Project Quality Management

Lecture Topics

- Definitions of quality
- Quality management processes in PMBOK
- Quality management framework
- Differences between quality control and assurance
- Quality management in RUP and in agile approaches

Description of techniques mentioned in these notes is out of the scope of this lecture. Information regarding these techniques can be found in the literature or by searching on Internet.

Definitions of Quality

- The degree to which a set of inherent characteristics fulfill requirements (PMBOK, originally ISO 9000)
- An inherent or distinguishing characteristic; a property or a personal trait, especially a character trait or essential character; nature or superiority of kind or degree or grade of excellence (The American Heritage Dictionary of the English Language)
- "...the characteristic of having demonstrated the achievement of producing a product that meets or exceeds agreed-on requirements—as measured by agreed-on measures and criteria—and that is produced by an agreed-on process" (RUP, in the context of software development)

It must be separate quality and grade (rank) where grade means a category assigned to products or services having the same functional use but different technical characteristics

Quality has two working definitions:

- Producer's Viewpoint – The quality of the product meets the requirements.
- Customer's Viewpoint – The quality of the product is "fit for use" or meets the customer's needs.

Achieving quality is not simply "meeting requirements", or producing a product that meets user needs and expectations. Quality also includes:

- identifying the measures and criteria to demonstrate the achievement of quality
- the implementation of a process to ensure that the product created by the process has achieved the desired degree of quality, and can be repeated and managed

The responsibility of project manager is to ensure that:

- project work end result(s) meet(s) stakeholder expectations (needs)
- project work (resource usage) meets stakeholders expectations (needs)

In the context of information system development to achieve these responsibilities comes into the play information system and information system development process quality management. In this lecture project quality management framework and processes are described.

Quality Management Processes in PMBOK

Project Quality Management by PMBOK includes the processes and activities of the performing organization that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken. It implements the quality management system through policy and procedures with continuous process improvement activities conducted throughout, as appropriate.

Project Quality Management addresses the management of the project and the product of the project.

It applies to all projects, regardless of the nature of their product. Product quality measures and techniques are specific to the type of product produced by the project. Failure to meet product or project quality requirements can have serious negative consequences for any or all of the project stakeholders. For example:

- Meeting customer requirements by overworking the project team may result in increased employee attrition, errors, or rework.
- Meeting project schedule objectives by rushing planned quality inspections may result in undetected errors.

Project quality management processes in PMBOK are as follows:

- Plan quality
- Perform quality assurance
- Perform quality control

Overview of these processes and mutual relationships through inputs and outputs is given on the next figure:

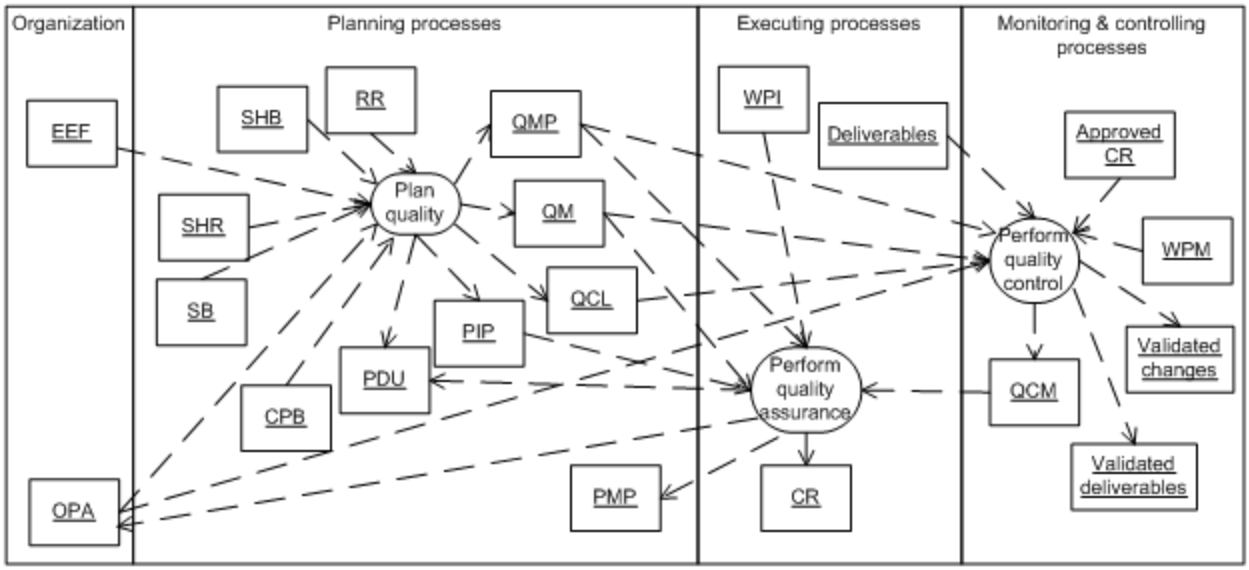

Figure 1. Project Quality Management Processes in PMBOK

Plan Quality

Plan Quality is the process of identifying quality requirements and/or standards for the project and product, and documenting how the project will demonstrate compliance. Quality planning should be performed in parallel with the other project planning processes. For example, proposed changes in the product to meet identified quality standards may require cost or schedule adjustments and a detailed risk analysis of the impact to plans.

The quality planning techniques are those most frequently used on projects.

Plan Quality process inputs and outputs are presented on the next figure:

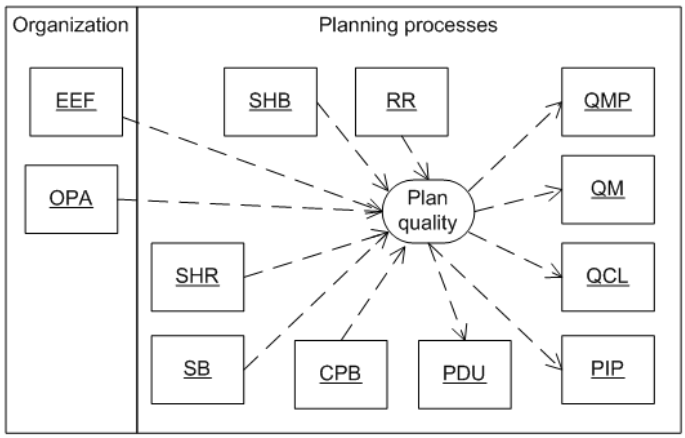

Figure 2. Plan Quality Process Inputs and Outputs

Plan Quality Inputs

- Scope baseline (SB)
- Stakeholder register (SHR)
- Cost performance baseline (CPB)
- Schedule baseline (SHB)
- Risk register (RR)
- Enterprise environmental factors (EEF – rules, standards etc)
- Organizational process assets (OPA – quality policies in organization)

Plan Quality Tools and Techniques

- Cost-benefit analysis
- Cost of quality
- Control charts
- Benchmarking
- Statistical sampling
- Quality management methodologies

Plan Quality Outputs:

- Quality Management Plan (QMP) - describes how the project management team will implement the performing organization's quality policy
- Quality metrics (QM) - an operational definition that describes, in very specific terms, a project or product attribute and how the quality control process will measure it. Quality metrics examples: on-time performance, budget control, defect frequency, failure rate, availability, reliability, test coverage
- Quality checklists (QCL) - a structured tool, usually component-specific, used to verify that a set of required steps has been performed
- Process improvement plan (PIP) - details the steps for analyzing processes to identify activities which enhance their value. Areas to consider include:
    - **Process boundaries -** describes the purpose of processes, their start and end, their inputs/ outputs, the data required, the owner, and the stakeholders
    - **Process configuration -** a graphic depiction of processes, with interfaces identified, used to facilitate analysis.
    - **Process metrics -** along with control limits, allows analysis of process efficiency
    - **Targets for improved performance -** guides the process improvement activities

Perform Quality Assurance

Perform Quality Assurance is the process of auditing the quality requirements and the results from quality control measurements to ensure appropriate quality standards and operational definitions are used. Perform Quality Assurance also provides an umbrella for continuous process improvement, which is an iterative means for improving the quality of all processes. Continuous process improvement reduces waste and eliminates activities that do not add value. This allows processes to operate at increased levels of efficiency and effectiveness.

