Total Quality Management - I
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Lecture – 12
7 New Tools for Quality Assurance

Hello everybody; a very good morning, good afternoon, good evening to all my dear friends and the students who have taken this TQM on course number 1. And I am Raghunandan Sengupta from the IME department, IIT Kanpur. So, we are going to start the 12th lecture; as you know till the 11th lecture, we have discussing about before that the concept of Kaizen and the fishbone diagram cause effect analysis, then we went into the 7 tools of statistical process control. We considered how the (Refer Time: 00:41) concepts could be utilized. So, we will continue on that and; obviously, build up as I said there would be a detail discussion about the different type of charts, like x bar and r charts p charts would be considered in a separate mode in much in details.

So, continuing with the 7 new tools of quality control. In 1976 the union of Japanese scientists and engineers collected and promoted the ideas and the concept of 7 managements and planning tools.

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So, these tools and the general the emphasis of these tools for in the following areas, and how the concept could be utilized one is basically the affinity diagram and it will give

you the core idea so called not directly, but definitely what are the cause and effect and how these things can be analysed. If you remember in this scatterplot I did mentioned though fleetingly that you can find out excellent diagram and excellent analysis using histograms and all these concept, but what is the actual relationship between the actual causes and it is effects have to be analysed both from the of mathematical and statistical point of view as well on as from the quality diff point of view that you will try to analyse; actually whether those cause and effect or the relationship between say for a say for example, humidity and quality if those we are interest to study actually make sense and whether we can utilise all the tools and the techniques in order to understand what are the effects and how they can be reduced.

Like variability can be reduced quality improvement can be done cost can be reduced and all these things. So, continuing with the 7 tools for quality control, new con tools for quality control one is the affinity diagram the any if the relationship diagram the any of the tree diagram the matrix diagram and the matrix data analysis. So, beyond general course I will just discuss as they are important. So, often it is replaced by a prioritization matrix due to the complex mathematical relationship which may happen between the cause and effect. And you may be able to utilize different type of brainstorming session different type of paratoo charge different type of quality control charts in order to make a simplistic view point of how would matrix data analysis can be utilized. We and continue with matrix data analysis. A prioritization matrix in a L shaped matrix should be utilise in a pair wise comparisons like case cause 1 and cause 2 or Similar your x and y you want to understand what is that relationship and how it effects the overall quality in the whole scheme of things.

So, if they uses pair wise comparison of a list of options to select the criteria and obviously, you can utilise different type of non parametric optimisation tools which we are not going to discuss here, but I will just mention like ahb topses electra and all these process can be utilized to find out the priority based on which you can proceed to understand the overall cause and effect in the much better way.

So, I am not saying this is the only way, there are other methods also. But these are very heavily utilise, when the overall feedback which you getting for the process for the system for the services may not be quantifiable. So, such that you use some conceptual and qualitative feel that how they can be modelled. Then the other the last 2 tools under

the new tools for quality control are aero diagram the process decision under program chart.

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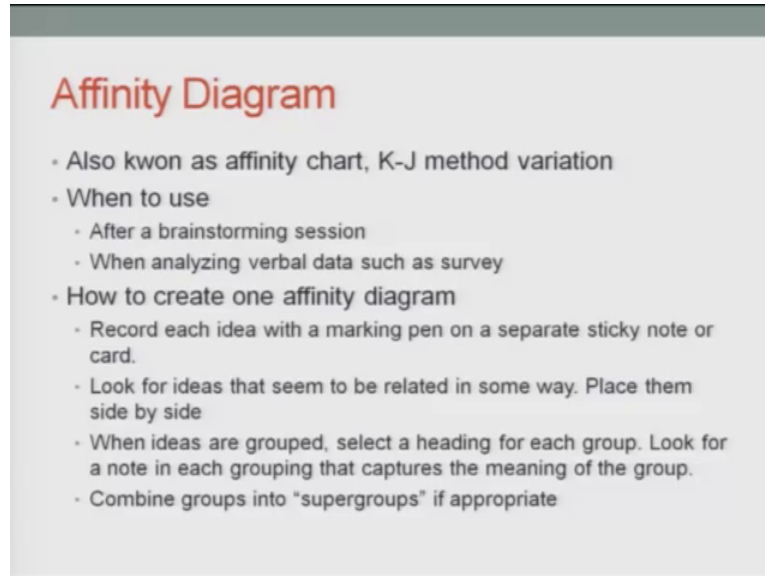
So, in the affinity diagram so, also known an affinity charts. So, they are known as the; so, call the K-J method of variations what are those I will just briefly mention them. When to use is that after you have done a brainstorming session like say for example, their issues of cause issues quality humidity is a problem temperature is a problem cutting tool is a problem, or the cool end which is being utilised for different type of cnc machines are a problem. So, if there is a problem the shop floor manager the workers the engineers, the design engineers, the purchase manager, the vender, they sit down together do a brainstorming session try to find out what are may be the causes and try to basically go into the depth do cause and effect analysis. And try to find out the actual bullet points based on which some analysis and some actions can be taken.

