Software Engineering
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Lecture - 34
Project Quality Management

We are now going to talk about project quality management. The project quality management processes are aimed at ensuring that the project delivers the product as per specifications and also it is done according to the processes that it was supposed to be following. Before we go any further let us look at some of the definitions of quality.

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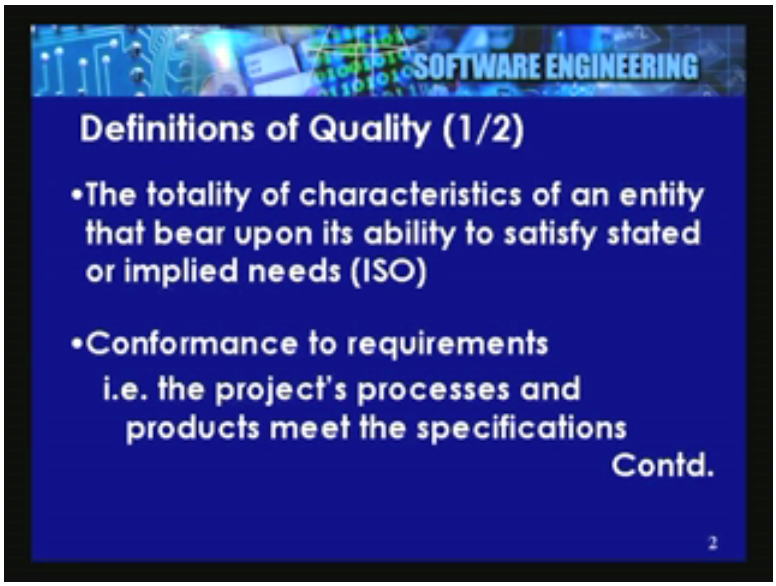

The first definition of quality is the totality of characteristics of an entity to bear upon its ability to satisfy the stated or implied requirements. So understand the words particularly, the totality of characteristics all characteristics, ability to satisfy stated and implied. Implied is very important. Many times we have a very restrictive kind of a definition of what are the requirements and the developers are able to meet the stated requirements but they are often not in a position to meet all the implied requirements.

Now if you look at the quality concept then it means different things to different people. So if you look at this from the developers' point of view the definition is conformance to requirements. That means the project's processes and products must meet the specifications. But from the customer's point of view this particular definition may not be adequate. From customer's point of view meeting the intended purpose is more important than just meeting the requirements because if the customer is not in a position to specify the requirements then we have a real problem.

So, from our particular point of view if we look at it and we ask; what is the definition of quality from the customer's point of view?
From customer's point of view the definition of quality is fitness for use. That is the product must meet its intended need. And ultimately if you look at all the other particular things then what the customer thinks is very important.

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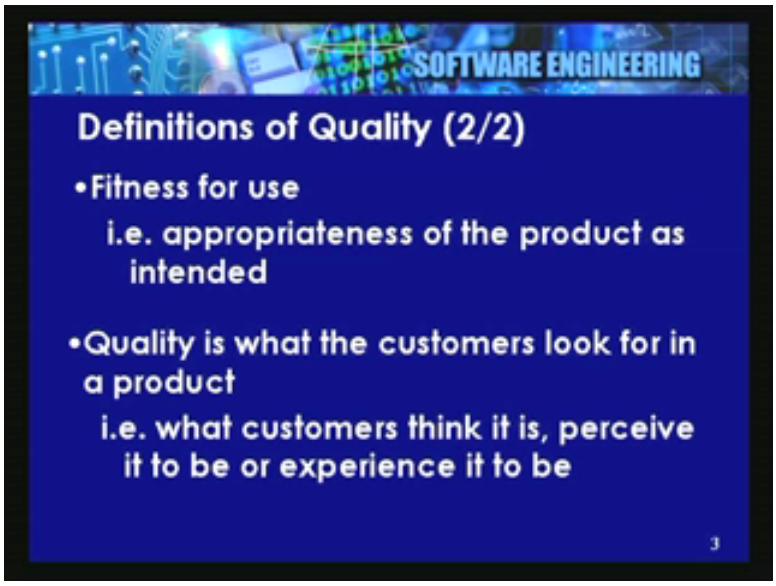

then from our point of view we will say that quality is what the customer looks for in a product or what the customer thinks it is or perceives it to be or experiences is to be. It can be any of these particular things. So, from our point of view meeting the requirements is not an adequate definition of quality. Now if you look at the modern quality management concepts then we say that it drives down certain basic issues.

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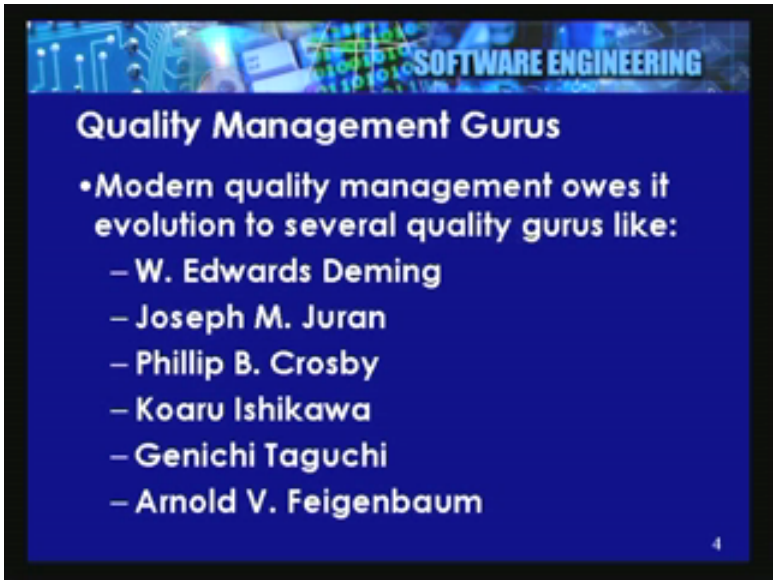

First it begins with customers and gives a very heavy emphasis on specifications; it ends with customer because the judgment about the appropriateness must also be given by the customer. So in that sense it stretches much beyond the stated requirements and imply requirements like reliability, safety, maintainability, portability etc are also equally important.

Another important aspect of imply requirements includes the legal requirements. So all our management studies basically are aimed at ensuring that the customer basically gets what he wants. Now let us ask a question like why we have a poor quality. There are two major reasons why we have a poor quality; one is lack of discipline. So we do not define the requirements, they are poorly defined requirements. Then we are not disciplined in bringing about the changes into the requirement so uncontrolled changes. Poorly documenting the requirements and all other intermediate steps would also create a problem. So, poor documentation is another particular problem.

Then the quality control is not being up to the mark. We are not having a proper test plan or review being done in a haphazard manner would lead to a problem. So, poor quality control is also one of the reasons as to why this can happen. Then we have problems of integration. Integration often is taken up as it is as is where is and whatever is available you try to integrate without giving too much thought to how it should be done. So, planning for integration is very important. So integration problems can occur. And last but not the least the testing may not be satisfactory.

Therefore, all the steps that are involved including doing adequate amount of regression testing may not be followed. So from all particular point of view lack of discipline is one very important reason. This second particular thing is, lack of discipline basically steps from poor management. Hence, poor quality can result because of poor management so

aspects like, first of all there may be lack of quality objectives, you do not know what really you are trying to achieving in terms of the quality, what is your expectation.

If you have a quality objective then only you can thing of making a quality plan. You cannot make a quality plan unless you have specific objectives to be specified. Then you need to make sure that you have adequate facilities for doing that particular thing. So, the facilities required for performing the project are not adequate then again you are likely to have a problem. You may have a problem with the staff, like inappropriate staff or inadequate numbers or low motivation problems many of these could lead to the problem. The constraints on the project may be insurmountable, you may have a demand for submitting the project in a time which is really unrealistic or the cost may be too unrealistic.

