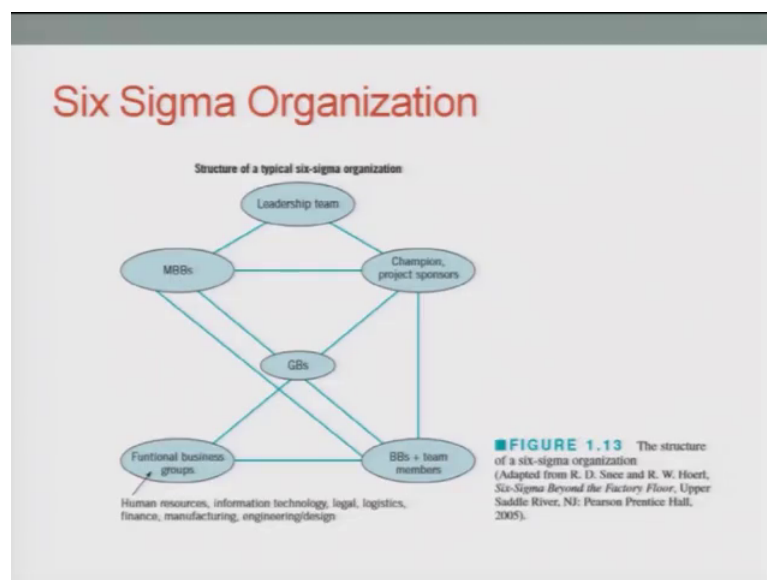
So, the 3 generations of 6 sigmas are; six sigma is implementation can be divided into 3 technically generations like stage wise depending on the development. The first generation focused on defect elimination and variability reduction so obviously, when you whenever you man and it was basically in the initial years the main emphasis was on manufacturing. Whether it is a car or telephone or bus or some different type of machine tools whatever it was main emphasis was basically to eliminate the number amount of defects which was which are there, like you are manufacturing a screw or gearbox or different or different type of gadgets obviously, they would be defects.

So, your main emphasis was to eliminate the defects and reduce the variability; that means, obviously if there are if there are defects and they are outliers which means the variability of the incoming raw materials variability of the machine tool. Coolant being use variability of the temperature variability of the humidity, all these things basically have a negative effect on the amount of defect or the number of defects which are there. So obviously, we will try to decrease that. And one of the best examples which we know or even if you do not; I would not go into the details because examples and all these things can definitely be discussed, but first let us compare the overall concept. And clear the actual fundamental things such that we can appreciate the examples in a much better way.

So, one of the important examples which is discussed in TQM circles and statistical process control areas is the Motorola case. Second generation mainly focused on integrating the above improved business performance through cost reduction. So, basically first was elimination of defects and reduction of variability. Then was the cost component and a very nice example is the g case and how they handle their cost reduction in different type of manufacturing units. Third generation is marked by focus on creating value throughout the organization and it is stakeholders, stakeholders can be the owners, can be the employees, can be the customers, can be the employers whoever it is Basically they have some positives.

So, called say in the function in the company because it basically benefits the stakeholders. Now if I am a promoter; obviously, if the overall value of the company increases my net worth increases if I am a employing. And if the actual performance of the company is doing good. So, obvious, I would basically be appreciated I may be able to get a better salary and benefits so on and so forth. If it is a customer the customer would be happy to get very good products where the services or actual manufacturing products whatever it is.