So, where they are basically use when analysing verbal data such as survey which has been used where you would not get any quantity feedbacks such that it is easily explainable to all the people who are in part and parcel of the decision making process. So, you have done a data you have got some informations, oh and those are quality giving nature you want to basically get the feedback on the quality if it is sends from different stakeholders who are there in the as I mention the stakeholders. So, based on that you try to collect the data and get the best so called set of information from them.

So, how to create one affinity diagram. So, record each idea with the marking pen on a separate stick note or a card. So, whatever the idea is that you have a board you continue sticking the information set or the ideas which are coming out from different player.

So, they may be random ideas which may not be directly related to the problem which you are facing they can be. Say for example, if the product is bad information or the or the workers make sti may sticks say for example, some information related to the vendor issue may be related to the humidity may be due to the temperature which there may be say for example, the food quality is not good whatever it is. You write down in stick notes stick them and then from there when all the ideas are there. So, idea should be coming out without any hesitation from all the stakeholders; obviously, they would be describe they would be ideas which will be diametrically opposite people you may not agree.

But at least encourage and have all ideas coming out from the discussion and make a collection of them. Look for ideas that seems to be related in some way and place them by the side such that now it is make makes a logic of sense that all the ideas which you have got all the brainstorm sessions, which you have done with the players basically are now making sense as you basic collide ant and make a logical sequence or logical flow or a logical idea that how they are related to each other. And these ideas can be grouped into different categories, may be some are more related to say for example, technical issues some maybe related to be say for example, environment issues some may be related to say for example, vender issues. So, collect them in separate groups.

So, ideas I groups select the heading for each group what you thong at the important points and try to basically prioritise them. And put some amount of importance on them look for a note in each group that captures the meaning of the group. So, say for example, it is related to the environment may be see for example, what is coming out may be too much of humidity or maybe say for example, too much of temperature increase in the environment where the machines are being utilised. Or may be see for example, there is a issue of raw materials not being of same quality. See for example, the issue may be related to the vender, but once you basically dig deeper in to the problem it may come out that the raw materials which you are getting is actually an issue which the vender also does not have any control.

So, it may be that may have to things the vender. So, rather than blaming on the vender try to find out what are the actual set of groups which are important and from that basically they get one main idea out of the focus idea way on which you can concentrate in order to basically tackle the problem. Combine the groups into super groups give appropriate and try to find out what is the linkage flow of all these subgroups such that they give you a logical sequence how you tackle the whole problem.

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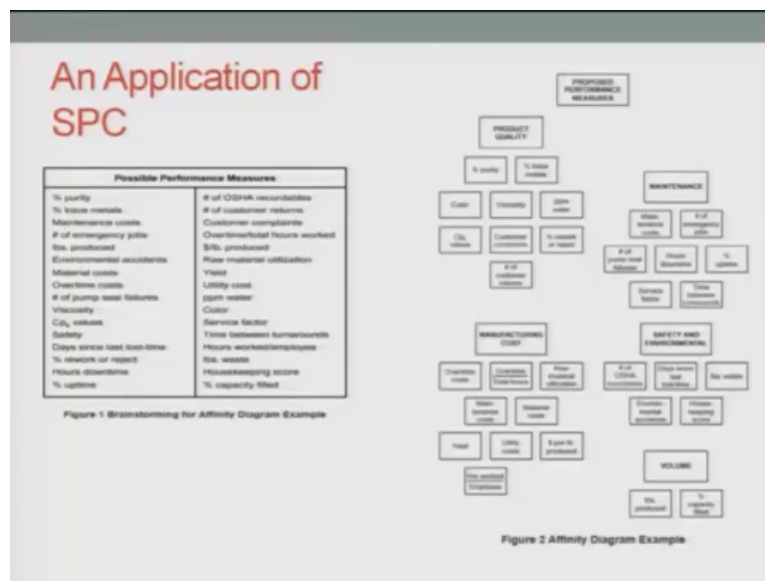
So, an application of statistical product control would be say for example, you are trying to find out some problems which you have getting from the air in the area of measurement.

