Quality Control and Improvement with MINITAB
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Lecture - 07
Design Failure Mode and Effect Analysis

Hello and welcome back to session 7 on Quality Control and Improvement using MINITAB. So, we are trying to see tools that are used in quality for visualization, data visualization like that. So, some of the tools we have already discussed in previous sessions.

And today we will highlight some more additional techniques which are used in quality and which has an interface in MINITAB and so, what we are doing in the last session is that, we are discussing about cause and effect diagram. So, let us go to that and try to recap what we have seen last time.

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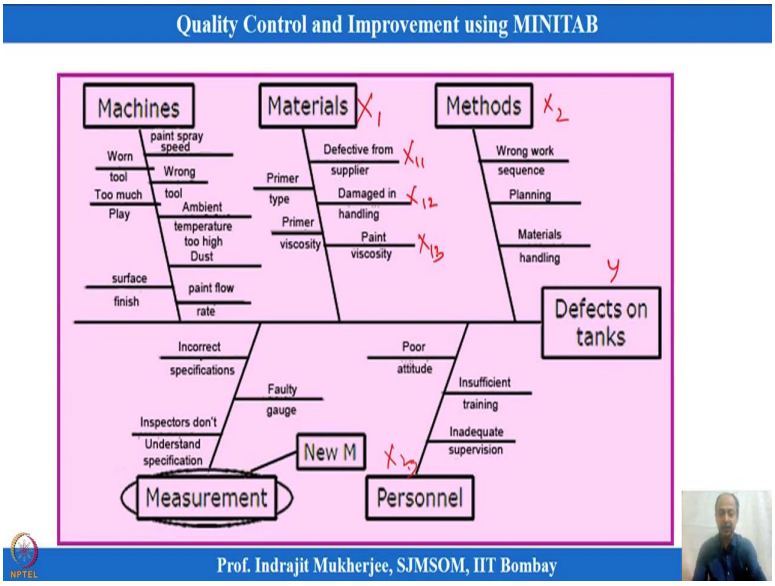

So, one of the thing that we mentioned over here in cause and effect diagram is that all our potential cause over here ok. So, there are 5 M's and 1 E's over here. So, environment is one of the another important aspects which is not shown over here maybe some of the causes and sub causes may not be present in certain scenarios, it depends on what type of problem we are addressing like that. Here we can see is that man, material, methods, machines, measurements.

So, personnel means, man over here. So, in this case. So, 5 M's are present over here, but environment is not so prominent over here. So, there is no such environmental influence which is creating defects in the tank like that. So, these are the what we are seeing over here these are the causes and these are the and this within every type of cause what we can say is X over here and these are the sub causes what we can see defectives from supplier can lead to defects on the tank like that.

So, this is basically why we can think of and these are the X_1, X_2's like that variables and within that sub variables we can think of. So, X_2, X_3 over here. So, this we can think about X. So, within X there can be potential sub variables. So, X_{11} like this, X_{12} like this. So, X_{13}. So, for a given cause, there can be sub-causes also. So, MINITAB has an option to add sub causes also like that ok.

So, there are 5 M's and 1 E's like that. So, and all these causes what we are mentioning over here is basically we can think about these are potential cause that means, that there are evidence or either from empirical relationship what we have seen by scatter plots or something like that or maybe theoretically there are some relationship that exists like that from literature we can figure out those things like that.

So, before we identify all potential causes much brainstorming is required to identify potential causes because we have to eliminate the causes or minimize the effect of the cause basically so, the defects on the tank can be reduced. So, which is the CTQ , what we want to reduce ok and so, how do we do it in MINITAB? So, let me just illustrate in MINITAB how we are doing that. So, for that I will take some examples which we have already hypothetical examples over here which is taken from book.

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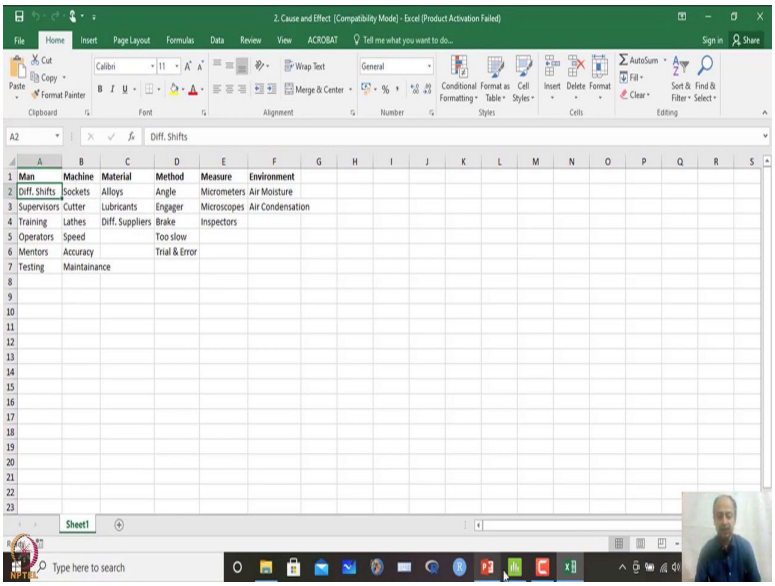

And here what we can see is that these are the dimensions. So, 5 M's and 1 E's over here and the sub causes for these are highlighted over here. So, this is in excel sheet what we can do is that we can just copy paste this one to MINITAB worksheet.

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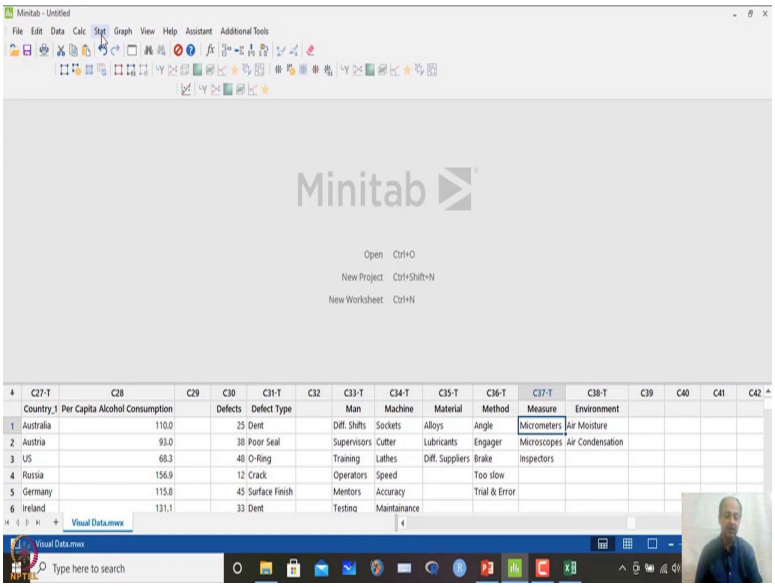

So, our worksheet that we are using was named as visual data like that and we will place it over here and so, we will copy this one causes and sub causes like that. So, here we will just copy paste this one over here and whenever we have done that we are ready

with the use of MINITAB. So, what we can do is that, we can just save this one save worksheet and replace the earlier one. So, that this data is saved like that.