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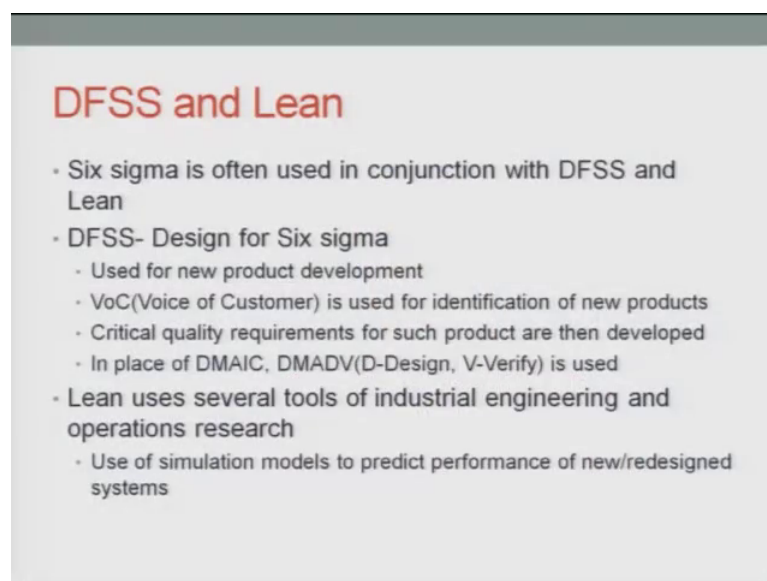
The 6 sigma; so called organization looks like this, where you have this has been taken from the six sigma and beyond factory floor concepts which is erupted from snee and hoerts book.

So, basically you have a structure of a six sigma which has the leadership team, and the basically they divide the work accordingly such there is a champions or a project sponsors. Then you have the human resources information legal logistics and so on and so forth. Now one thing we should be remember the so called structure of organization working concept or principle which is their which is being shown in this slide, need not be fixed for or all the organization at the same go. So, like say for example, one set of manufacturing units may have a structure of a of six sigma organization which would be different and quite the opposite if you are considering the point of view from the service sector or even.

If it is the service sector or even if it is the manufacturing sector company why is it the fundamental concept may be same the overall idea would definitely be different. Now the arrows there are no arrows here, but the lines which you which you see on the slide is basically gives you a idea that the information flow and the communication flow, and the sense of responsibility can be both ways such that the overall cycle is maintained in such a way that you take care or the main tenants of six sigma. And if you consider the main tenants of six sigma for the first generation second generation third generations would be to reduce the cost reduce variability, increase the overall efficiency, increase the quality level and awareness.

Six sigma is often in conjecture with a design of the whole production system.

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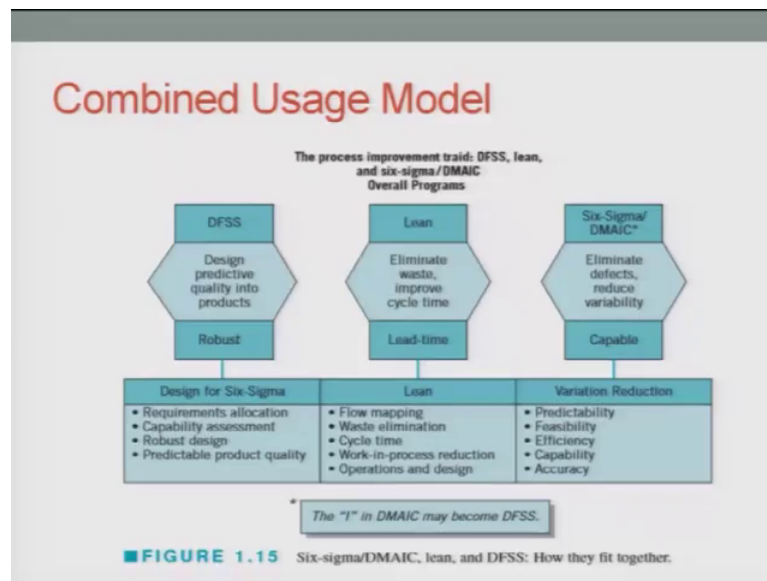
**DFSS and Lean**

- Six sigma is often used in conjunction with DFSS and Lean
- DFSS- Design for Six sigma
  - Used for new product development
  - VoC(Voice of Customer) is used for identification of new products
  - Critical quality requirements for such product are then developed
  - In place of DMAIC, DMADV(D-Design, V-Verify) is used
- Lean uses several tools of industrial engineering and operations research
  - Use of simulation models to predict performance of new/redesigned systems

So, for the DFSS designer six sigma you use a new product development concept to use. Voice of customers used for identification of new products. Critical quality requirements for such products are then developed in details, and you do the design and the verifications concepts are used in such a way that you find any if many mismatch is there between what the customer requirement is with respect to what the products is being supplied or the services, which are being rendered can we made 0 or as low as possible. Lean uses several tools of industrial engineering concepts. Operation research statistics all these tools are used in a very big way.