So in case some body puts constraints which are beyond the project manager's capability then obviously you are likely to have a particular problem. So in general we say that the poor management can manifest in terms of having lack of quality objective, lack of quality plan and unsatisfactory facilities, stock problems, constraints being prohibitive or inadequate resources and so on and so forth. So how do we get over this particular problem?
There are lots of management gurus as listed in this slide. These particular gurus have told us many things and these will help us in making sure that we achieve our quality objectives. Deming, Juron, Crosby, Ishikawa, Taguchi and Feigenbaum are some of the big names in our quality particularly. Basically if you look at it the sum and substance is that these people ask you to concentrate on three things in particular.

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The first and the foremost thing is, if you are interested in ensuring customer satisfaction at all cost, that is the foremost the customer satisfaction is the total aim. Next particular thing is prevention of inspection. The idea is that you do the job right. In case you do the

job write then the need for inspection is only incidental in the sense that it is to confirm that there is no errors. So, emphasis on first time right aspect is very important. The third is the responsibility for the quality is with the management. When it comes to blaming or something the person down the line the last person the hierarchy seems to be the one to get all the blame for things going wrong. There is the other way; the quality responsibility primarily rests with the management. So all the gurus whatever they tell us is that basically they tell that these three are the very important aspects from any quality management activity.

Now if you look at the quality management processes that we have these processes are aimed at ensuring that the project will satisfy the customers' needs for which the project was undertaken. Second; the quality management must encompass all activities of the overall management function that will determine things like quality policy, quality objectives, quality related responsibilities and also it must make sure that implementing these particular above mentioned quality policies etc within the framework of the quality system is a very important part of the quality management processes.

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Basically there are three quality management processes that we have. The first is quality planning process. The second particular one is quality assurance process and the third one is quality control process. Let us look at these particular processes more in detail now. Let us begin with quality planning process.

Quality does not happen by accident it needs to be planned. The management has the ability to anticipate situations and to take action that causes the desirable outcome. Therefore, identifying the relevant quality standards, incorporating quality standards into both the products and the processes and determining how these particular standards could be achieved is all the activity that we have in the project planning process. So quality planning process is a key facilitating process in the project planning activity that we have.

So, again remember our quote; “plan is nothing planning is everything”. Therefore quality planning is performed in an on-going basis along with the other planning processes. We have already seen the different knowledge areas and in each of them the first particular process is basically the planning process. So quality planning is just like scope planning, time planning, schedule planning, cost planning, risk planning etc so these are the particular key processes that we have performed in an on-going basis with other planning processes. So we have this particular situation.

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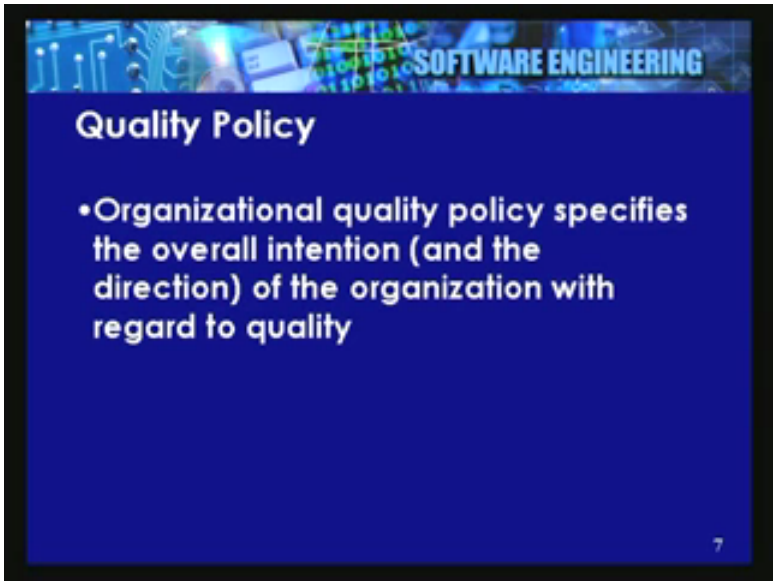

The first thing that we really need to do is to start the project, to set a quality policy. Therefore organizational policies specify the overall intention and the direction of the organization with regard to quality as formally expressed by the top management.

Remember, quality policy has to be documented and must be having the commitment. It indicates the intention of the top management in terms of achieving the quality for all projects. So we need to take the quality policy of the organization make sure that we appropriately support it by the project related quality policy. So in case the performing organization does not have a quality policy or if multiple performing organizations are involved then it is the responsibility of the project management to ensure that some kind of a quality policy for the project is put in place.

Thus remember, regardless of the origin of quality policy the project management is responsible for ensuring that all stake holders are available of the quality policy followed by the project. So, from our point of view if you look at it how we do the planning.

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First is we need to do planning at the organizational level. So organization will have quality goals, systems, controls may be aware of the competition and wanting to take those particular factors into account. For example, somebody like Motorola may say that we would like to have a six sigma kind of a performance on all projects. So the first particular thing has to be at the level of the organization.

The next particular level of planning has to be at the project level. So at project level you will really decide what kind of test planning is to be done, how you are going to do the scheduling of the test and how you are going to do the allocation of resources, what are the constraints, what are the policies and so on. You may have a policy by saying that if the number of first pass defects observed during testing exceeds so and so then we recommend that this particular product be recoded. So it is from that particular point of view of a project level policy.

Then you have operational level policies. Operational level policies are at the bottom level. this is like individual person working on a small set of programs of modules or working on one task like preparing NSR or something, at the operational level you have strategic planning in terms of test data, what test runs will be conducted, how and when the reviews will be conducted, how the reporting will be done and so on and so forth. So, from our particular point of view it is necessary that we do this particular planning for the project at various levels.

Once we have done this particular planning at various levels it will help us in achieving our overall objective. So, strategic planning at a high level document prepared, it needs to be prepared with the project planning, it should define the scope and the general direction in which the VVT or Verification Validation and Testing activity of a project schedule should go. Therefore different issues that are to be addressed at different levels of strategic quality planning need to be specified.

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The next level is we need to identify what are the characteristics of the quality that we are really assuring. So the quality characteristics can be identified at three levels. So first you look at the product operation level. Therefore the typical quality characteristics at product operation are usability, security, efficiency, correctness and reliability. Remember, these are broad characteristics and each one of these will have to be ultimately spelt out in more details to a attribute level or the attribute that is going to be actually measured for each of these.

The second set of quality characteristics is at the product revision level as shown in the slide. We have maintainability, adaptability, expandability etc. Remember, no product will always or ever perform in the same environment the hardware, system software, utilities, operating system and all kinds of things may undergo changes are if you have a product all the users may not use the same particular environment in which case you must be in a position to make sure that this particular products fits on all the desired environment so those kinds of things are called product revision.

Now another particular part that is very important is product transition. What is product transition?
Characteristics like reusability, portability, interoperability are all product transition. So from our particular point of view, you look at it from different points of view and you say yes the different components needs to be used again and again so they need to be made with that particular intention. To give you a very simple example, an Udupi restaurant makes mango pickles for convention on the same day and probably your grandma made it for being used for the whole year and obviously the way these two were made is not going to be the same. So the portability, [inter……18:36bility] all these particular aspects are there. And in the product revision not only the environment is in the thing. But any changes that may happen to the requirements over a period of time must also be taken care of.

So, if you again look at the slide you find that basically the quality characteristics can be classified into three parts such as the product operation related issues, the product revision related issues and the product transition related issues. Now if you were to look at any one of these particular characteristics these can again be specified far more in detail.