So, we want to replace, yes I want to replace this one. So, this data gets saved over here and what we will do is that, we will go to now we want to use draw this diagrammatically and try to see. And so, in this case what we go what you do is that stat over here and then go to quality tools and there is a cause and effect option over here, click cause and effect over here and then there will be causes mentioned over.

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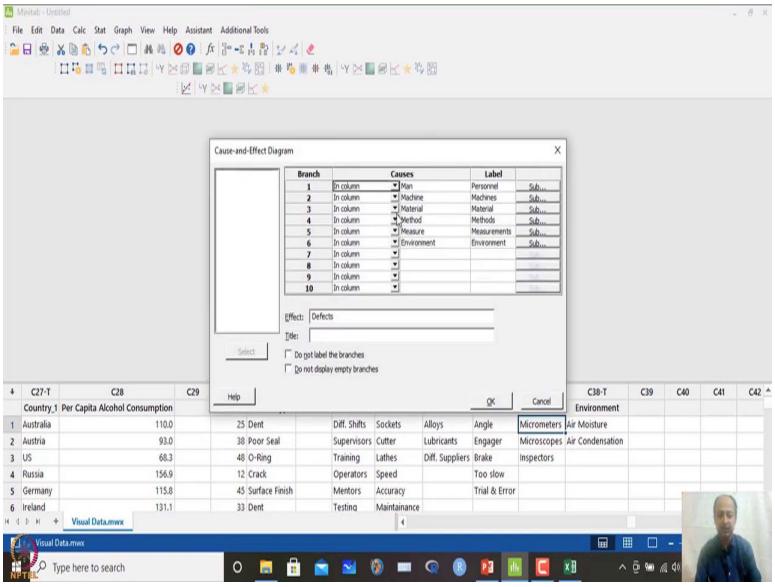

So, if you have not mentioned this one. So, it will be blank like this whenever you start this one and effect will also be blanked over here which you can title like that.

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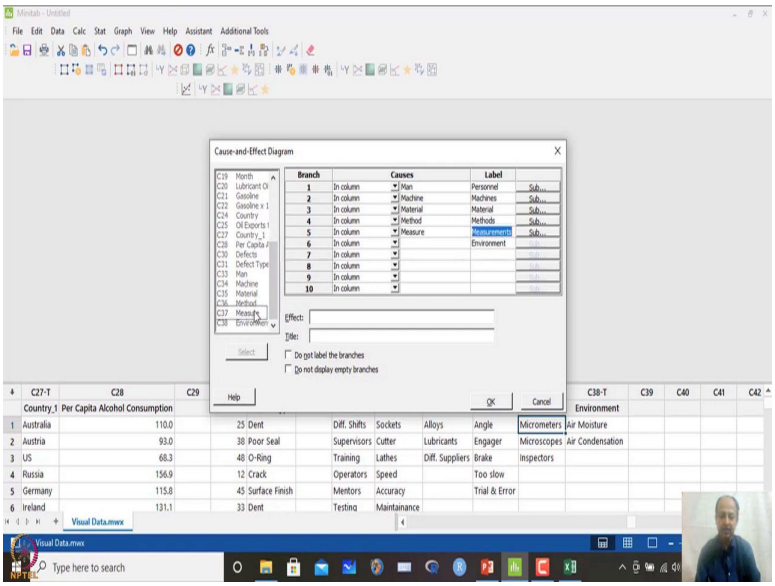

So, you have to just click this one in personnel, personnel means man. So, in this case and then you have to identify where you have saved that one which is related to man over here. So, I have saved in C33 columns like that. So, I will highlight that one then second one I will highlight the next one.

So, machines. So, then I will highlight the third one materials, where are the sub causes like that. So, methods so, then again I will go to methods over here, then measurement over here. So, I will highlight measurements over here and the final one is environmental issues that is considered over here.

So, effect is let us say that defect is the defective items that is being produced like that. So, you can just name it this is hypothetical. So, I so, effect is Y category over here. So, we can say some forms of defects like that which is creating defective items like that ok. So, title you can always gives let us say cause and effect diagram or something like that C and I E or something like that.

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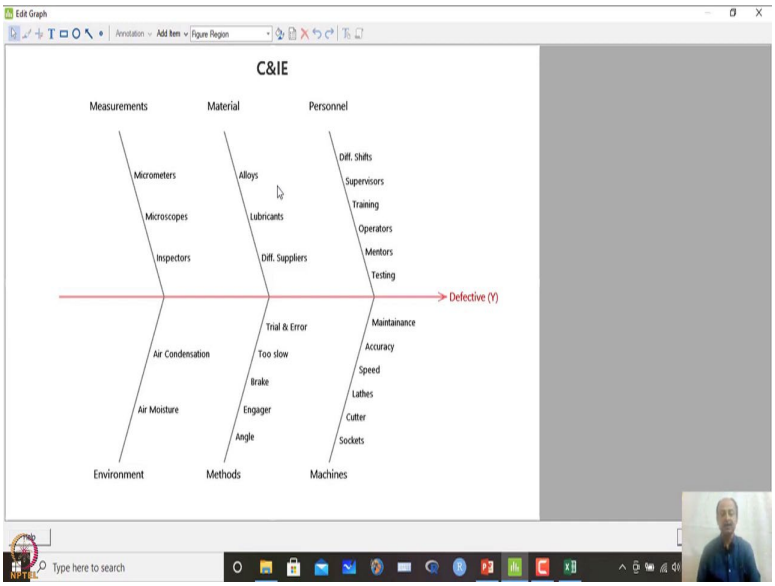

So, I click ok over here and immediately what will happen is that you will get a cause and effect diagram with titles and all. So, if you see and maximize this one you will find that different categories are given over here. So, you can just change the font size over here and these are the categories that is already identified.

So, immediately this is like a fishbone what you can see is that defective items are produced which is in red and these are the sub-causes which is leading to this one. So, this sub causes we need to see and try to minimize the effects of this. So, if there is a problem with alloy, we need to monitor and we need to experiment and try to figure out which is the best alloy that does not produce any defects like that.