So, it may be that percentage of purity is a problem percentage of trace material materials which are there is a problem. Maintenance cost is very high, then it may be number of emergency jobs which has been it done is an issue. It can be say for example, the amount of product which is produced in the issue, it may be the amount of raw materials or wastage which is done is an issue. It can be see for example, if we are trying to basically use some coolant and viscosity of a coolant is an issue, rate of flow of the coolant is an issue or may what are the jigs and fixtures you are trying to utilize may be an issue.

So, all these things are basically under noted down and one. So, in the in the in the left most diagram that these 2 columns in the chart which is there on the slide. It basically
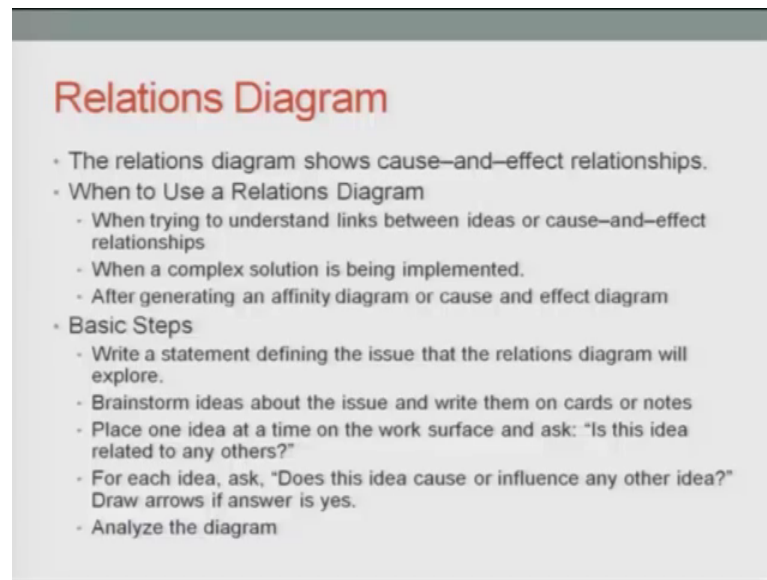
gives you the after the brainstorming sessions, what are the affinity diagrams or the affinities concepts which we have got the bullet points of the groups which we have got they are noted down. And once they are noted down they are basically grouped into sub groups such that you have a clear cut idea that what are the important main headings you have to basically analyse or where you have to concentrate.

So, what this is an example you can basically some people who work in the factory or who have done all these things would be aware. So, what you do is that from this you get the affinity diagram and you have basically the main headings which is coming out if you consider the bullet us points here, one is related to the product quality. When I am pointing my pen one is the product quality, one is the maintenance concepts. So, under maintenance you have the maintenance costs the number of emergency jobs it have to done number of pumps and seals for this failures for this example you can be say for example, hours or down times, service factors Percentage rough time between turnouts or on how, frequently the maintenance work is done.

So, all these are related to maintenance hence maintenance is one of the main key bullet points on which you have to basically concentrate. Others in this whole example are one is the product qualities it may related to colours viscosity parts vermilion which is being utilized it can be number of customer returns or the feedback from the customers which are negative. They are under product quality. Another can be say for example, the manufacturing and a man print costs, they maybe maintenance cost, material cost, the utility cost and the ours and employment the overtime which you agree and all these things which are there.

Other issues can be say safety and environment it may be due to a house keeping how the house keeping has been done. The environmental the how is the temperature, what is the humidity, what is the wastage amount and so and so forth. Another may be say for example, volume and so and so forth, you can have such that you understand that, all the ideas which I come out from the brainstorming session can be basically club into groups. Such that the groups when combined gives you the overall idea where the problem lies.

In the relationship diagram, the relationship diagram shows cause and effect relationship. So, is exactly like in concept wise is like fishbone diagram which you have discussed. So, it gives you the cause the effect relationship and what degree which is which the relationship holds.