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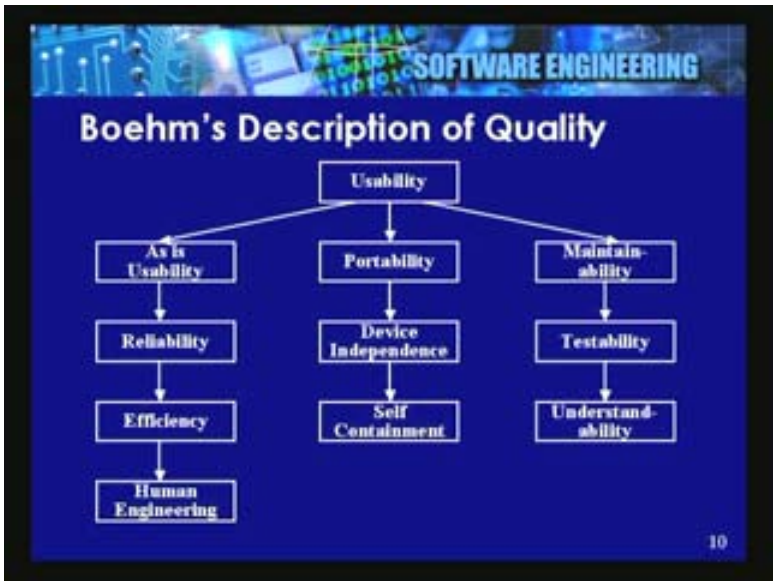

If you take the first particular characteristics like usability, on one's hand you can look at things like "as is" usability, reliability, efficiency or human engineering. On another particular side the usability may pertain to aspects like portability, device independence, self containment of the particular product or you go further you might look at maintainability, testability, understandability etc. So when somebody says something as simple as usability that characteristic is not all explanatory. So what is important from our particular point of view is any of these particular quality characteristics must be brought down to a measurable level. At first quality cannot be assured unless it can be measured. What it means is basically it has to well defined, planned for and measured. If you are measuring the quality what are the typical applications of this particular thing?

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These are going to help you a lot in making estimates very important, tracking project progress, establishing baselines, analyzing defects, achieving continuous improvement, evaluating tools you name it there is a whole list of applications for good measurements and take it to the contrary if you do not have good measurements then the absence of measurements can lead to exactly the opposite thing inability to assure quality.

For instance; you just give the product what it comes out to be but you have not planned it that way. Quality compromises with cost and schedule are persistent of problems even after delivery, something does not really seem to get piped down or last but not least the inability to accumulate for improvement for estimating and so on and so forth. So please remember that measurements are very important. Now what we mean by the particular measurement is that you need to convert a particular quality characteristic into individual attributes which are measurable.

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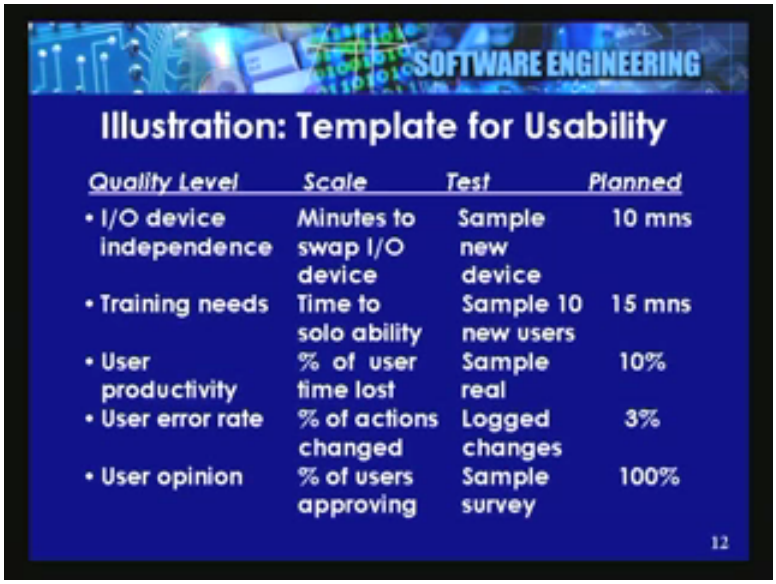

Here is an example, suppose we take the template for usability you need to agree with the customer in terms of what is adequate usability. Now take the first example. Suppose from customer's point of view the IO device independence is important then you find what is the scale?
So you say minimum time or number of time in minutes required to swap an IO device, suppose you need to change a printer, mouse, keyboard, scanner or any simple kind of devices you need to somehow change these particular devices.

Thus, how will you do the testing?
You say that you will sample a new device, whenever a new device comes our way we will sample it and in case we are able to change this particular device in ten minutes now this ten minutes is not [sac…..22:35] and what you agree with the customer is important. So suppose we say they we have agreed with the customer that it can be changed in ten minutes then we say now this particular quality attribute has been defined to a measurable level.

So you look at the slide and you say for IO device independence the scale is minutes to swap the IO device, the test is to sample any new device that you like and the plan time for doing this particular job is ten minutes. Take another particular attribute training needs. So we ask what is the scale, so you say how long it takes for a person to [s…23:11] ability. The solo ability means basically the person should able to use the software without frequent references to the user manual. So from our particular point of view if you were to look at it you say that it is like a cyclist being able to ride the cycle without a support being given by a third person or without having the side wheels or the fighter pilot going up to the sky without a trainer accompanying him. Therefore these are some of the references for time to solo. So we again say how you will find this out so the test will be on ten new users. And suppose the customer agrees that we should be in a

position to say within fifteen minutes the user should be in a position to go solo then we say yes, fine and that is our attribute.

Again, looking at the slide we want quality needs with the training needs, the time to solo is the ability and the sample ten new users will be tested and if fifteen minutes is the time within which those users should be in a position. Here of course we wanted to be more precise, we could easily say that all ten must be able to go solo in less than fifteen minutes or some more precision kind of a statement. Now let us look at one more particular thing the user productivity.

There are many ways in which you can look at user productivity. Suppose we look at percentage of time lost by the user as one particular matter, that is fine we will sample the real life situation, you can do it by tools or observation or whatever you have in mind but if the user spends more than ten percent as the lost time then we are in trouble. The user has the productivity in very loose sense 90% productivity in terms of using this particular product. You can go on and on and another one is the error rate.

Therefore, in user error rate the percentage of action change, how often does it change, simple thing is how often does the user go backwards in the menu or uses back space as a key or escape as a key or something like that can easily be. Now this can be logged very easily using a cookie or a small tool while the job is being particularly done. And we say if the customers makes more than 3% changes to whatever action he has taken where we will say that the product is not very useable in that sense. Last but not the least ultimately another important aspect is what is the user's perception of this particular software.

And again we can say percentage of users who approve and we can take some kind of example survey. Let us take a simple example, in case you have a system for facilitating a teller operation of a branch of a bank and you have hundreds and thousands of tellers you could easily undertake a sample survey and we would like to say yes 100% of course is too tall a claim but we would like a very sizeable percentage of this particular population to say that they are extremely happy with the product. So if you look at this particular thing what happens is what you are doing is basically you are converting each quality characteristics into attributes and each attribute is being put in a measurable form and then at the end of the day when the product is being done or when the product is being planned then at that particular time we can aim to achieve those particular goals.

Another very important aspect that we have in quality is benchmarking. What is benchmarking?
Benchmarking involves comparing a project's practices with those of the other projects within the same organization or with other companies. Why we do it? It is a simple intention. One is providing the basis for measurement that you like to compare this particular project with other particular project and generating ideas for improvement.
Benchmarking is what you seem to be doing all the time. Even if you are driving in a traffic jam kind of a situation you will try to benchmark yourself and say that how fast or slow are you compared to another car in the adjoining lane. And in case you find that a lane on your left or right is moving much faster then you might get a brilliant idea of

changing over to the lane you prefer, it is not a very good idea to change lanes in the middle of traffic jam. But in case you get the idea that you have to shift the lane may be the performance of that particular thing is better.