So, this comes under experimentation like that. So, we have to our objective is to create cause-and-effect diagram. So, I know what are the potential cause which is creating the failures and then we try to block those causes or minimize the effect of those causes like that. So, MINITAB gives you an option to draw the cause and effect diagram which I wanted to illustrate over here ok. So, then what we have is that. So, the cause and effect diagram.

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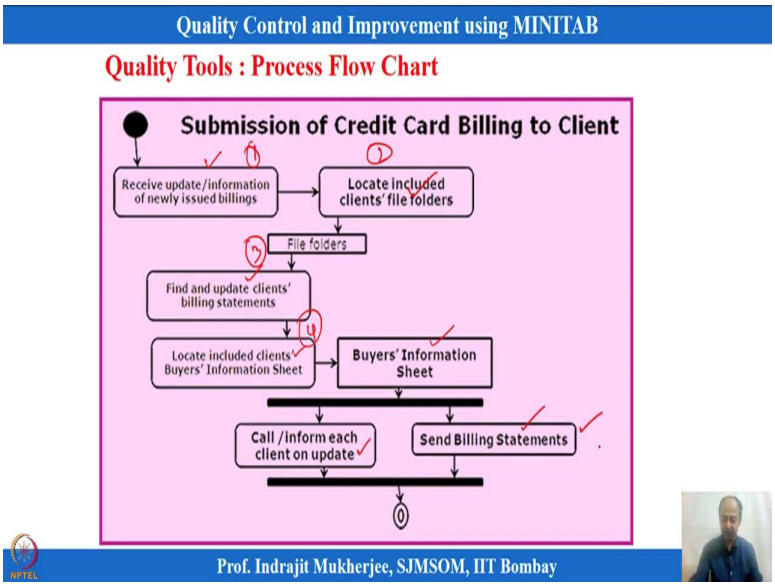

So, then another important tools sometimes we use whether it is quality management, whether it is lean management like that. So, some of the things that come into our mind is that process flow diagram. So, one important aspect is process flow diagram over here ok.

So, what is required is that to identify where the problem is what we do is that we try to draw the flow diagrams of the process. So, this is a hypothetical example where we are seeing that credit card processing, billing processing like that. So, how it goes to the client and billing is done and internally billing processing is done and then it goes to the client end like that. So, there can be mistakes and any other sub-processes like that.

So, what do you see is that, this is the information that is received then client folder is located over here. So, then updated client folder over here. So, these are some information sheets over here, buyer information sheets like that. So, then update on clients like that and send the billing statement like that this is one of the hypothetical ways there can be processes and sub-processes like that. So, this can be process-1, process-2, process-3 like that. So, all are processes over here.

So, these are sub-processes that lead to final billing statement over here ok. So, any problem in the billing statement can be happened and in any of the sub-processes like that due to any mistakes in the sub-process like that.

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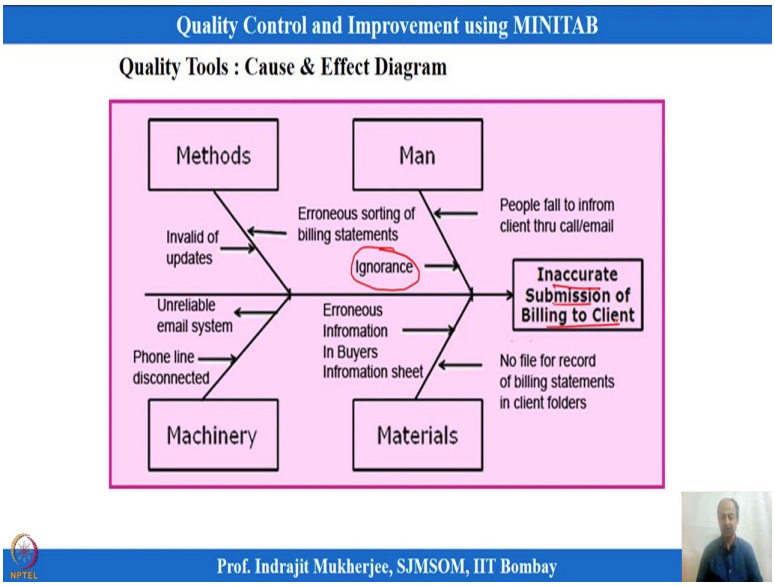

So, over here also we can just draw the cause and effect diagram for this and we can figure out what are the sub causes over here. So, maybe by ignorance we have done this and that is due to manpower or somebody who is supervising the things or who is coding the information like that in the database like that so, that can happen like that.

So, then there can be other reasons like over here methods machines materials it may not be manufacturing it may be service processes also. So, you can draw cause and effect diagram in various processes like that. Here it is in accuracy in submission of the bills to the client like that, how much we can be accurate like that, what can go wrong basically those are the causes we want to block those causes like that.

So, whenever I have a process flow diagram immediately what I can do is that what are the failure chance where it can fail basically. So, those things are the causes and we want to block those causes. So, everywhere manufacturing, service everywhere cause and effect diagram is required and also we make a rough flow diagram over here, we try to draw a flow diagram, MINITAB does not have any option to draw the flow diagram like that ok.

So, you can explore other software's where flow diagram can be drawn like that ok. So, maybe smart draw is one of the one of the options where we can draw flow diagrams like that and because that makes a visual impact and immediately people tries to identify with

within that n number of sub-processes where something can go wrong and which is leading to inequity in any accuracy in submission of the billing to the clients like that ok.

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So, MINITAB interface we have seen that how to use cause and effect diagram.

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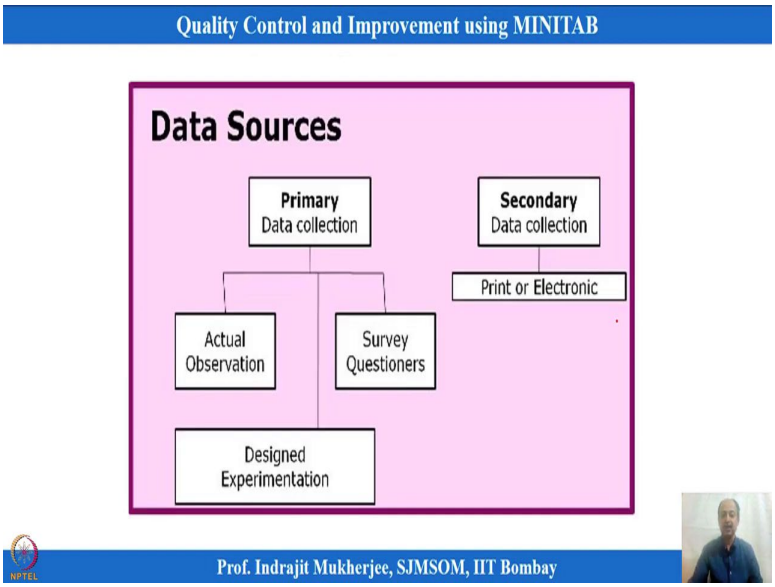

So, we will come to a different topics and we will try to see what are the other things we need to know primarily before we go into quality control and improvement. So, you see the data that I am representing over here are secondary data, which is known as secondary data, somebody else has generated that one I am just using those data those

are known as secondary data like that. Primary data what I actually collect as a quality engineer or quality professionals like that from the process directly I rely on this.