In order to basically put forward the ideas of six sigma and quality control in a much better perspective such that it can be implemented in the shop floor, in the factory, in the house, in the design department, in the HR department in different spheres such that we can appreciate the reduction in cost the increase in the level of quality the decrease in the variability the decrease in the number of defects and so on and so forth.

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The combined uses mode model basically has it should be lean should basically have the concept of six sigma's should have basically the robustness, and the reliability part should also be there. It should have a concept of lead time and capability. So, the designer six sigmas are done in such a way.

That it recommends allocations are done proportionally capability assessments are done. Robust designs and reliable designs are done both for the working of the of the overall

system, which is basically delivering the product the product I am using in a very generic sense. So, it should be lean; that means, the flow mapping process and the accountability and the information flow should be without any hindrance. Waste elimination should definitely be looked into, the cycle time of the process time for the whole information flow starting from the initial stage with to the final stage should be as low as possible. Work in process should be reduced or should be made as far as possible 0.

So, working process can be inventory working process can be incomplete products and all these things. Operations and designs optimization should be done whether qualitatively or quantitatively such that you are able to take care of the overall process to the best possible extent considering the concept of quality is applicable everywhere. Variability reduction is very important, if you remember in the first stage is basically reduction or of the total defects, and the and the deduction of the variability in the amount of so called dispersion which is there. So, variability can be of different types it can be predictable.

It can be it is basically feasible to look into the variability, and understand how they can be reduced. You would also like to basically understand that how feasibility concept can be utilized in order to basic reduce the overall defects or the concept of defects which are there. Increase of efficiencies of main concern you will try to basically increase the capability, and also the accuracy of the work for different type of components I am using not as a product component means different type of areas of working which is there to manufacturing this product. Like if it is a component you are manufacturing one unit can be say for example Design department, one unit can be procurement department, one unit can be say for example, the vendor department one unit can be the production department, and all this units which are there.

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**Link between Quality and Productivity**

- Rapid evolution of technology->urgency to exploit the new technology->problems in designing and manufacturing superior quality products
- Dimensions of an optimal process
  - Economy, efficiency, productivity, quality
  - Effective quality improvement can be instrumental in increasing productivity and reducing cost
- Basic categories of quality cost
  - Prevention Costs – new product review, Burn-in, Training etc.
  - Appraisal Costs – Inspection of incoming/outgoing products, maintaining accuracy of test equipment
  - Internal Failure Costs- Scrap, Rework, Downtime, Failure Analysis
  - External Failure costs- Warranty charges, liability costs, Complaint adjustment

So, link between quality and productivity so obviously, conceptually this makes sense because the higher the level of quality is obviously, the productivity level would definitely increase and productivity level what I am saying is not only the level or the competence of the type of products which you are manufacturing it can be related to the environment. It can be related to the mental setup, it can be related to how the people interact within themselves in the factory in the shop floor in the design department in the restaurant who are working restaurant.

I do not mean the customers themselves it can be the interaction between the people who are employed to work in the restaurants. So, rapid evaluation of technology led to urgency to exploit the new technology; obviously, the newer the technology; obviously, we will try to utilize that in order to get the best benefits. So, if you have a different type of computers I will try to utilize computing and information flow to the best possible extent to disseminate information such that the best practices can be followed up. Problems in designing and manufacturing of super superior quality products was very important in the industrial revolution and later on when manufacturing was the main essence of the world economy.

And based on that when we try to basically analyze you will find out that a technology had a huge impact on how the designing and the manufacturing units could be redesigned redone in such a way that you are able to reduce cost increase the level of

efficiency decrease the so called bad products; that means, increase the quality level reduce the variability and all these things. Dimensions of an optimum process when you basically design would be economy on based on economy on efficiency productivity and quality.

So obviously, quality is the main focus, but it can have different repercussions in the overall system for which you are interested to study how the quality would basically be increased. I am using again the word quality in a very generic sense, can be increased depending on the overall working efficiency productivity of the whole system. Effective quality improvements can be instrumental in increasing productivity and reducing cost. Basic attitudes of quality cost can be they could be prevention cost. So, you I do not want to raw bad raw materials to come or I prevention can be basically, I do a thorough inspection of the raw materials.