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By the same token you can have a project benchmarking itself with other projects or with other organizations. So if you benchmark it provides the basis for measurement and it also facilitates providing ideas for improvement. Now, achieving quality does not come free, you need to spend lot of money. So we basically say how can the cost of quality can be attributed, how can this particular thing be attributed. So you find that the cost of quality can be classified into, there are many ways in doing it, take one simple example.

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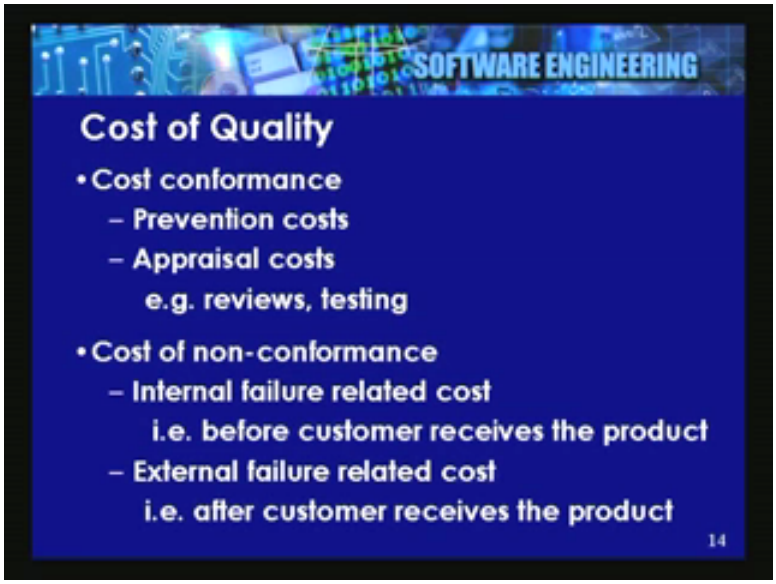

One will say cost of conformance, what is the cost of conformance? It is every money or every penny that we spend to prevent from something going wrong. It is like the prevention cost which may include everything from setting standards and selecting people and training them well, all these things will go in prevention cost. Similarly you might have appraisal cost. Appraisal cost is after making the product you plan that you will go and review it or test it. Remember the initiative is your own, you call it as conformance because it is the effort that we have planned to make sure that too many mistakes go past this particular stage. So anything like measurements, test equipment cost, harnessing cost, all the facilities, resources and everything that you need for achieving quality basically and what you promise up front and deploy is basically cost of conformance.

Why this particular thing is important is because of lot of other costs called cost of non-conformance. What is the cost of non-conformance?
Every time a product fails or gets bounced off when it is not supposed to, this can happen while the job is yet to be delivered to the customer or it can happen after the job is delivered to the customer. So in either of these particular cases if the product failure happens in an unplanned manner not because of our initiative but it happens then we say that this is a cost of non-conformance.

Now remember, the cost of non-conformance is very high. Specially if there is an external failure then imagine the cost of bringing a product down and bringing it back to a sight and rectifying it, sending back or sending a person from your team all the way to the site and fixing that particular product. These are very expensive activities, it is not very easy plus you have added things like loss of goodwill so external failure has to be really feared in that particular sense. You would like to aim to keep the external failures to a minimum.

Remember one most important particular dictum; the consequential cost of failure is very high. Now in this particular [……31:49] we just mentioned what is the difference between testing a product and running it in real life situation. Actually there is no difference between the two except that when you are doing testing of a product there is no consequential cost of failure because even if the product was to fail it is not going to cost any subsequent losses. The losses are restricted to the failure itself. So the consequential cost from our particular point of view is to be feared.

There are other ways in which you can classify the cost: One is stat-up cost. The stat-up costs are like setting up the policy, the standards and matrix identification and tools are all spent up front before the project starts. Of course many of them are common to all the projects that we may undertake. Then we have project related costs.

Project related costs are making a quality plan, providing all the quality assurance support, then supervision for the cost, supervision is also very costly, then quality control activity is also costly so these are basically activities which we are performing during a particular project. And then there is the continuous cost where you have to have overheads the management, staff training, marinating the standards, standards is not a one time activity, then during research metrics management keeping the data acquiring, keeping and using that particular data. So these are all the particular aspects that fall under cost of quality. So it is possible for us to look at the cost of quality in more than one side. So we can now end up say that in case we had a quality planning process the typical quality planning process will end up with four outputs.

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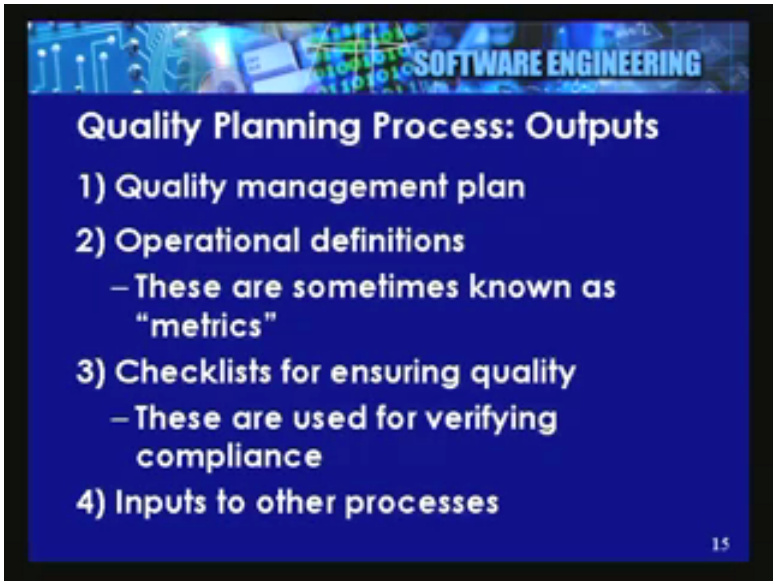

As shown here in the slide the first particular output is quality management plan. The quality management plan basically describes as to how the project will implement the quality policy. It addresses aspects like assurance, control, quality improvement and so on and so forth. So if you are doing something like ISO 9000 if the project quality system

is consistent with the expectations like the organizational structure, the responsibilities, the process and then resources extra.

The second particular thing is it gives you operational definitions of the quality. Basically those are called as the metrices as to what in terms of measurable form are you expected to achieve. So the quality planning will give you operational definitions of all the parameters which need to be measured and assured. The third particular thing is it will give you checklist for ensuring quality throughout the life of the project.

Checklists are very useful for verifying if the instructions have been complied with. There are slight deviations let us say there are three places where an organization accumulates its [35:27]; one is the processes, the other is metrices and the third particular thing that we talk about is the checklist. So checklist is very important. If you are going to do a review you must say which kind of a checklist you will use for doing the review. Last but not the least the quality process can give inputs to other processes.

In case you find that there is some problem associated with the achieving quality which requires modification or which has interference with other knowledge areas then those particular items are also identified during the quality planning process. The second quality management process is quality assurance process. We need to start by understanding what quality is. Remember, assurance is something that you give before hand and not after post-facto, it is a-prior requirement that you have.