So, this is the primary data source like that and this is the most authentic data which is used for analysis any kind of analysis. So, we need primary data which is collected by me ok. Sometimes secondary data does not make much sense because the information that is required or related to a process may not be available in secondary data like that which may be of primary focus for my research or any other analysis or projects like that.

So, we believe on primary data. So, whenever I am generating primary data can come from various sources actual observations, survey questionnaires like that and maybe experimentation what we talked about like design of experimentations which is basically done by me when I am trying to improve the process. So, systematic variation, inducing variability and then trying to see what is the effect on Y like that so, on CTQs like that ok.

So, these are primary information primary data information which is collected. So, always believe on primary data source for any quality control and improvement ok. Secondary data is not so much reliable when we are talking about quality control and improvement.

So, you have to go to the process collect the data and information and then act on that data based on the data analysis you act on that. So, make some inference, make some decision and act on that. So, that is the objective. So, it can be primary or secondary. So, we are talking about primary data source that on which analysis is done.

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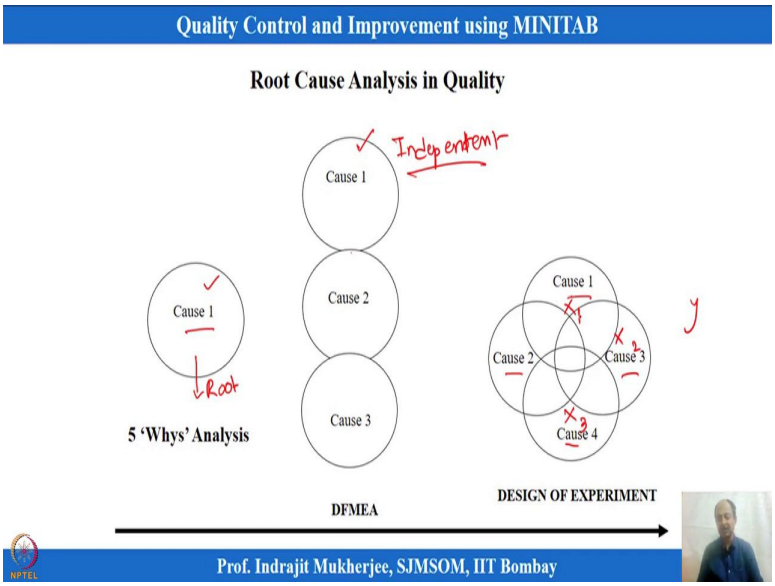

When we talk about quality control and improvement ok another important aspect is that whenever I have told about cause and effect diagram. So, we can think of various how to handle those causes because I want to minimize the effect of the causes or I want to eliminate those causes like that.

So, whenever I have a single cause in that case very easy to solve, this is not realistic one, but there can be only one cause which is creating defects like that. So, there can be one cause, and if we have to go to the root cause over here. So, if you have to go to the root cause over here. So, what can be done is that we can use a 5 Why analysis, 5 why 5 times like that and we come to the root cause like that.

So, this is quite easy and this can be done. So, I ask a question why this is happening then subsequently I ask again why this is if this is the reason why that is also happening like that.

So, like this I come to the root cause and then I eliminate the cause like that or minimize the cause like that. So, this is impractical scenarios where only one cause is leading to defects in CTQs like that and there can be scenario when we have multiple causes, but they are independent basically.

So, when they are independent. So, what happens is that there is little interference between the causes like that they are very independent like that and in that case what analysis quality tools is used over here is known as failure mode and effect analysis.

So, if it is done in the design stage, it is known as design failure mode and effect analysis and if it is done on the process stage when it is conformance stage when we are just implementing these those things and trying to see the CTQ effect like that in the process so, that is known as process failure mode and effect analysis.

So, failure mode and effect analysis is to try to minimize the effect of the clauses causes or maybe eliminate those causes occurrence of those causes like that ok. So, that is failure mode and effect analysis we will discuss something some briefly about this failure mode and effect analysis which is an important tool in quality so, but you have to remember that all these causes what we have what we are trying to address over here are mostly independent like that.

So, one does not influence the other one like that. So, if I take corrective action on one that does not impact the other causes like that. So, or there is no relationship between cause-1, cause-2 and cause-3 or very minimal interface like that, but scenarios this is also sometimes impractical like that, but nowadays they are trying to make modular design. So, in that case it becomes easier to handle those things.

So, in that case sometimes this design failure mode effect analysis is quite efficient to handle the or minimize the defects or defective items like that ok. So, it is scenario design scenario should be like this. So, all are independent whenever something goes wrong. So, I can just replace that one. So, immediately modular type of designs like that. So, minimum interplay between the causes like that. So, that is the most favorable scenario.

But scenario may not be like that where scenario may be most typically like this cause 1, cause 2, cause 3 and cause 4 where there is a fair amount of an interaction; that means, they together act on the y's like that. So, there is a interaction between cause 1, cause 2, cause 3 like that cause 4 and there is a complex scenario what we are seeing in this and then eliminating the cause becomes very difficult or minimizing the effect of the cause becomes very difficult. So, there is a interplay between the causes over here.

So, there is interplay between the X variables over here and that can impact the Y over here. So, if that is the scenario when multiple X's are interacting with each other. So, in this case scenario is not so, simple this needs to be addressed in a different way. So, when we are facing such kind of scenario mostly what we will see is that, we need design of experiments for that to deal with that one ok.

So, there are three ways we can deal with this one is Y-Y analysis if the causes are single causes like that and we can address that one or maybe we can use failure mode and effect analysis when causes are mostly independent like that. And the third one may be when interplay is there we use design of experiments or statistical experimentation to minimize the effect of the cause like that or set the set the factor X where we have what we are mentioning over here in such a level so, that we get the best delivery on Y or CTQs like that ok.