When to use the relationship diagram is a question. So, when trying to understand links between ideas or causes a cause and effect relationship we need to use the relation relations diagram. When a complex solution is being implemented then. The overall relationship between different elements becomes complicated. So, hence you what you do is that you try to basically find out what is the overall linkages between different important points in the cause effect diagrams such that you find out what is the linkages between them. You also use relations diagram after generating an affinity diagram or cause and effect diagram such that it gives you. So, if you go back to the last slide the affinity gives you the bullet point and what are the important sub points under them so, but how they are related who basically come out when you do the relations diagram.

The basic steps in relations diagrams are write a statement defining the issue that the relations diagram will explore what you want to basically analyse what are the relationship. Brainstorm the ideas about the issue and write them on cards or notes. So, this is the second stage you now you go and do readapt then basically try to find out what are the issues. Place one idea at a time.

So, initially in the brainstorming sessions you have all the ideas and subgroups or the sub ideas. Now you pick up one of them and basically go and to readapt. And once you have basically analyse all of them separately then you try to combine that what is the relationship between them, what effects which one and how to what level the cause and effect concept can be found out. Place one idea at a time as I was standing on a work to works of in ask is this idea related to others. If not is does not stand alone or if they are related what is the relationship between them.

For each idea ask does this idea cause and influence any other idea. If it does the draw the arrows in which deductions the arrows of flowing and try to find out what is the quantum of an influence, these ideas or the sub groups have amongst themselves. Analyse the diagram and then basically make a judgement based on both the brainstorming as well as the which you are collect collecting from the quantity point of view.

So, say for example, I am giving as a very simple example our relations diagram.

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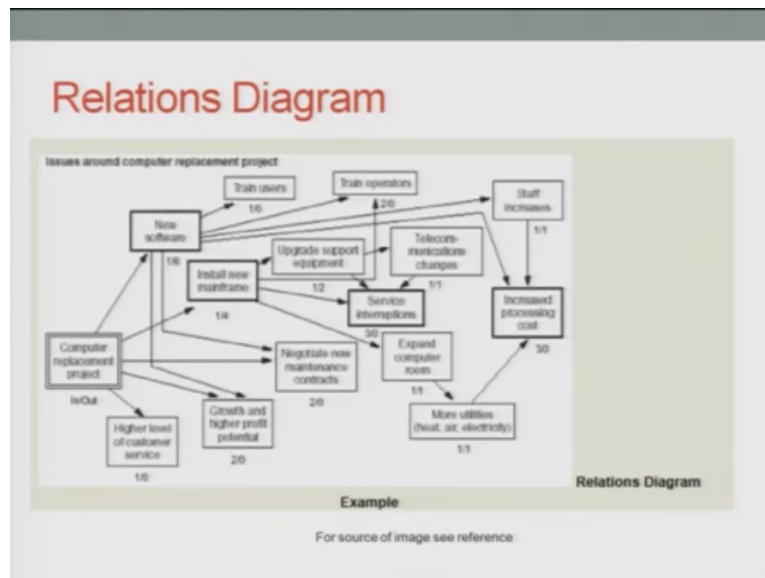
So, for this is basically issues are under computer replacement project. And once you do that So, these bullet points which you see I am using the word bullet point by this is the rectangles which you see are the main ideas or they may be sub groups may the ideas which is basically effecting the overall the concept of statistical process control. So, once these ideas are linked together you will understand the linkages which you shown by the

arrows would give you to what degree they are related; obviously, the degree of relationship would come out later apart from the brainstorming and the and the quantity of techniques being utilized, but as of as of now when you do the brainstorming session do the relations diagram it will give you that, there is some linkages between these bullet points of the ideas which need to be considered on a serious note.

So, you have basically the ideas I am just reading out there is computer replacement project is there. So, there may be higher scores of service are there. There would be basically the services interruptions which are which are an issue. There would be staff increase or decrease an issue. You need to create the operators you need to create the in uses. So, if all of them are related you basically try to find out that to what degree they are effecting each other.