So obviously, with it will entail a sampling cost. So, people have to be employed some statistical test has to be done in order to understand, whether the raw materials which you are purchased really meets the requirement based on which you are going to work to makes the manufacturing a thing. Next say for example, in the service sector in a restaurant if you have the very good fresh products; obviously, it means that the type of food or the quality of food you are going to serve to your customers would be of higher level satisfaction which is higher level quality; obviously, would not go for steel product or steel raw materials.

So, they would be basically prevention costs. So, new product would be reviewed, and burning and training would be required so obviously, if a new product is coming into the market and you are trying to float a new product, you will try to basically train your workmen train your people; who are working on that in order to understand what are the implications of such trainings in the overall cost component quality component of the overall process. Appraisal costs are there, because if you want to be a price or take a note of how the things are working; obviously, that that entails a cost. So, that can be reduced if you are aware of the cost component from the process the word go.

Inspection so, what are the appraisal cost it can be inspections of the incoming materials outgoing products if they are more; obviously, means the cost is more; obviously, it is into the overall total so called net positive value which the company wants to make, I am



not using the word profit like say for example, for a government school it does not mean that you have to make a profit, but main focus can be basically to churn out very good students, have very good results or say for example, for a for government hospital it need not be only profit it can be say for example, how fast people are able to recuperate and they are healed or the operations are successful or the number of bed utilization.

The turnover time turnover time a person patient comes gets healthy or is relieved; obviously, his or her sickness and then goes back. So, faster it is better the overall working efficiency of the hospital. So, those are basically the cost which I am talking about. So, maintaining an accuracy of the tests of equipments these points which are being dictated by me and which are written on the slides are based on the idea the manufacturing sector was the main focus based on which this examples are being cited. So, maintaining an accuracy of the test equipment and how you do their presence is definitely costly and that has to be taken into consideration internal failure costs are there they are scraps they are residuals reworks have to be done and all these things can be done.

So, external failure cost warranty charges liability costs compliant adjustments all these things can definitely be a part and parcel of the basic category of quality cost, which definitely have a positive or a negative impact, depending on how you been to able to utilize that.

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**Implementing Quality Improvement**

- Management must recognize that quality is a multifaceted entity
- Important step of strategic quality management is identification of those dimensions in which the organization will compete
  - Select and develop the "niches" of quality
- In industries where a high percentage of parts in the end item are manufactured by outside suppliers, selecting suppliers is an important task
  - Selection of suppliers should be based on quality, schedule, and cost, rather than on cost alone

So, implementing quality improvement basically means management must recognize that quality is a multifaceted entity. And it would have different implications important state for of strategic quality management is an identification of those dimensions in which the organization can compete, and make improvements. So, say for example, if my main concern is to basically manufacturing steel.

So obviously, our main focus would be to get good raw materials of iron or coal and then manufacturing the making the steel to the best quality as applicable and floating in the market I sell it to the customers. So, it may not be that I start too much concentration or say for example, on the switch system of how of the places where the people who are working in the factory stays, I am not saying that it is not important definitely that is important. Because the more facility is considering the overall cost component which is there, we are able to give to your to your employees and to the people who are working; obviously, your so called productivity increases.

But if that becomes the main focus rather than focusing on the quality of the raw materials which you are trying to get, then it basically defeats the whole purpose. So, important steps of strategy quality management is identification of those dimension in which the organization should will compete as I said. Select and develop the niches areas of quality where you can improve the quality, in industries where a high percentage of parts in the end item and manufacturing by outside suppliers selecting supplier is basically a very important task. So, vendor selection for people who are going to supply you with raw materials for the products which you are going to manufacturing is very important because the moment, there is an error in the end from the vendors end is basically immediately it will have a negative impact.

And exponent so called exponential increase the overall variability of the product which has been manufacturing at your end, and it will have a devastating effect for the end product which you are going to sell in the market. So, selection of supplier should be based on quality schedules and cost rather than on the cost component only. So, cost is not important it may be say for example, if I get a good vendor, but a little bit higher cost, but I know the quality sense which the vendor would implement in his or her raw materials, and try to basically manufacturing the goods which he or she will supply to my end if they are of higher quality I would not mind paying an extra amount from the perspective.