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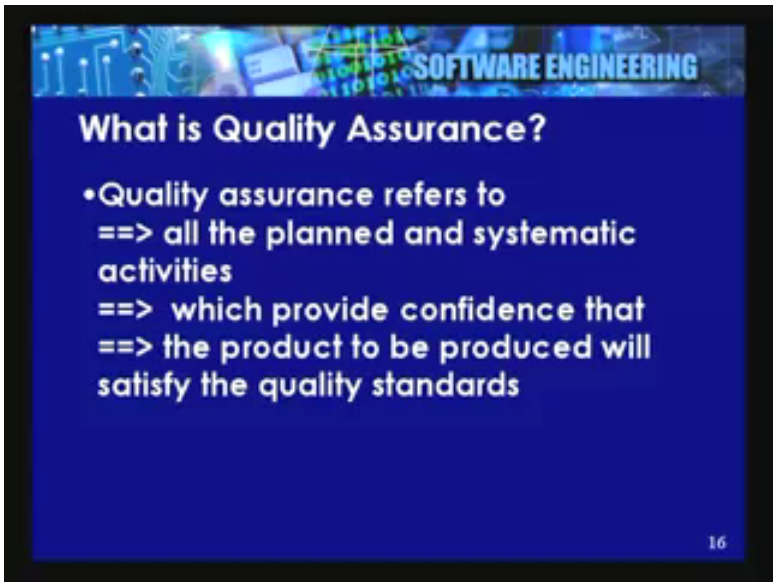

Thus, quality assurance where if you look at the definition point of view then quality assurance refers to all the planned and systematic activities which provide confidence that the product to be produced will satisfy the quality standards when ready. From our particular point of view remember that “will satisfy when ready” is very important. So

the main goals of quality assurance activity are; to undertake all those activities that are essential for ensuring that the product needs the quality standards.

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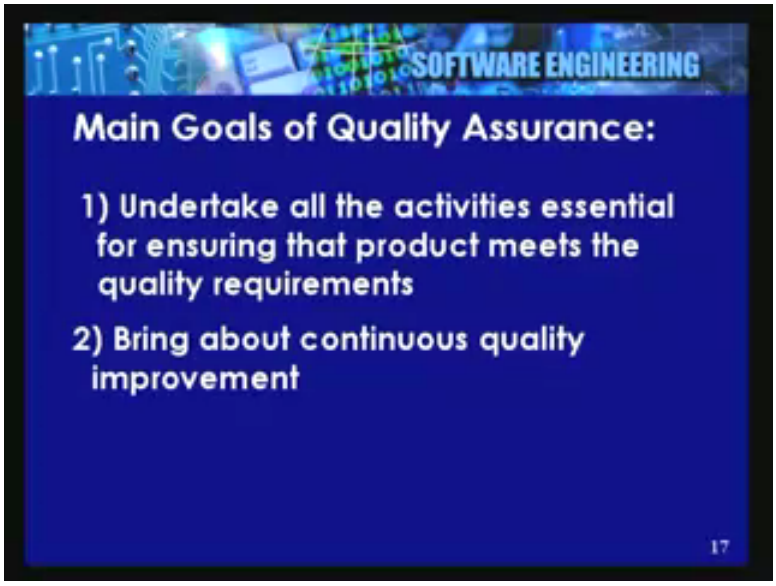

The assurance in respect of quality must come from defining appropriate standards, procedures, guidelines, tools, techniques, etc and secondly by providing appropriate resources with right skills, right supervision and right guidance etc. The first particular goal is to undertake all activities essential for ensuring that the product will meet the quality standard.

The second particular part is to bring about continuous quality improvement. It is like you say err, err and err but less, less and less. Making a mistake once is fine but in case you have to repeat the mistake again and again then you will operate like a memory-less process. So it is very important that the quality assurance must keep at the back of our mind is that first prevent any mistakes from occurring. If any mistake was to occur then do two things; correct the product and then correct the process so that the same mistake hopefully will not occur again. So, bringing about continuous quality improvement is also an essential part of quality assurance activity.

Another particular thing is somehow it looks like people have perception like planning and estimating is a one time activity that is farthest from the truth.

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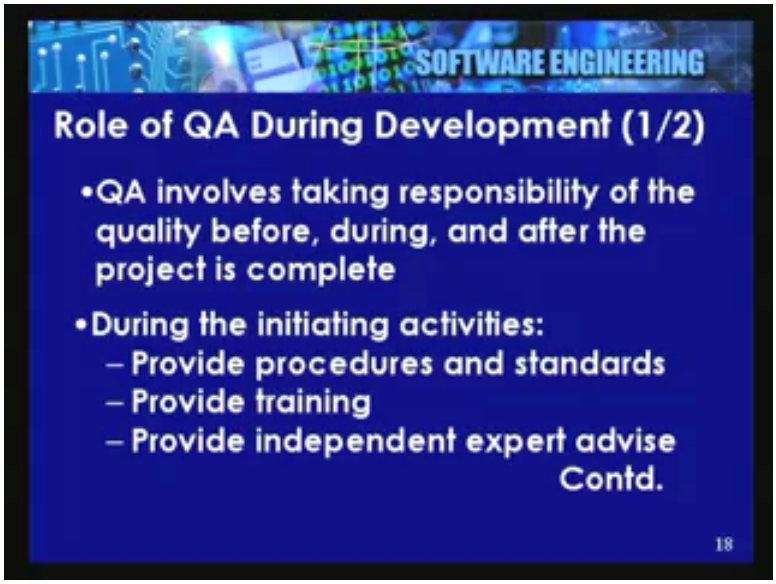

The quality assurance involves taking the responsibility for the quality before the project starts, during the project and to some extent after the project is complete. Now let us see what kind of activities we really need to ensure that before, during and after a particular project. So if you look at the slide again during the initiating activity what you need to do is to provide procedures and standards for the project. There may be lots of them and the project manager may be required to select the appropriate procedures and standards for his particular project. Then providing training is another very important activity. Then we have providing independent expert advice.

Please remember that quality assurance, quality control are the responsibilities of the making group. But providing guidance, making standards and all these particular things are ensuring that the right kind of instructors available etc may be done as a corporate activity. But individually the project is responsible for its own QA activity. So providing independent expert advice at the initial stages is another particular requirement that you have.

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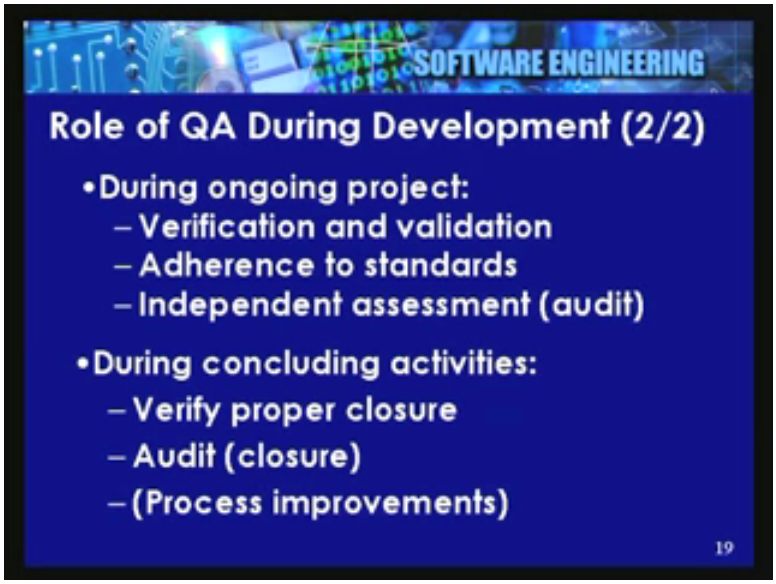

Then what we do during the project?
During the project what you need to do is to ensure that the verification and validation takes place as planned. It involves planning and then implementing the plan. You must understand what is the difference between verification and validation? For that let us look at the picture here.

In case you had a job which required a series of steps to be taken then this would be your verification activity. At the end of each particular step you make sure that you got the job right. And validation would involve making sure that this particular job is really achieving its intended purpose. So this would be your verification this would be your validation activity.

Many times you find that both these verification and validation activities at different points of time planned to a different level of severity. Then there is ensuring throughout that adherence to standard. Of course we have chosen the standard before hand but choosing the standard does not imply that they will automatically adhere to. there are small exceptions like suppose you are interested in making sure that the C coding is done according to coding standards you may not worry too much about the coders following the standard but you could easily write a program and this particular program could reformat the code according to C coding standard of the organization. But that is a different issue altogether. Then we have independent assessment or some kind of audit. This particular activity is not a part of the project. The audits can be of different types, it can be internal audits or external audits but in this context we normally mean internal audit. So, periodically an independent assessment that the project does have a plan and it is following that particular plan is very important.