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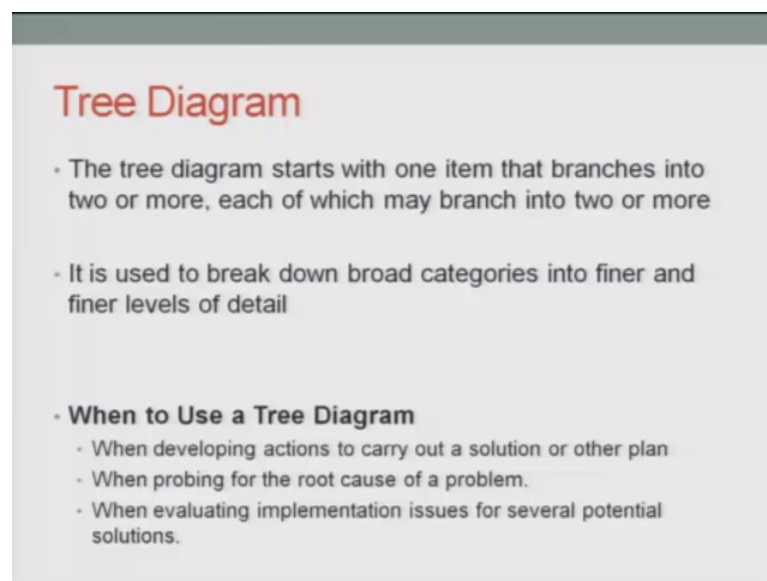
So, the tree diagram which is the third one is the tree diagram starts with one item that branches into 2 or more. And it could continuous doing that each of which may branch into 2 or more. So, basically it is a tree diagram or a hierarchy of importance.

Such that you are starting from the most important one and they are basically going down into the depth as you go down into the primary the tertiary the So, the and so and so forth, gives you a idea that how linkages are there and what are the different important points you need to consider. It is used to breakdown broad categories in to finer and finer levels of details and information. So, the more in depth you go like primary secondary

tertiary and so and so forth, they would give you the detailed information as you go down the table the tree.

When to use a tree diagram when developing actions to carry out a solution or other plan when probing for root cause of a problem. Then you if you need to find out that what is the important factor which is effecting this whole problem. When evaluating implementation issues for several potential solutions are there, you break basically break down all of them into their sub groups and basically try to see them on a micro level what are the important factors based on which you can take a decision.

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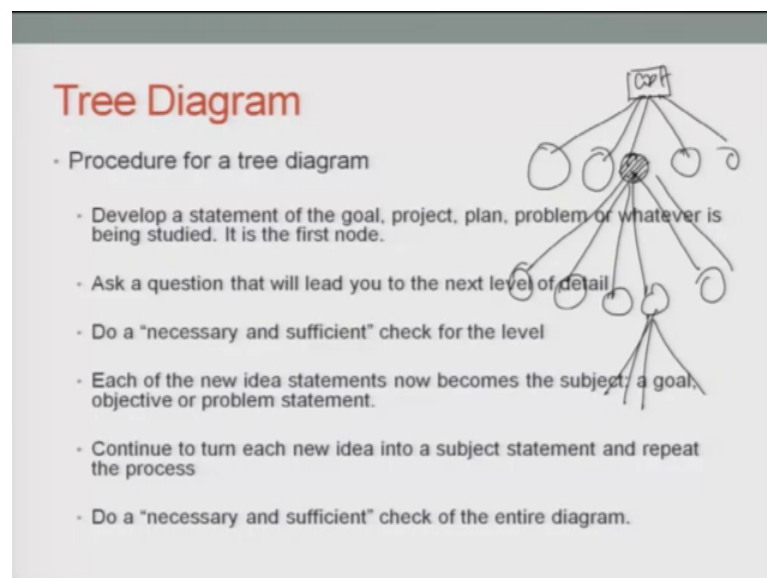
To continue the tree diagram this is the procedure for the tree diagram is develop our statement of the goal, or up on idea or a project or a problem or whatever is being studied. So, that basically becomes the main note. Then you ask questions that that will lead you to this next level of the detail. So, say for example, I am finding that cost is an issue in the shop floor one. So, once I have the idea that the I need to basically concentrate on the cause then I would basically going to the second level I need may come out that say for example, cost is coming out Because the temperatures are very high.

So, hence the air conditioning costs running them is very high or may be see for example, there are huge amount of dust particles hence you have to use a very special machine which may not be required if you are able to utilise, some different type of air

conditioning machine or may be see for example, the cnc machine is poor it is capability is low it is old you need to replace it So, if; obviously, it means the law amount of wastages which is coming out from the cnc machine is very high. So, in this way you break them up and then go to the secondary level and the tertiary level into on in order to understand.

The idea based on which you are trying to proceed. So, for that example which I gave for the cause you will basically break down into more finer levels in order to find out what that cost implications are. So, you ask yourself do a necessary and a sufficient check for the levels and basically go down the level in order to understanding in depth. Each of the new ideas statements now becomes the subject which is a goal and an becomes the objective based on which you will go into this next level.