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## Implementing Quality Improvement

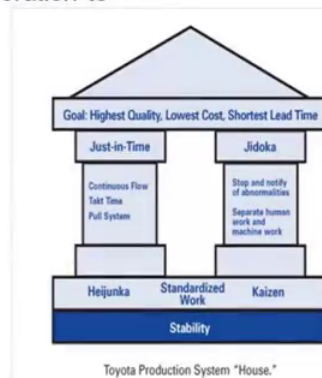
- Quality improvement must be a total, company-wide activity, and that every organizational unit must actively participate
  - A significant challenge to senior management
  - Responsibility of quality assurance is to assist management in providing quality assurance for the companies' products
- All of the individuals in the organization must have an understanding of the basic tools of quality improvement
  - There must be some specialised experts but everyone should know the basics

Implementing quality improvement processes to continue the discussion. Quality improvement must be a total company wide activity and that every organization unit must actively participate. A significant challenge to senior management is this issue, as I just mentioned responsibility of quality assurance stresses management in providing quality assurance for companies products. So, all the individuals in the organization must have an understanding of the basic tools of quality improvement. They must be some specialized experts, but everybody should know the basics and how they can be implemented accordingly.

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## Toyota Production System(TPS)

- Developed by Toyota Motor Corporation to
  - Provide best quality
  - Lowest cost
  - Shortest lead time
- It consist of two pillars
  - Just in Time
  - Jidoka
- TPS - Taiichi Ohno
- Jidoka – Sakichi Toyoda
- JIT – Kiichiro Toyoda
- The Machine that Changed the World
  - Published by MIT in 1990



So, we will consider just the way very simply with the very simple notion of a Toyota's production system. And as we know that Toyota was one of the main players in the market of quality apart from GE and Motorola.

But Toyota from Japan was considered a stalwart company or a pioneering company, in the area of trying to implement the different concepts of quality in different spheres of production and so on and so forth. So, developed by Toyota motor corporation it was to basically provide the best quality concepts at the lowest cost and the shortest lead time; that means, time was also factor if you delay the production delay your delivery of goods; obviously, it has a negative implications for your company and because the customers would be denied the product which they had wanted within a stipulated time. So obviously, it will basically may end up in litigation costs may end up in to say for example, higher costs as you are able to deliver the products later on so obviously, there would be penalties.

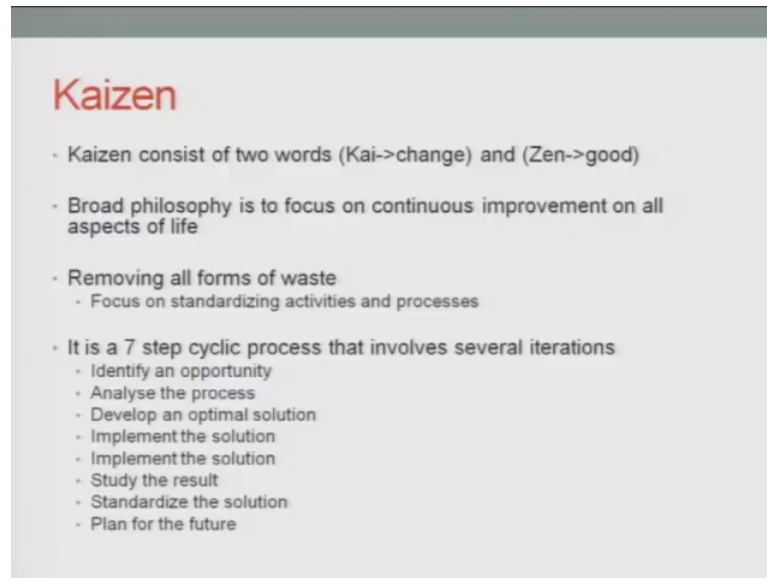
So, all this things should be should be considered, I am just mentioning as an important point, but these were the main focus of Toyota production system. It basically consists of 2 pillars. So, if you see the diagram it these are just in time a jidoka. So, basically just in time would basically mean continuous flow. And on and it basically mean is depends on the pole system so obviously, you are not going to push the system such that if the indent tree is already high pushing would basically have a devastating effect in many of the cases.