Perform Quality Assurance inputs and outputs pictorially are presented on the next figure:

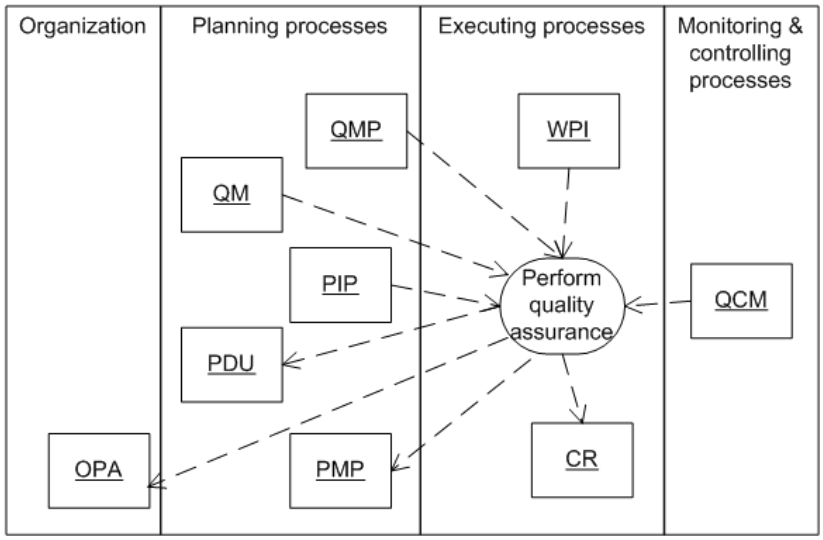

Figure 3. Perform Quality Assurance Process Inputs and Outputs

Perform Quality Assurance Inputs

- Project management plan (PMP), specifically quality management plan (QMP) and process improvement plan (PIP)
- Quality metrics (QM)
- Work performance information (WPI):
    - Technical performance measures,
    - Project deliverables status,
    - Schedule progress
    - Costs incurred.
- Quality control measurements (QCM). The results of quality control activities. They are used to analyze and evaluate the quality standards and processes of the performing organization.

Perform Quality Assurance Tools and Techniques

- Plan quality and perform quality control tools and techniques
- Quality audits
- Process analysis

Perform Quality Assurance Outputs

- Organizational Process Assets (OPA) updates
- Change requests (CR): they can be used to take corrective action or preventive action or to perform defect repair
- PMP updates
- Project document updates

Perform Quality Control

Perform Quality Control is the process of monitoring and recording results of executing the quality activities to assess performance and recommend necessary changes. Quality control is performed throughout the project. Quality standards include project processes and product goals. Project results include deliverables and project management results, such as cost and schedule performance. Quality control activities identify causes of poor process or product quality and recommend and/or take action to eliminate them.

Perform Quality Control inputs and outputs pictorially are presented on the next figure:

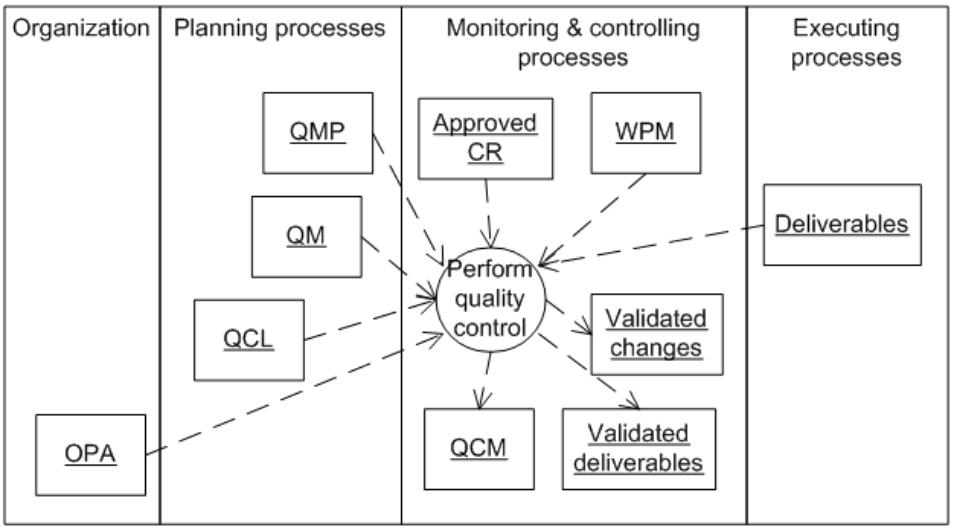

Figure 4. Perform Quality Control Process Inputs and Outputs

Perform Quality Control Inputs

- Project management plan (PMP), specifically quality management plan (QMP)

- Quality metrics (QM)
- Quality checklists (QCL)
- Work performance measurements (WPM): they are used to produce project activity metrics to evaluate actual progress as compared to planned progress. These metrics include, but are not limited to:
    - Planned vs. actual technical performance,
    - Planned vs. actual schedule performance, and
    - Planned vs. actual cost performance.
- Approved change requests: they can include modifications such as defect repairs, revised work methods and revised schedule. The timely implementation of approved changes needs to be verified
- Deliverables
- Organizational process assets (OPA)

Perform Quality Control Tools and Techniques

- Cause and effect diagrams
- Control charts
- Histogram
- Pareto chart
- Run chart
- Scatter diagram
- Statistical sampling
- Inspection
- Approved change requests review

Quality Control Outputs

- Quality Control Measurements (QCM) - the documented results of quality control activities in the format specified during quality planning
- Validated Changes - any changed or repaired items are inspected and will be either accepted or rejected before notification of the decision is provided. Rejected items may require rework
- Validated Deliverables - a goal of quality control is to determine the correctness of deliverables. The results of the execution quality control processes are validated deliverables. Validated deliverables are an input to Verify Scope for formalized acceptance

Project Quality Management Framework

As bases of this section I use quality management framework proposed by Herman Steyn in his article „A Framework for Managing Quality on System Development Projects“.

Management is to a large extent planning and control. Project Quality Management thus comprises of three elements: Quality Planning (QP), Quality Assurance (executing the plan) (QA) and Quality Control (QC) as illustrated in Figure 5.

According to the Shewhart cycle or Plan-Do-Check-Act cycle QA is defined as the “Do” element and QC as the “Check-Act” elements. QC is the process of ensuring that Quality Assurance corresponds with the plan and in Figure 5 QC overarches Planning for Project Quality and QA to illustrate this relationship.

If QA is the “healthy lifestyle” to prevent nonconformities, QC is seen as checks to verify that the healthy lifestyle is pursued as well as the “medicine” to eliminate (or preferably to prevent) defects and other nonconformities when the healthy lifestyle proves insufficient.

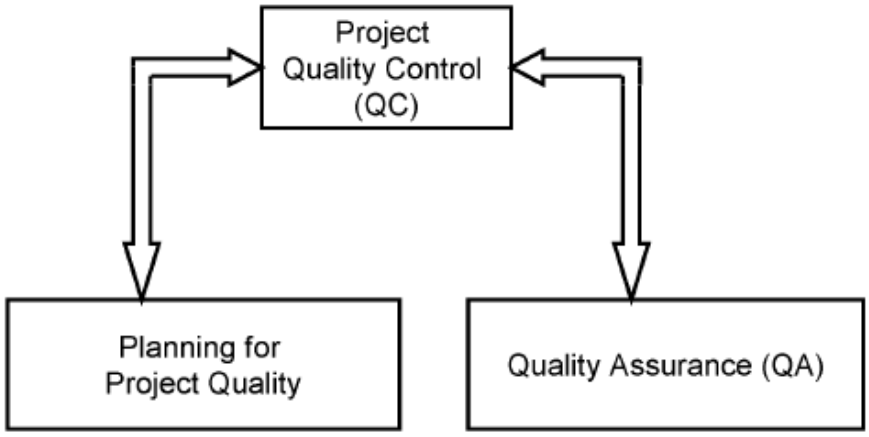

Figure 5. Quality Management Processes

The summarized project quality management framework is presented on the next figure:

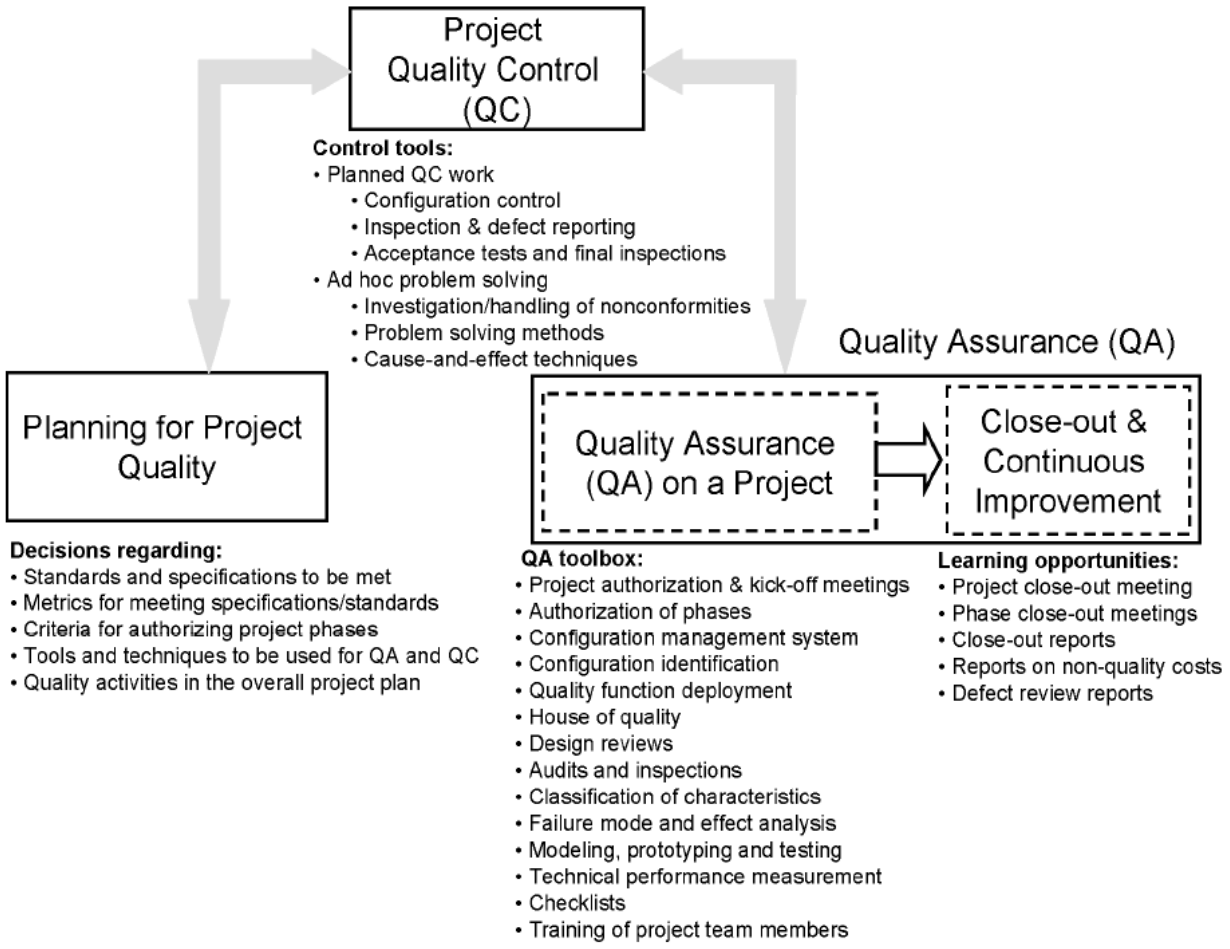

Figure 6. Quality Management Framework

In the context of information system development we can find project quality management processes as illustrated on the next figure:

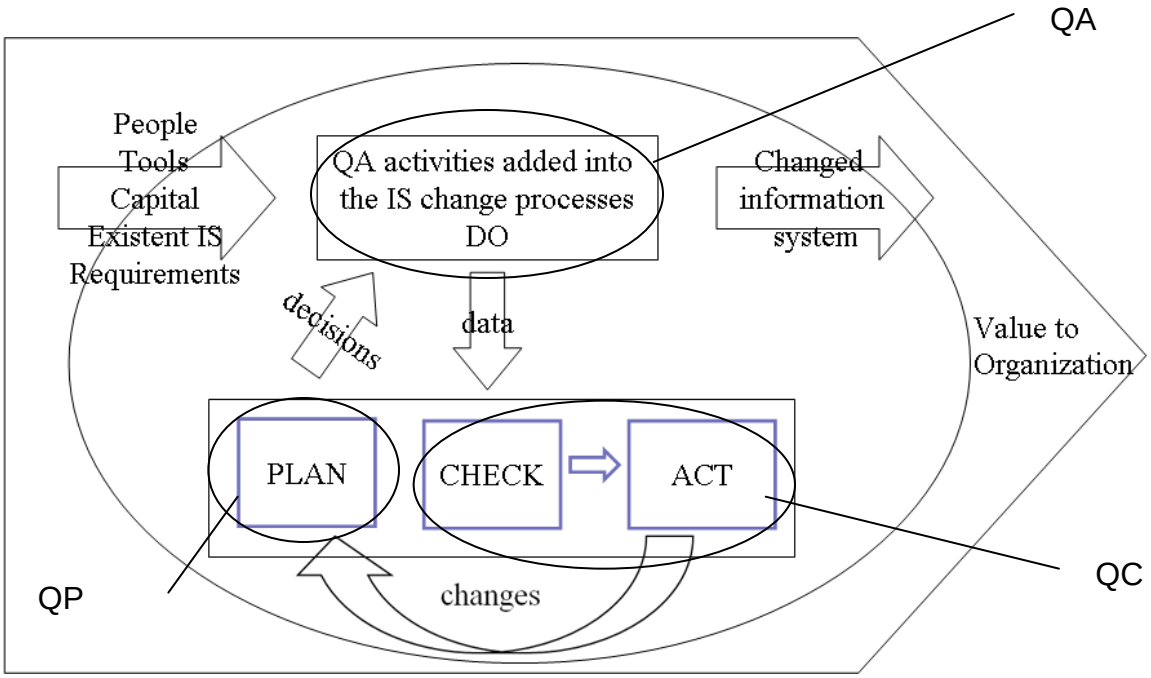

Figure 7. Quality Management Processes in the Context of IS Development

Differences between Quality Control and Assurance

Quality Control

- relates to a specific product or service.
- verifies whether specific attribute(s) are in, or are not in, a specific product or service.
- identifies defects for the primary purpose of correcting defects.
- is the responsibility of the team/worker.
- is concerned with a specific product.

Quality Assurance

- helps establish processes
- sets up measurement programs to evaluate processes.
- identifies weaknesses in processes and improves them.
- is a management responsibility, frequently performed by a staff function.
- is concerned with all of the products that will ever be produced by a process.
- is sometimes called quality control over quality control because it evaluates whether quality control is working.
- personnel should not ever perform quality control unless it is to validate quality control.

Quality Management in RUP

Managing quality is done for these purposes:

- To identify appropriate indicators (metrics) of acceptable quality (= quality planning)
- To identify appropriate measures to be used in evaluating and assessing quality (= quality planning)
- To identify and appropriately address issues affecting quality as early and effectively as possible (= quality assurance)

Managing quality is implemented throughout all disciplines, workflows, phases, and iterations in the RUP. In general, managing quality throughout the lifecycle means you implement, measure, and assess both process quality and product quality. Some of the efforts expended to manage quality in each discipline are highlighted in the following list:

Managing quality in the Requirements discipline includes analyzing the requirements artifact set for consistency (between artifact standards and other artifacts), clarity (clearly communicates information to all shareholders, stakeholders, and other roles), and precision (the appropriate level of detail and accuracy).