So, say for example, you have a level which is the main idea which you are trying to consider which is the cost. And cast have different implications it may be due to the cnc machine it may be due to the electricity usage it may be say for example, raw materials are not right and all these things.

So, once you considered this as the main goal say for example, the electricity cost. So, you will basically go into the secondary level it will again have different implications on the cost structure and this way you will go down to the next the tertiary level. And continue doing this such that you have a have the overall idea how the cost structure. For this main idea which we have discussing on the cost structure can be analysed.

So, continuing this let me read continue to turn each new idea into a subject statement and repeat the process. Do a necessary and sufficient check for the entire diagram and see this is a logical sequence how the idea has been explored. So, this is one now So, the diagram which I just showed you in the last slide was done in a horizontal manner. And in this case is basically the tree diagram is give in a vertical manner. In such sense the trees are moving from my left to the right and in the other diagram which I showed to you just few seconds back; it was give me basically coming from the top to the bottom.

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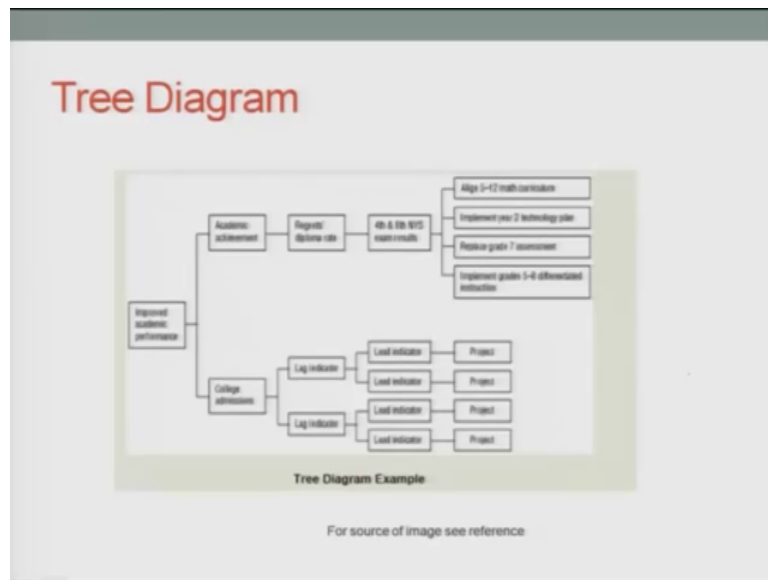
So, here is a tree diagram and it gives you the improved accommodate performance you want to analyse for any academic institutes. So, the a main important ideas that which are coming out yes as stated in this diagram it will be academy achievement, college admissions, they would be a lack of indicator how the college admissions could be done how the ranking of the colleges could be done and so and so forth. So, would be basically; it will go to the to the secondary level tertiary level and you basically try to analyse each of them at the lowest level and then collate all the information till you reach the main idea based on which you have started this tree diagram.

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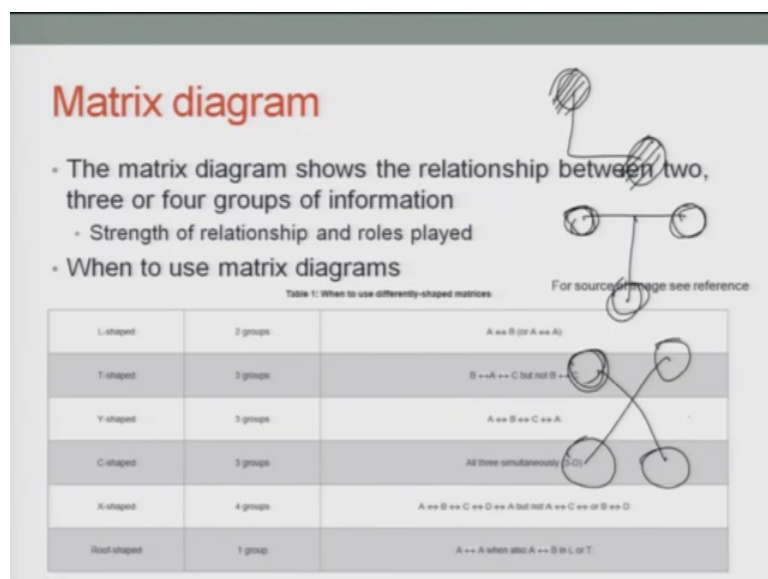
Now, coming to the matrix diagram and the matrix diagram concept; she matrix diagram shoes the relationship between 2, 3, 4 or such groups of information. The strength of relationship and the role played or the inter relationship between the so called the groups would be important in order to analyse the matrix diagram. So, when to use matrix diagram. So, here is basically I am considering the examples. One of the matrix diagram concept can be explains at L shaped, one is the t shaped, one is the y shaped, one is the c shaped, one is the x shaped and one is the root shaped. So, in this case you can analyse in the L shaped you can consider 2 groups while in the x shaped you can consider 4 groups.