But it is basically pull such that the flow the materials are much almost constant. And the stoppages of the raw material stoppages of the working progress stoppages of the finished products are minimum. Because the more they stop they are bottlenecks more there they are bottlenecks they are costing involved. So, the overall productivity of the whole system decreases. In jidoka you have basically to stop and notify the abnormalities takes a actions accordingly. And for the for the overall stability of the of the Toyota production system. So, it can be implemented for other companies also, but the example which is given here is for the Toyota. So, their goal was of the high to achieve highest quality levels at the lowest cost and the shortest lead time.

So, those were the 3 bullet points based on which the discussion started if you remember. And on the other sphere the base work would be the kaizen, and the heijunka and the

standard work. So, basically they would have a solid feedback not a feedback mechanism, but basically a solid feedback such that the stability or the working concept of the company is to the best possible extent.

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So, kaizen basically means the consist of 2 words which kai which is a change of the good. So, the more you do you want to basically trying to achieve better and better level in terms of quality in terms of productivity, in terms of cost, in terms of reduction of variability, in terms of trying to basically reduce the number of outliers trying to basically reduce the total time.

Which is taking as the lead time and all these things. So, the broad philosophy is to focus on continuous improvement on all aspects of life at all the time. So, if say for example, I am trying to teach, or if I am trying to basically do a research if I am trying to basically do some administration work if I am trying to basically tidy up the room. So, all this things should be done in such a way there is a continuous evaluation in such a way that I always try to improve, the improve means that if I am teaching. Say for example, in a way where I am able to consider only 2 examples in a sense; I will try to improve my teaching such that I am able to either go into the depth of the 2 examples or try to cover more better example, such that it will give the idea to the students what I am trying to say. Or say for example, if I am doing a research.

So, in this in this concept I will try to basically have a much better model improve my writings and do the overall work in much comprehensive and professional manner. So, that the improvement is always obvious in the way I am working. Removing all forms of waste is very important. So, in kaizen you always focus on standardizing activities and processes such that the amount of loss which you which one entails in the overall process. Whether manufacturing or basically say for example, for the service sector can be reduced in the maximum possible extent. So, it is basically a 7 step cycle process that involves several iterations. So, what are the cycles we will consider briefly.

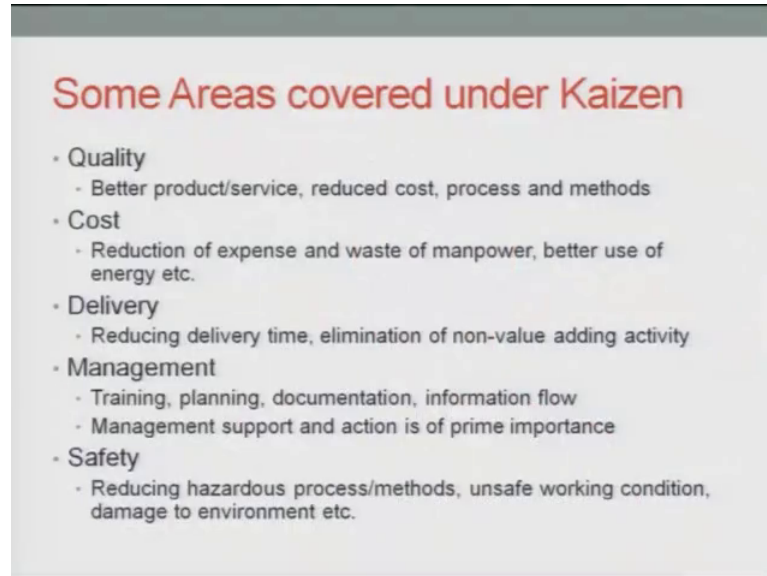
Basically you identifying an opportunity. So, what are the opportunities areas where you can reduce the cost or increase the cost reduce variability increases variability. So, I am using the word in both sense. Opportunities area if you are trying to basically go in the negative direction; obviously, you have a negative impact on the quality. So, you will always try to basically focus on the positive things. You analyze the process you develop an optimum solution and then try to implement that. So, implement the solution in such a way and if any internal achieve ah improvements need to be done you will basically go in a loop till the best possible solution is implemented.