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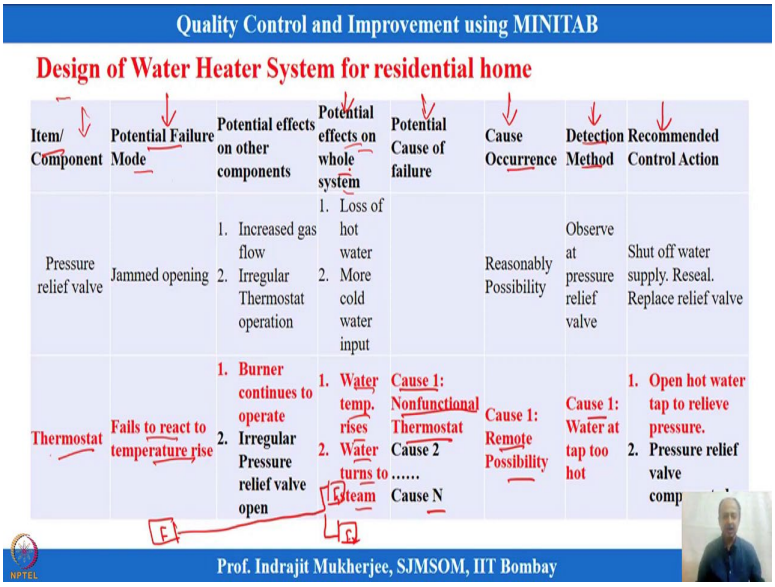

So, these are the different ways. So, let me try to just briefly talk about failure mode and effect analysis what is failure mode and effect analysis how it is used in design quality of designs. So, if I have to improve the quality of design. So, in that case this is a typical example what was taken water heater system for any residential homes like that.

So, within the water heater system there can be thermostat what you can see over here. So, there is a thermostat which controls the temperature basically ok. So, and it can fail, it can also fail like that ok. So, then there will be a potential failure mode of this item or

thermostat which is within the or component which is within the system water heater systems like that.

So, there can be multiple components like that and every components can fail. So, if it fails that in which way it will fail basically potential failure mode they says, potential failure mode over here. So, failure mode maybe it is not reacting. So, I am taking one example over here which is thermostat and fails to react to temperature rise like that.

So, this is the potential failure mode ok. So, if this happens if this happens failure happens and it does not react to the temperature, what will have what is the effect on the system what is the effect on the system. So, temperature water temperature will rise water turns to steam this can be the two possibilities like that. So, one failure mode can lead to two effects like that. So, it is the effect 1 and effect 2 like this.

So, this can be potential failure modes we can think of and then we can think of that there can be one effect and there can be two effects like that. So, there can be sub effects like this for a potential failure mode. So, failure mode and effect 1 and effect 2 like this. So, there can be multiple effects for a single failure mode like that ok. So, anyway we are talking about potential effect of the failure.

So, whenever there is a failure mode and there is a effect on the whole system like that it will affect the systems basically and whenever there is a failure it should be because of some causes over here. So, I have just identified hypothetically one of the cause, non-functional thermostat basically. So, this can be. So, what I am trying to say is that there is a potential failure that can happen because of certain reasons like that and then which that reason may be of several causes that may be of several causes like that.

So, one failure mode can be for various reasons. So, why this has happened because of various failure possibilities,failure causes various causes of causes are there which leads to such kind of failure basically. So, there can be multiple excess like cause and effect diagram what we are seeing, say effect is basically failure mode over here and X are the causes what we can think of over here.

So, in this case cause 1, cause 2 up to cause N what you can see like that ok and then every cause when we are trying to draw the pareto what we have seen is that there can be different reasons for failures of the systems like that. So, some of the some of the reasons

may be very frequently arising like that when I draw the pareto which is appearing frequently and there can be scenarios like which is not occurring. So, frequently like that. So, cause every cause will have some frequency of occurrence like that ok.

There is evidence that it will happen. So, because of this reason and that is why I am considering this in the in the failure mode and effect analysis. So, this is the basic format what you what you will find in failure mode and effect analysis, there will be item over here potential failure modes, potential effects will be identified on the system and all the components like that and potential cause will be identified there can be multiple causes and for each cause what is the occurrence frequency that also that will also be noted down like that.

So, is it very frequent is it not. So, here it is written remote possibility that is rarely this type of cause occurs like that. So, occurrence probability or something like that we can think of. So, cause occurrence over here if this is the cause is there any detection method that we have to detect failure because of this cause like that. So, the detection methods that is being followed over here and which will indicate that because this is a cause because of that. So, failure has happened like that.

So, this is the reason basically. So, do I have a detection methods like that. So, is it in place. So, do we have that one or there is no detection method to identify this cause,ok. So, and then recommended action in case it fails. So, what is the recommended design control that we have already mentioned already in place in the design like that. So, these are the recommended control action in case it fails and because of this cause then what action to be taken like that.

So, what is important is that failure mode and severity of this which is the effect, how much severities. So, that is also important how much severities and then what are the causes of that because if it is very severe we have to take action, we have to block those causes which is creating this failure mode basically ok.

Then for every cause what is the frequency of that also we need to identify then what we can think of is there any detection method to identify, if there is a failure because of this cause is there any detection method. Then accordingly we have a recommendation for that. So, this is what we do in basically failure mode and effect analysis and there are different formats for this doing this one.

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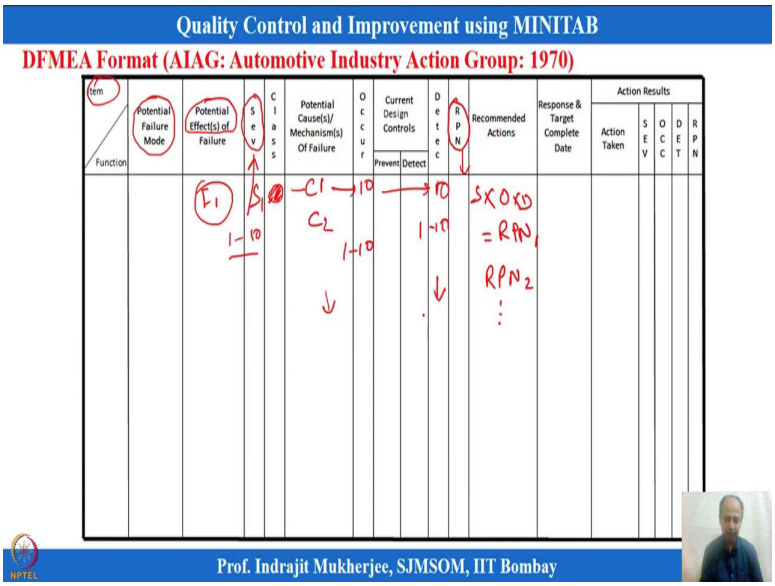

So, if you go to any industry you will find that design failure mode and effect analysis format will be there. So, potential failure mode you can see over here and items is mentioned over here, potential effect of failure what I mentioned will be mentioned over here.