So, if you see that the how the relationship can be done for the L shape would be either basically between a relationship between at a and b. So, basically I am trying to understand the L shaped as this and you will put all the set of informations or all the groups in the in at that so called 2 notes which I have hashed here and that will give you what is the relationship between them. In the t shaped basically you have 3 groups because there for the t; there will be one set of group here one set of group here and other set of group here. And say for example, for the x group it mentions 4 groups. So, it there would one set of groups here second here third here and 4th here.

So, would basically you will try to go in to the depth in the in the so called matrix note on not the matrix notation the matrix diagram in order to understand that how they can be grouped into different groups or collected into different groups in order to make the in order to understand that the how the relationships between the groups can be analysed.

L Shaped Matrix Diagram

Customer Requirements

	Customer D	Customer M	Customer R	Customer T
Purity %	> 99.2	> 99.2	> 99.4	> 99.0
Trace metals (ppm)	< 5	—	< 10	< 25
Water (ppm)	< 10	< 5	< 10	—
Viscosity (cp)	20-35	20-30	10-50	15-35
Color	< 10	< 10	< 15	< 10
Drum		✓		
Truck	✓			✓
Railcar			✓	

For source of image see reference

So, in the L shaped matrix here I am just given an example. So, here I am for the example when you are considering the tree diagram the cause and effect just few slides back. So, the main important points which to be analyse is a purity trace of materials parts per million, then viscosity colour and all these things which are there. The once you analyse say for example, you have the customer requirements for different customers. So, they are given like customer, D M R T are given and you understand and write them along the row and along the column you have all the informations from one particular customer. So, that at one go in a matrix formation gives you The relationship between the so called customers and their corresponding variable points of the group points on which you are going to analyse the overall problem.

It basically a matrix diagram. In the t matrix you basically have the product customers and manufacturing locations, and they are analysed like in the in the in the first part of the upper half you have the plants at different location which are texas mississippi Alabama and Arkansas. And then for different type of models model a, b, c you will basically get the informations that how they are placed. And then you go into the different type of companies which is zig corporation arlo lyle and time. So, they would give you the set of information for model A B C D in this way.

So, in the t 1 you would basically be able to combine the models which are shown where I am hovering my pen here, in such a way that you are able to basically analyse 2 different sets of informations at one go such that they will give collectively a sort of information which can be analyse on a micro level. Also micro level means plant location as well as the type of companies which are there for this example. In the y matrix notation it looks if you look at this diagram.

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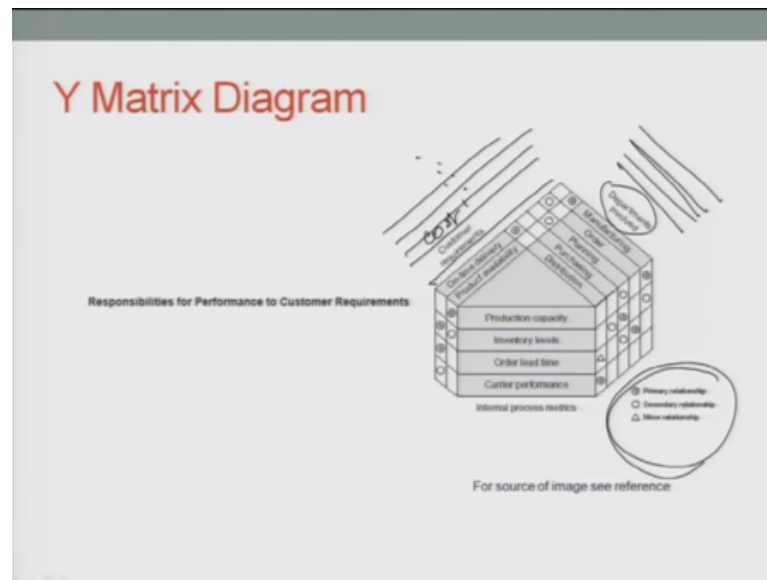
Along so, it technically it should be if you are able to do that it would be in 3 dimension one.