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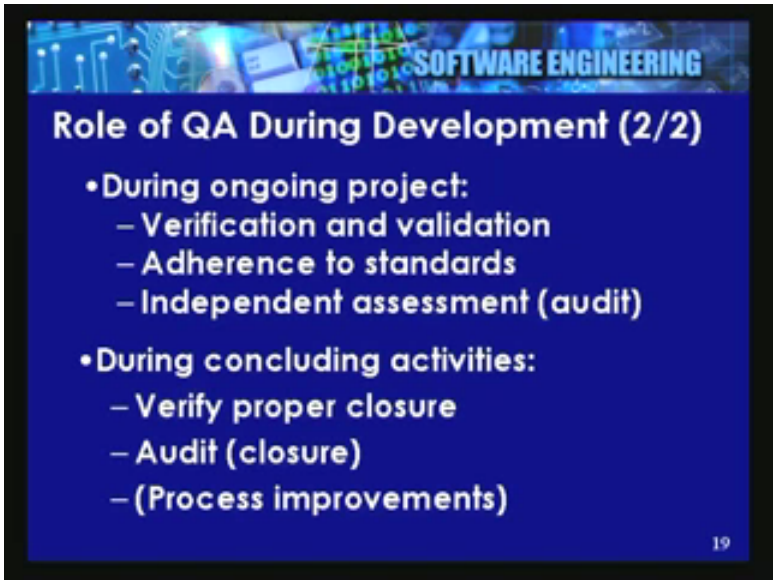

Then we come to the conclusion of the project. We need to make sure that we have formal testing happening according to the plan. Then you may have closer audits like once you have completed that particular project making sure that all the closing processes have been performed to the last level of details.

Now if you again look at the slide we have the process improvement. Remember, wherever you made a mistake correcting the product is essential but correcting the product is not sufficient. What we need to really do is to make sure that the processes are also improved as appropriate so that the subsequent users of the processes will not commit the same particular mistake. Now, to give you a brief idea about the VVT activity performed during the life cycle of a particular project, so in the requirement definition phase what you do.

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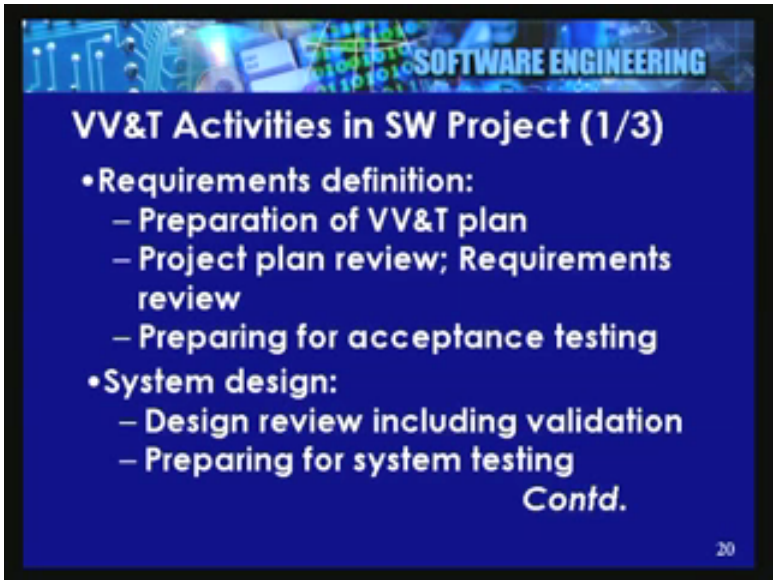

Here we have preparation of a VVT plan, project plan review, requirements review and preparing for acceptance testing data. These are some of the things which you can perform during the requirement definition phase; please understand that we are talking of a phase. Then during the system design what we do?
We have design reviews. As soon as you go to the next step you not only do verification but you also need to do validation. So you need to do design review including design validation preparing for system testing. Of course another small activity like traceability is making sure that there is a one to one correspondence between the requirement and the design.

It is like not a penny less and a penny more, the design should not give you any feature that the customer did not ask for at the same time not forget any feature that was specified in the requirement. So traceability becomes a very important issue.

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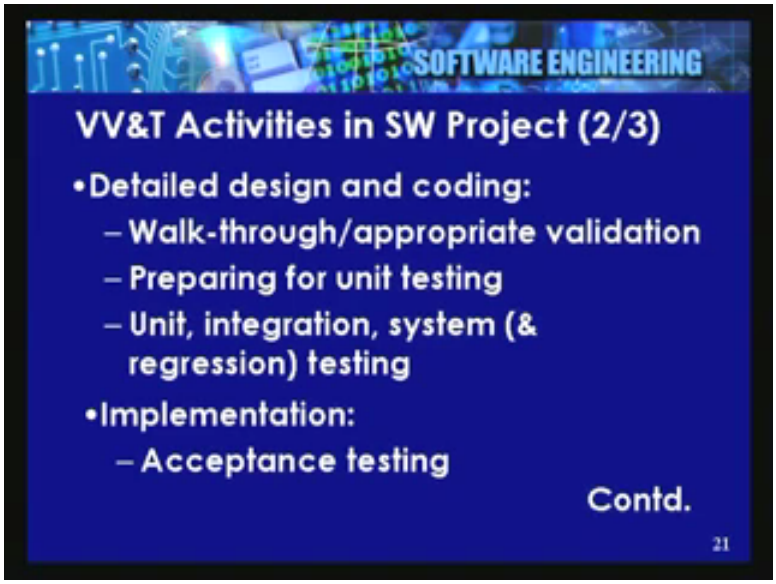

Now we have the development phase. During the development phase what we do? Construction activity as you can say you walk through the codes. Again you have verification and validation then preparing for unit testing then doing the unit testing, integration testing, system testing and obviously the regression testing as appropriate.

Remember, regression testing is the only part of testing which cannot be planned for up front; it has to be sort of taking it as it comes whereas all the other particular types of testing like unit, integration, system testing and the rest all can be planned for. Once you got that the next particular thing is doing implementation.

Here implementation means putting the software into use. So, the major responsibility at this particular stage is the conducting of the acceptance testing. Acceptance testing is a notion you always have. But it need not necessarily be done by the customer, it is to be done on behalf of the customer. Remember, in acceptance testing what is important is that the customer should get the confidence that the product that is being delivered to the customer is conforming to what its original requirements are. It is very important that the system testing should not be mixed up with acceptance testing.

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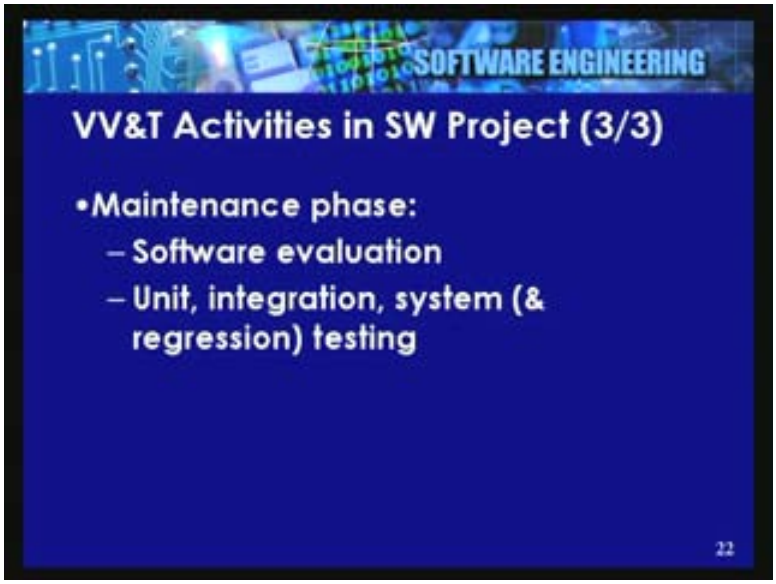

Then you look at the next particular part which is the maintenance phase. Sometimes the development and maintenance activities are not considered as the same part of the project but since maintenance is an inevitable kind of an activity.