And severity of this failure that means this is very severe harmful to the society or it is mild effects that we have in the process like that or where I am using this particular environment where. So, severity in a scale of 1 to 10 they gives and there is a guideline to give the severity also ok then class of problem very critical like that. So, they may use some symbols like that if it is very critical.

So, this type of failure mode is very critical like that so, severity will be high basically. So, if the failure mode and effect is effects on the mankind is very high. So, in our case severity rating will be very high like that. So, these things are rated in a scale of 1 to 10 let us say severity rating what you are seeing and then potential causes over here cause will be written for a failure mode. So, one failure mode we have identified let us say and there can be because of C1 and C2, C1 occurrence rating will also be given over here.

If it is very frequently occurring this type of cause, we can give it a rating of 10. So, here also a rating of 1 to 10 will be used over here and then is there any way to detect these causes over here. So, again detection for every causes will be given over here. So, in this

case. So, failure mode severity of this will be written over here severity one of this for failure mode.

So, this is in a scale of 1 to 10 then occurrence of each of this cause will be given over here and detection. So, if I can detect immediately that rating will be less. So, if I can detect and, but if I do not have any design control over here and I cannot detect those cause directly goes to the customers. So, in that case rating will be high. So, it may be rated as 10 over here. So, this is 10 severity occurrence also in a scale of 1 to 10 like that and this is 1 to 10 like that 0 is not included over here.

So, we because what we will do is that we calculated risk priority number out of this. So, this was started in 1949 I think approximately that time point US military force was using this one, then NASA has used this one in 60s around 60s then automotive industry action groups who developed this AIG which who develops also this QS 9000, quality system 9000 for automotive industry like ISO 9000 system they have developed initially and there they have given this format what you can see over here.

So, this is the generic format that they are recommended over here and then they calculate a risk priority number for a given cause over here. So, the risk priority number will be calculated. So, I want to prioritize. So, what they will do is that, they will multiply severity with occurrence with detection over here and that gives a risk priority number over here. So, for every cause there will be this priority number like that.

So, this priority number for cause 1, this priority number for cause 2 like that. So, for a given failure mode for a given failure mode and then they will rank all these risk priority numbers like that. So, then based on that they will take corrective actions like that ok and redo the FMEA.

So, every time you make some improvements you recalculate severity will not change, occurrence will reduce if you take some corrective action and detection will improve if you improve the detection in that case your score will go down. So, if the frequency of occurrence of the cause goes down, the score will go down and if you have a strong detection over here. So, in this case score will go down also then a risk priority number will also go down like that.

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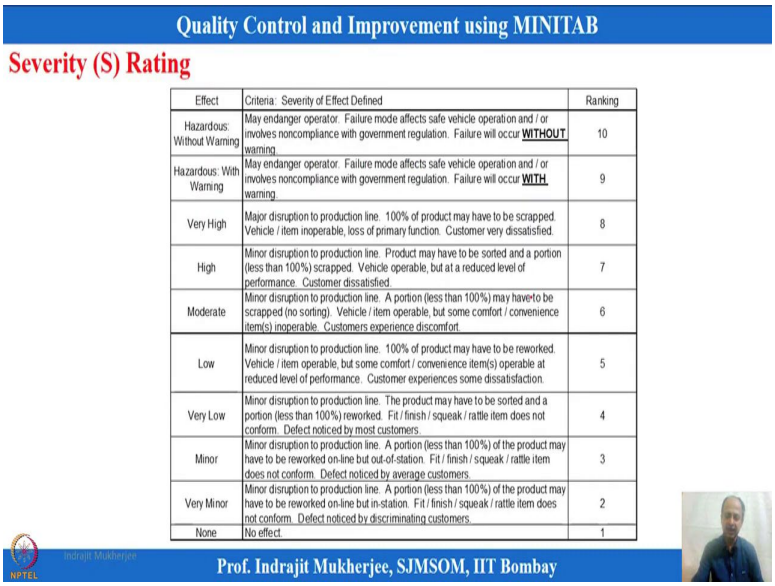

So, this is risk priority number every company decide what should be the cutoff for risk priority number like that before they takes the action.

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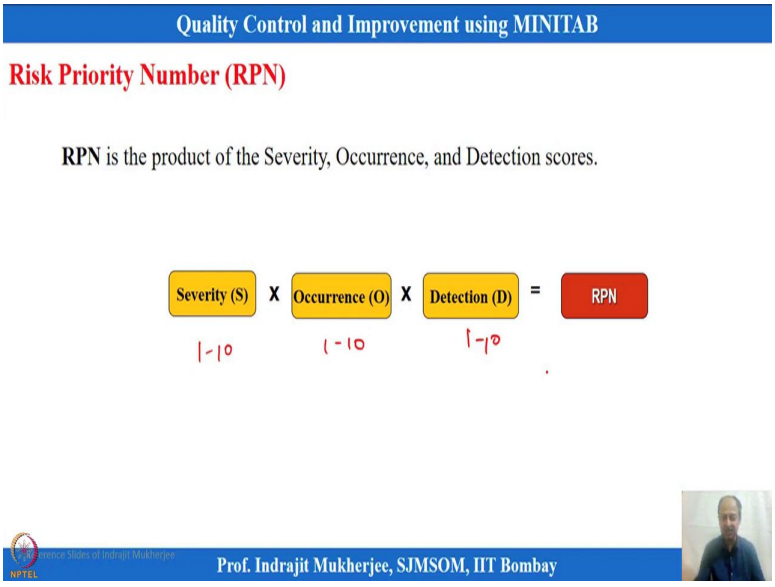

So, what they will do is that they will do a pareto analysis of this, risk priority number of each of this cause and they will do a pareto over here.