You and once the results are standardized which is the third last point you study the results check what are the implications and try to implement then to that to the best possible extent in the system, that once what and once that is done you standardize the overall working process. Make a note have a flow diagram may have a detail detailed plan such that people once they are given that they can understand how this these things can be done. And then you basically plan for the future whether as the process occurs, and if there are such huge amount of changes in the whole system like say for example, new raw material comes, or new technology for production comes.

Or say for example the cost of one of the raw meters increases tremendously such that you to replace that with some other raw materials. Or say for example, this is different type of design which has come into the market and you should take care of that. So, of the obviously, once they come you basically rehearse the whole process start for all the 7 steps and try to basically standardize how the work is being done. Some areas covered under kaizen are quality. So, for kaizen the better product and services are demanded. So, at the cost that you reduce the cost reduce the amount of processing which is required.

Reduce the total methodology concept which are being used and try to basically keep them at the minimum level.

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So, cost would be deduction on the expenses reduction of the overall amount of wastages reduction of the raw materials. Like as I said if you are able to get good raw materials at the lower cost; obviously, we will take those raw materials in our production system. The waste of the manpower should be reduced, like means if I have one 2 persons who are manning or working on ACNC machine, we will check whether if one person can done; obviously, it means I can utilize the other person in other working (Refer Time: 26:42) for the working for the company or the organization, for the betterment of the overall philosophy a concept of quality which we are talking about.

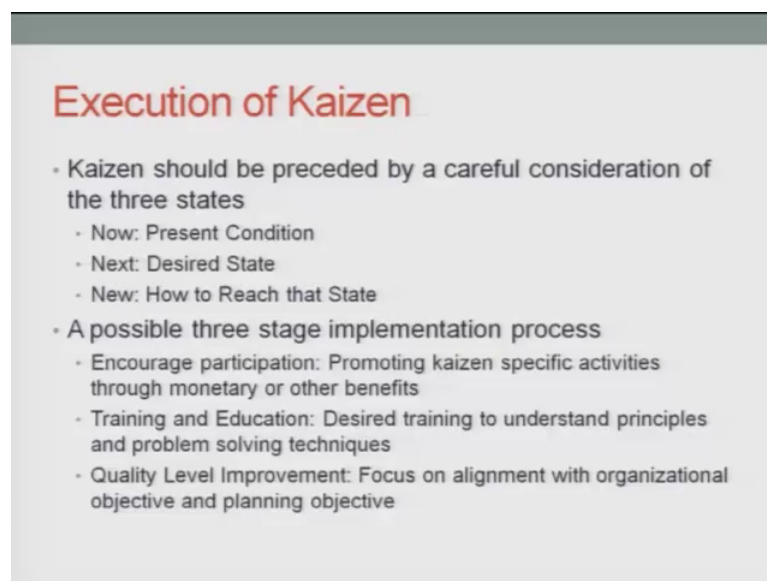
So, we will also consider the cost can come from the better utilization of energies. Energies can be say for example, electricity can be wind, can be water whatever you are trying to utilize in order to reduce the overall cost. So, you will deliver and try to reduce the delivery time elimination of non value adding activity should be made. As far as possible applicable such that the you are able to eliminate, all the non value adding activity to the level of 0. Management areas of focus for kaizen would be training planning documentation, information flow and the managing support and actions is of prime importance such that management is in sick. In how sink in how the overall

process is working such that things can be done in the proper framework in the right manner. Safety is also an issue under kaizen.

So, reducing hazardous process methods and unsafe working conditions. Basically leads to accidents and damage of the environment. So, that should also be taken care when you are basically considering the concept of kaizen. Execution of kaizen should be preceded by a careful consideration of 3 stage, which are basically what is the present condition. And what is the desired state later on and how to reach the desired state is basically of main concern for us. Say for example, I mean stage a; I want to stage reach stage b. So, what is the way how can proceed from stage a to stage b is also to be studied.

So, I am considering stage a and stage b are such that the stage b is a much improved version of staging in all the things it can be cost reduction, it can be reliability is increased can be reduction of manpower, it can be faster delivery of products whatever it is.