So from our point of view we will say that in the maintenance phase the VVT activity includes some kind of evaluation of the product and whenever you make changes we have said that changes are inevitable for three reasons; the requirement change or the platforms may change or the bugs which have not yet been sort of detected may come up.

In all the three cases you make changes and once you make changes then you are again required to repeat the whole thing the unit, integration and system testing and the corresponding regression testing need to be performed throughout. So, from our point of view these are the VVT activities that are performed during the life of a particular project.

Another very important thing from quality assurance point of view is the opportunity for improvement. Each non-conformance is an opportunity for improving. It is the need to fix the problem and the need to fix the cause of the problem. So this particular activity will have to be done all the time. Then we ask the question that who identifies the OFI's. The answer is anybody and everybody, anybody who detects a fault.

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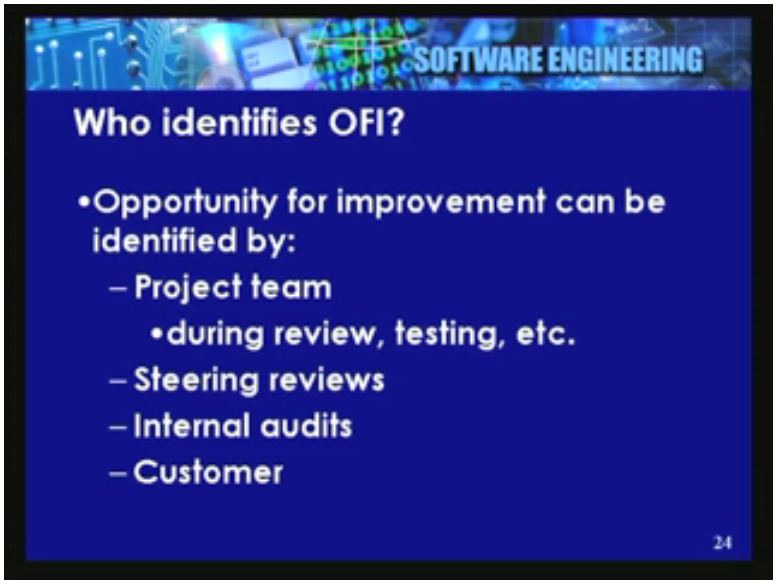

So the project team may detect a fault during development, during the review, during testing or you may have steering reviews or you may have internal audits you may have a customer but do not worry how the fault came to your notice. What is important is every time you have fault that was detected, recorded, rectified also investigate if there is an opportunity for improving the process.

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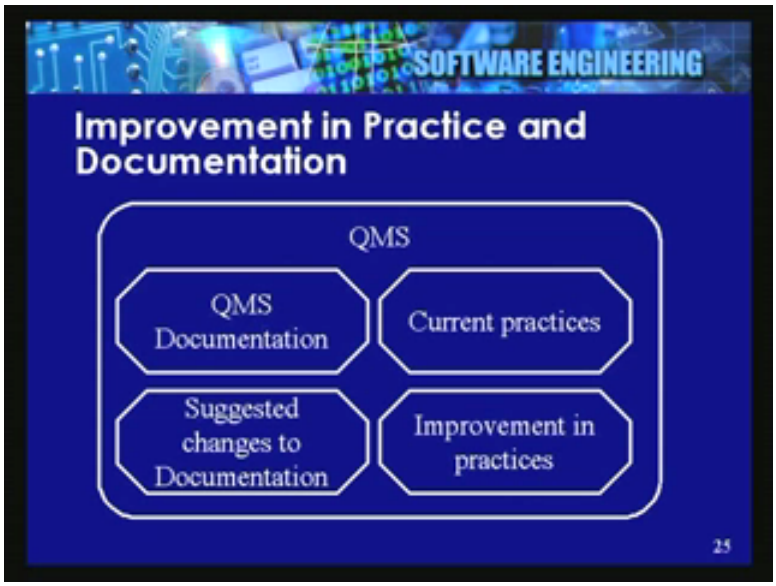

So if you were to look at this particular aspect schematically and you look at the slide we can have a QMS Documentation and corresponding to the QMS Documentation you will have the current practices.

Now this is like the chicken and egg problem. You say that do you have the current practices first and then make the QMS Documentation or you make the QMS Documentation and put it into practice. Do not worry about the starting point. Once you have got these particular practices in particular motion then you will find things have wrong which provide an opportunity for improvement.

Once you find that opportunity for improvement then those particular changes need to be made to the documentation and then the new documentation forms the basis for the practices. So, the opportunity for improvement is a very important kind of an activity. This brings us to the end of the second process called the quality assurance process in a project. The third particular quality management process that we are concerned with is the quality control process.

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If you look at it what is the quality control process?
So the main goal of quality control process is to improve the quality by conforming adherence to requirements. Quality assurance includes preventive actions and planning for quality control. Quality control in that particular sense may be viewed as a subset of quality assurance. But in quality assurance you do a lot of things which happen before the product is produced whereas in quality control we perform all the things after the product is produced.

What we are basically trying to find out is that the product that we have produced is conforming to the original requirements. So the main goal of quality control is to improve the quality by conforming adherence to the requirement. QC involves monitoring specific project results including the products and to ensure that they do comply with the project standards. Whatever standards you might have set in the beginning we need to make sure that those things are available.

In case there is a deviation the attempt should be made to identify the causes for the deviation for instance unsatisfactory performance and try to eliminate the causes and if required you might even need to make changes to the quality plan that we have made.

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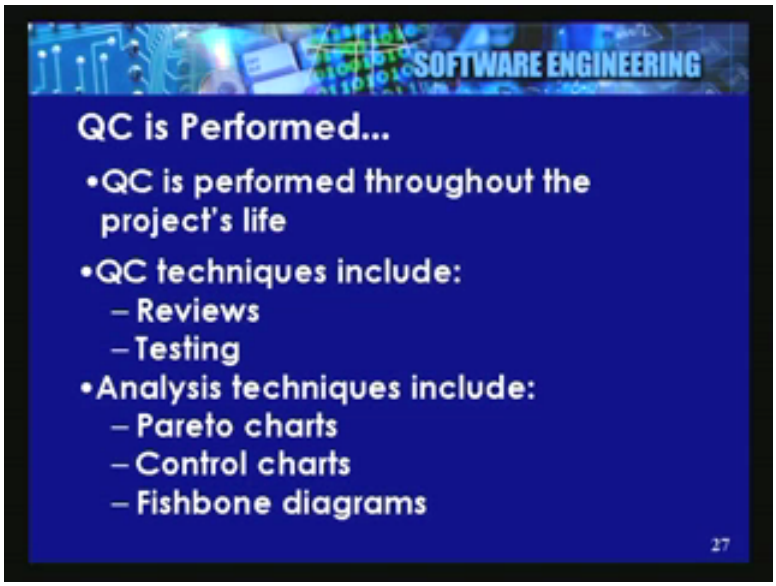

So generally speaking if you look at it quality control from that point of view is performed throughout the life of the project. It is not a one time activity, you need to remember the earlier quote; instead of falling from the top of the first floor to the bottom you would rather roll down the staircase. So instead of doing this activity make, make, make, make, make and then check I would like to split now into make, check, make, check, make, check. So, by that particular virtue that QC will have to be performed throughout the life. Therefore typically the two techniques that we use for QC are reviews and testing.