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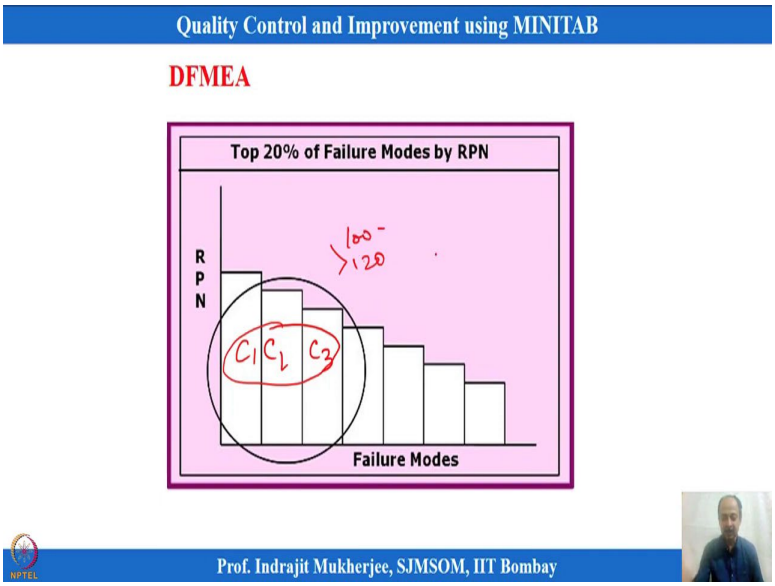

So, top risk priority number. So, maybe for cause 1 is very important cause 2 and cause 3, we have risk priority numbers and then we will tackle this first because this is very critical and the risk priority number is very high may be greater than 120 here what we are getting.

So, this we have to consider over here. So, generally risk priority number more than certain cut off let us say 100 or 120 like that we will take corrective actions like that. So, this can be severed in a scale of 1 to 10. So, what I am telling over here this will be in also 1 to 10. So, maximum score you can get 10 multiplied by 10 multiplied by 10, but this does not happen generally we have some detection possibilities of this. So, in this case priority numbers can change.

So, this so, then severity how do you how do we give severities ratings like that there are guidelines if it is very hazardous like that and appears without warning the effect is very hazardous and it will not give an any indication to the customer. So, it will happen immediately like break failures or something like that, it is hazardous like that. So, rating will be 10. So, severity rating will be 10 like that ok and severity rating will not change for a potential failure mode.

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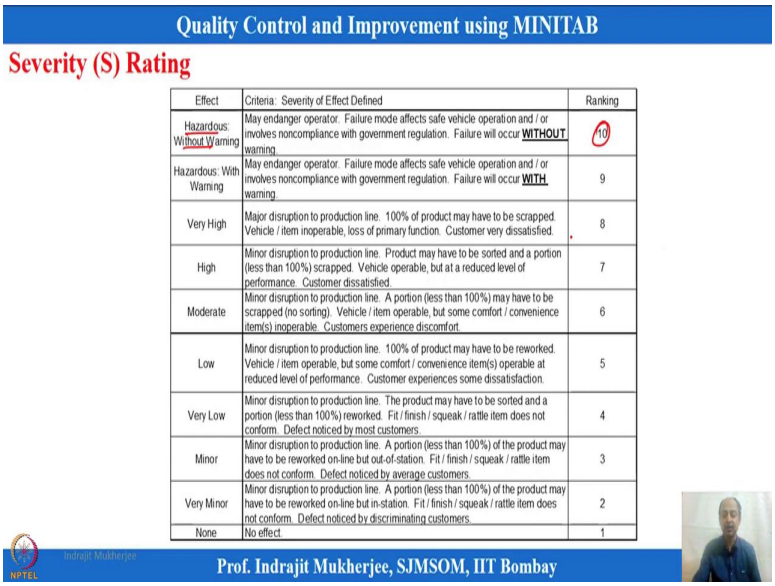

So, that is severity rating then occurrence, how frequently this cause is coming like that. So, if you are taking a if you have blocked that cause and occurrence you can reduce like that, here also very high frequency of occurrence is very high this type of cause is coming several times. So, rating will be high.

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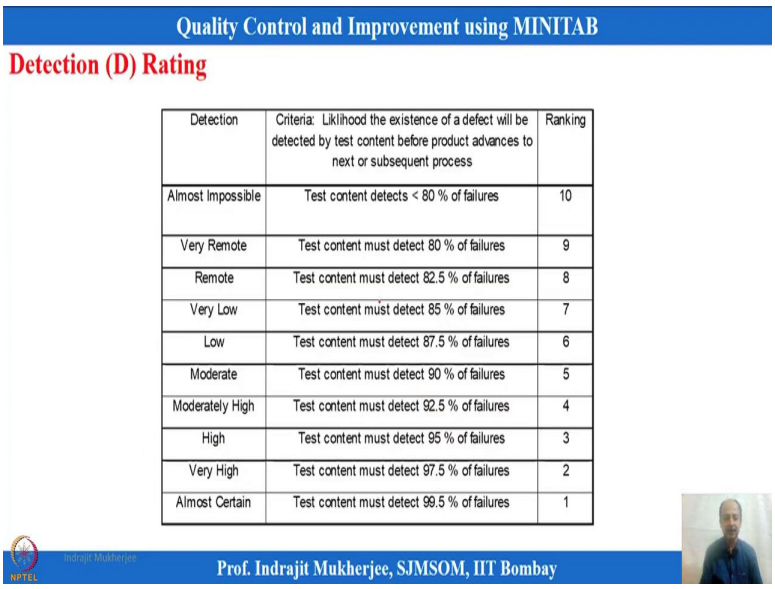

So, in this case and if detection method is not strong for this cause what will happen again ranking will be 10. So, the minimum score is 1 and maximum score is 1000 what

we can think of. So, this is 1000 maximum and minimum is 1. So, it cannot be any of this cannot be 0 like that.

So, that is the risk priority number what we get out of that ok. So, this is design failure it can be done in design stage also, it can be done in process stage also. So, whenever processing is placed we want to improve that one and we want to block the cause. So, also we do process FMEA we do process FMEA.

So, if you go to a company and quality control departments or quality assurance departments what you will find that, they have a failure mode effect analysis and design if you go to a design where design department there also you can find design failure mode effect analysis is being done. So, a general guideline is given if you want to see guideline is given in this QS 9000. So, those things you can see around 1982 this was proposed like that. So, ford general motors and Chrysler.

So, they developed this one and they have developed given a framework to do failure mode and effect analysis in design stage and process stage like that. So, that can be followed as a guideline and this priority number can be prioritized and then accordingly which cause to be tackled first which cause to be taken second like that we can prioritize that one. How do we block the cause and how do we minimize the effect of the cause like that in the design or in the process like that ok.