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**Execution of Kaizen**

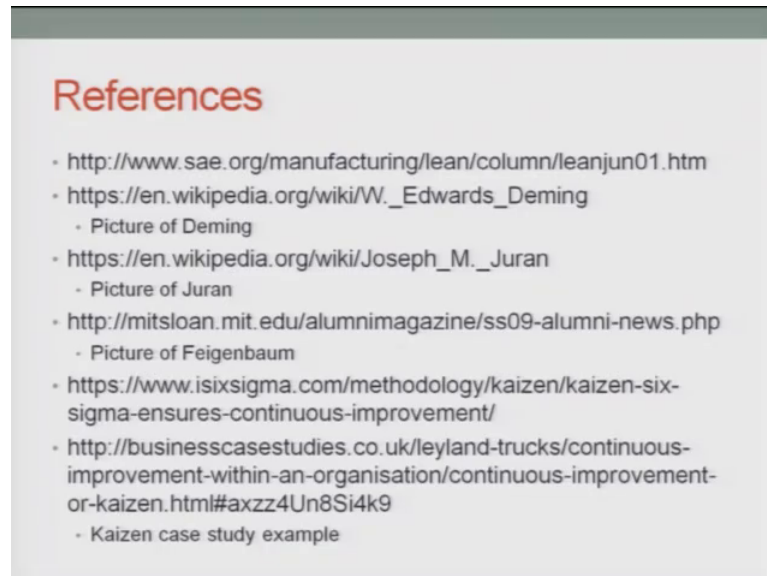
- Kaizen should be preceded by a careful consideration of the three states
  - Now: Present Condition
  - Next: Desired State
  - New: How to Reach that State
- A possible three stage implementation process
  - Encourage participation: Promoting kaizen specific activities through monetary or other benefits
  - Training and Education: Desired training to understand principles and problem solving techniques
  - Quality Level Improvement: Focus on alignment with organizational objective and planning objective

So, how we are going to implement from stage a's to stage b is also important. A possible 3 stage implementation process are encourage participation of all the employees and the workers and the customers. Training and education for the workers employees and even customers are required. And quality level improvement should always be the focus and of the top (Refer Time: 29:08) such that they are in alignment with the overall organization concept based on which the company or the organization is working.

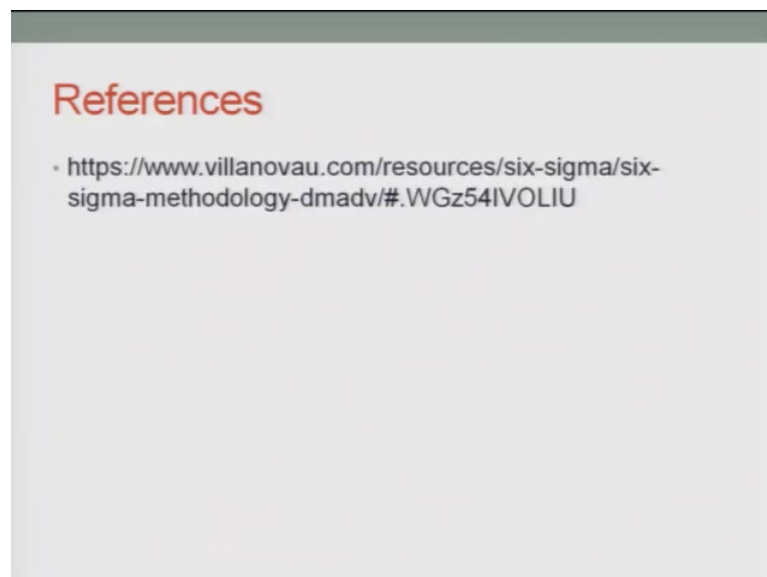


So, few of the references just for the interest of the of the readers. One is basically you can have a good discussion about Deming and Juran I am did not go into the details through the wikipedias. You can also have ideas of six sigma from the second last link which is about six sigma. So, the business scale studies are also there for Leyland trucks which is given in the last bullet point.

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And there are references of the resources for six sigma's from where people can understand six sigma; apart from the book which has already mentioned is given here.

With this I will end the tenth lecture and start with the 11th lecture with the other concepts have a nice day.

Thank you.