Here reviews are a technique which can be applied to non code products. For instance; a project plan, estimates you can look at a service document, user manual, test plans etc. All these particular documents are not in the code form then they are never going to be compiled and never going to be in that sense tested. And in the early days that is what the problem was. You really never formally conformed that these particular products were okay. So there are wide ranges of review techniques that are available. They range from very rigorous kind of techniques like sudden inspection to relatively not so rigorous techniques like a walk through.

Obviously the amount of time, money and effort that you are going to spend in review is going to be directly proportional to the likely consequence of an error. So upfront when you are doing upstream software engineering like SRS and design the reviews are more rigorous because each of the requirement errors for instance can have a very significant damage to the project as the time passes. We have already seen two principles. One is the

time between making the fault and detecting the fault increases then the cost of correcting the fault also increases.

Very frankly review is also a testing technique in that sense but when we normally talk of testing we are taking of testing the code and the techniques like unit testing, integration testing, system testing and acceptance testing and in case of products alpha testing, beta testing and various testing techniques white box, black box etc can be used. Now it is not enough to do a QC on a [product….53:31] look at one individual fault and let go ahead it. The QC data can be analyzed in more detail and there are various analysis techniques which are available where the QC data can be put to valuable use. There are three techniques that we often use; the Pareto charts, control charts, fishbone diagram etc.

Please remember these are not the exclusive list of all possible analysis techniques we have. But the QC data needs to be analyzed in a very great deal of details.

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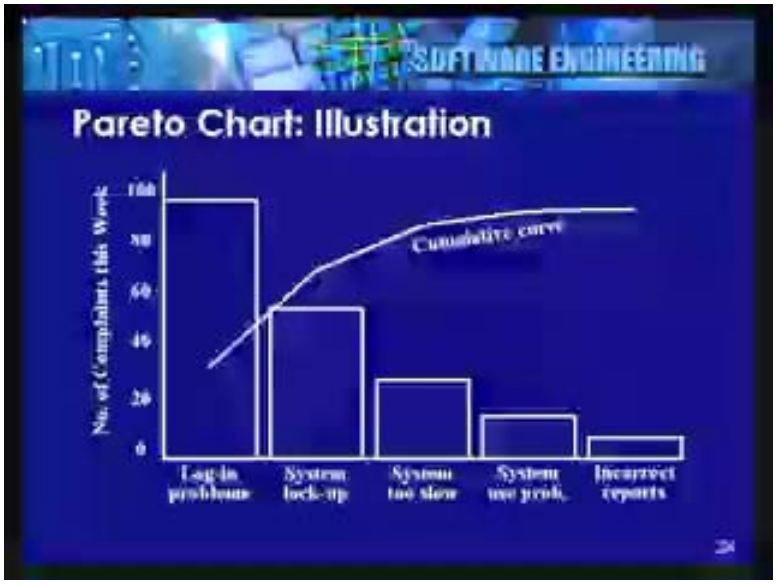

So look at the first particular thing. The chart shows a Pareto chart. What is a Pareto chart?
Basically it takes all the defects that we have observed and it tries to classify them and arrange these categories in increasing or decreasing order usually in decreasing order and it will tell you that the top few categories are something that need your attention immediately. In our particular example the login problem seems to be the most serious problem followed by the system lock up or whatever the implication of this particular job is. Another way of doing it is to look at the control charts.

In the control charts using the statistical techniques we have the control limits namely the upper control limit and the lower control limit associated with the mean and you keep on tracking the various parameters overtime. Take a simple example; suppose we are looking at the number of faults reported per program as the programs keep on coming in

to the configuration manager and we go on plotting for each subsequent particular program the number of defects that we have detected and corrected will give you a chart of this particular type.

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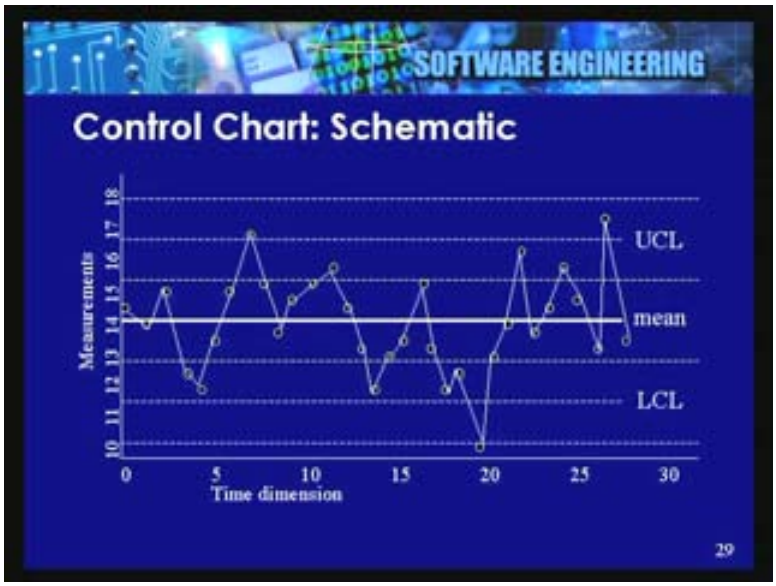

In case you find that your particular point goes outside so if you were to look at the slide again if one of the points was to go outside the control limits then you will need to pay attention to find out what really was the reason why the point went outside. There are also other indicators for instance you say that in case you had seven points inside the control limits but on the same side of the mean then it is a danger because probability is that this situation is very rare and then you will have other particular problems.

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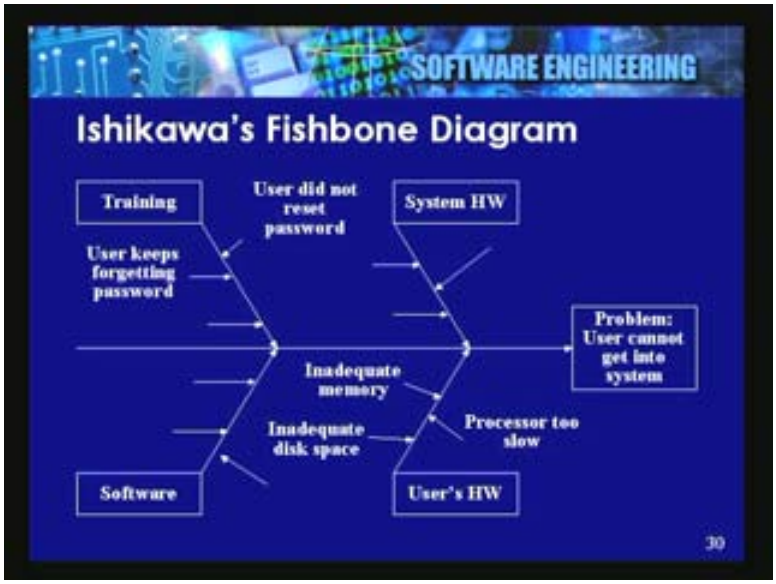

Another very useful technique is that once you got this particular thing you use fishbone diagrams. In fishbone diagrams suppose you have a particular problem and the problem is that the user cannot get into the system and now we try to find out that this particular problem can be attributed to what.

Basically here we have four categories like; training, systems hardware, the user's hardware and the software. Then we can look at it an each particular item that we get as the reported problem can be put into one of the categories. The user did not reset the password is a very good example where good training might solve that particular problem. Or user keeps forgetting the password again we have another particular issue may be for training. Or the user's hardware may have inadequate memory or disk space or the processor may be too slow and because of that persistently the user may keep on encountering such a particular problem. Therefore you can go on and on and on. But basically the technique helps you in identifying the major categories of a particular problem.

So we can summarize now and say that the quality management processes are aimed at ensuring that the quality is delivered to the customer. Among the three sub processes that we studied the quality planning process is the most important and then of course the implementation that is the quality assurance process and the quality control process.