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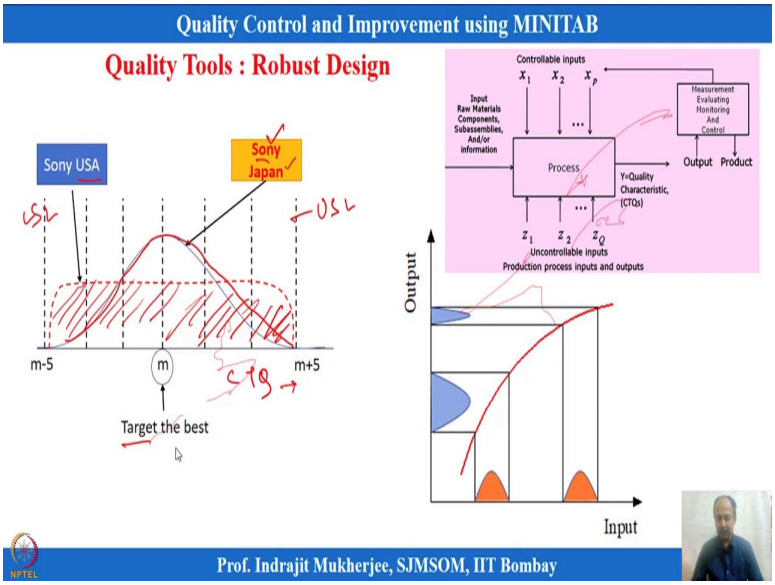

So, there is another important techniques that we will discuss in which is used in design basically is robust design. The concept of robust design what happens in robust design is basically when this was in 1980 when this came into highlight. So, Taguchi is one of the engineer who developed this concept of robust design and what was observed is that TV is manufacturing Japan Sony same company manufacturing Japan is far better than manufacturing in US.

So, variability of the process when it is in Japan. So, you see variability is less over here as compared to which is manufactured in Sony. So, this is the specification let us say upper specification and this is the lower specification limit of the products like that. So, variation is too much over here when us products are developed.

So, this is for a specific CTQ over here and in that case what was observed is that maybe picture clarity over here which is color density or something like that which was monitored at that time point and recorded and that this is that the CTQ is variability is very high for US and for Japan it is very less like that people are buying Japan and because of this behavior what is what you can see.

So, picture clarity it is always hitting the target value with minimum variability like that. So, that was happening and that is why. So, people are buying more TVS from Japan like that ok. So, then why this was happening analysis was done. So, in that case what was seen is that this noise variable is impacting basically outcomes of the process CTQs like that.

So, then a concept of robust design came into in quality in quality methodology like that. So, this was implemented in design stage also and in process stage like that. So, here interplay between these controllable variables and the uncontrollable variables what you see over here.

So, interplay between this was used and still used nowadays also to get the best outputs like that. Although I cannot control the uncontrollable variables over here I do not have options to do that one so, but what I can do is that I can always minimize the effect of that. So, that is the concept of robust design what we will discuss afterwards also. So, concept is hit the target and with minimum variability hit the target. So, mean and variance of the mean and variance both are important.

So, this is in the design experimentation emphasize that both has to be mean should be in target and variability should be minimum and in one go I should do this. In one go I should not do it that first I adjust the mean and then I do the variability adjustment like that. So, let us find out setting conditions like that let us do it together and immediately one setting and with minimum experimentation.

Let us figure out that variation will be less for the CTQ even in presence of noise variable which is uncontrollable variable like that is known as robust design and this concept is very popular although it is controversial, but still people are using this in design phase you go to any car industry they may be implementing this one, this may be used in screening experimentation also before we implement we do full-fledged experimentation or response surface designs like that. So, this can be used for a screening factor screening also ok. So, that we will discuss afterwards at the end of the course ok.

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So, history says that history of quality management if we are just highlighting which are the key concepts that was developed at this which are the key things that has happened. So, 1923 approximately around that time point Ronald Fisher developed this Design of Experiments, 1924 Shewart developed the control charts, 1930 these are the milestone what was achieved like that.

Acceptance sampling, I told that cannot reduce variability, but that was developed 1930 and still people are using in processes for supplier products when they are supplying to the to your company what type of plans do you do you implement. So, acceptance sampling plan is there. So, ok so, then 1950 around Ishikawa I discussed about cause and effect diagram, 60 around zero defects concept ok cross b zero defects concept came into existence.

So, I want to minimize the defects like that 80 Taguchi what I told is that robust design concept was popularized at the time point although he started the work around 50. So, 87 ISO 9000 are which was taken from the concepts of total quality management and that came into that gives a guideline to the industry and companies or organizations how do we implement quality philosophies like that in your organization like that and what are there will be some 8 principles based on which this ISO 9000 was built like that.

So, 1987 8 principles of TQM. So, that was used to develop this one. So, this is ISO 9000 and there are certifications. So, if you are ISO certified company you some of the your client may be willing that may be willing to see that certification whether you are ISO certified or not.

But many organization may not prefer to get this they can they may be needing some other certification like that, but this is in European organization mostly they ask for this ISO 9000 certification. So, this was revised in 1984, 87 it was first started ISO 9000 1987 version, then 1994 and currently maybe 2015 was the latest version like that ok.

So, this is a international organization for standardization which has implemented this one. Then Six Sigma was developed 86 to 89 like that and lean Six Sigma philosophy also came into existence at that time point ok. So, Motorola started this concept of Six Sigma like that. So, we will discuss some aspects of this also and in 2000 I told revision of ISO 9000 2008 another division came, 2015 is the 5th edition of ISO 9000 that is I can these are the milestones what we can think of there can be many more like this, but I have just highlighted some of them.

So, we will stop here discussion at this time point and we will start with control aspects from the subsequent classes ok. So, I hope you have understood the basic concepts. So, failure mode and effect analysis you can see many books are there on failure mode effect analysis, but what is important is that severity occurrence and detection. So, that gives

you a risk priority number, but that is that also I mentioned that this can only be used when we have causes which are very independent from other causes.

So, then that is a key idea what I want to emphasize over here. So, cause and effect diagram is very important tool in quality and then pareto diagram is also important to prioritize risk priority number what we have mentioned like that and based on that we will take some corrective recommended actions like that ok. So, then robust design is also used in quality of design like that.

So, these are all things which you can think of in quality of design what generally people follows and some of the quality tools which are also used in this quality of design and then we will subsequently start with next sessions we will start with quality of conformance ok.

So, let us stop over here and continue in our next class session 8 on quality of conformance ok with quality using MINITAB ok. So, thank you for listening we will again start in session 8.

Thank you.