So, along one direction you have the customer requirements we are on deli. So, what are the points. So, they can be different sub categories also like where I am how I am drawing this lines parallel to the customer requirements. So, they can be I have the points related to the customer can be on time delivery product availability it can be cost also it can be say for example, after sales service. So, all these things would be club together layer by layer or one side where the main emphasis customer requirement. Then would be who are the departments involved it can be distribution purchase planning order and manufacturing vendor sales and all these things can be clubbed in the other direction. And then in there would be internal processes internal processes ideas and matrixes would be production capability inventory levels order levels carrier performance and so on and so forth.
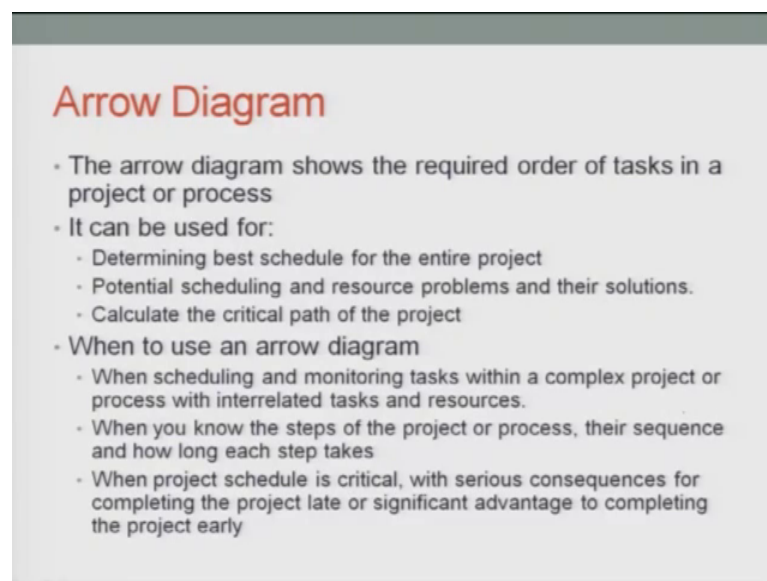
So, once you have them you will basically try to club them and try to find out what is the level of importance. So, where I am now circling my this pen is in actually this gives you that you are trying to basically club them and try to categorise them depending on different levels of importance. So, here the level of importance have been drawn diagram, where the primary relationship is known it given by these 2 concentric circles. The secondary relationship is given by this so called square or a circle. And the minor

relationship it can basically given by a triangle. So, you can subdivided into more sub categories are also in order to understand the overall importance in much greater details.

So, once you have that you can basically combine these 3 bullet points or the ideas which is basically customer requirements it can be something else also, but for this example is a customer requirement the department involve and the internal process matrix are analysed on each sub categories, Such that you are able to give a set of info imp importance between the sub categories based on the fact that what is the relationships whether is primary secondary or minor.

In the arrow diagram it shows the required order to of tasks in a project or process and logical sequence it can be used for determining the best schedule for the entire project and based on which you can take the decision. Potential scheduling and resource problems and solutions are all or also available Using this arrow diagram concept.

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It basically calculates the critical path of the project. So, if people are aware of critical path method and the project evaluation review method pert or zert or q zert. So, they can be you analyse in order to understand that what is the relationship and you do the arrow diagram.

When to use that arrow diagram? When scheduling and monitoring task within a complex project or passes with inter relate inter related tasks and resources. So, what are

the relationship between the precedence and the work which are going to come up? Later whether in the number of days of work or on number of days such of such questions are required between 2 different jobs whether they are enter looping all these things would be analyse.

When you know the steps in the project or the processes their sequences and how each sequence takes place what is the op operations between them whether they are resource constraints are there whether the prob whether the completion of the project based on the fact that I am basically drawn the pert of the cpm for the project is important all things can be analysed.

When project schedule is critical with serious consequence for completing the project, late or significance advantages of completing the work on time. So, those should also be analyse. So, if there are some penalties for overflowing the work overflowing the say work that you are not able to finish the work right on time.

So, if those things are there you need to basically analyse them and draw the arrow diagram in order to understand the overall things which are very important from the total quality management or the statistical process control point of view. So, with this I will end this 12th lecture and then again start the 13th lecture continue with the concept over spc and the TQM concepts. Have a nice day.

Thank you.