In the Analysis & Design discipline, managing quality includes assessing the design artifact set, including the consistency of the design model, its translation from the requirements artifacts, and its translation into the implementation artifacts.

In the Implementation discipline, managing quality includes assessing the implementation artifacts and evaluating the source code or executable artifacts against the appropriate requirements, design, and test artifacts.

The Test discipline is highly focused toward managing quality, as most of the efforts expended in this discipline address the three purposes of managing quality, identified previously.

Managing quality in the Deployment discipline includes assessing the implementation and deployment artifacts, and evaluating the executable and deployment artifacts against the appropriate requirements, design, and test artifacts needed to deliver the product to your customer.

The Project Management discipline includes an overview of many efforts for managing quality, including the reviews and audits required to assess the implementation, adherence, and progress of the development process.

Measuring Quality

We measure primarily to gain control of a project, and therefore to be able to manage it. We measure to:

- evaluate how close or far we are from the objectives we had set in our plan in terms of completion, quality, compliance to requirements, etc.
- be able to better estimate for new projects effort, cost and quality, based on past experience.
- evaluate how we improve on some key aspects of performance of the process over time, to see what are the effects of changes.

The measurement of Quality, whether Product or Process, requires the collection and analysis of information, usually stated in terms of measurements and metrics.

Measuring some key aspects of a project adds a non-negligible cost. So we do not measure just anything because we can. We must set very precise goals for this effort, and only collect metrics that will allow us to satisfy these goals.

There are two kinds of goals:

- Knowledge goals
- Change or achievement goals

Knowledge goals are expressed by the use of verbs like evaluate, predict, monitor. You want to better understand your development process. For example, you may want to assess product quality, obtain data to predict testing effort, monitor test coverage, or track requirements changes.

Change or achievement goals are expressed by the use of verbs such as increase, reduce, improve, or achieve. You are usually interested in seeing how things change or improve over time, from an iteration to another, from a project to another.

Examples:

- Monitor progress relative to plan
- Improve customer satisfaction
- Improve productivity
- Improve predictability
- Increase reuse

These general management goals do not translate readily into metrics. We have to translate them into some smaller sub goals (or action goals) which identify the actions project members have to take to achieve the goal. And we have to make sure that the people involved understand the benefits.

Examples: the goal to "improve customer satisfaction" would decompose into:

- Define customer satisfaction
- Measure customer satisfaction, over several releases
- Verify that satisfaction improves

The goal to "improve productivity" would decompose into:

- Measure effort
- Measure progress
- Calculate productivity over several iterations or projects.
- Compare the results

Then some of the subgoals (but not all) would require some metrics to be collected.

Example: "Measure customer satisfaction" can be derived from:

- Customer survey (where customer would give marks for different aspects)
- Number and severity of calls to a customer support hotline.

All metrics require criteria to identify and to determine the degree or level at which of acceptable quality is attained. The level of acceptable quality is negotiable and variable, and needs to be determined and agreed upon early in the development lifecycle For example, in the early iterations, a high number of application defects are acceptable, but not architectural ones. In late iterations, only aesthetic defects are acceptable in the application.

The acceptance criteria may be stated in many ways and may include more than one measure. Common acceptance criteria may include the following measures:

- Defect counts and / or trends, such as the number of defects identified, fixed, or that remain open (not fixed).
- Test coverage, such as the percentage of code, or use cases planned or implemented and executed (by a test). Test coverage is usually used in conjunction with the defect criteria identified above).
- Performance, such as a the time required for a specified action (use case, operation, or other event) to occur. This is criteria is commonly used for Performance testing, Failover and recovery testing, or other tests in which time criticality is essential.
- Compliance. This criteria indicates the degree to which an artifact or process activity / step must meet an agreed upon standard or guideline.

- Acceptability or satisfaction. This criteria is usually used with subjective measures, such as usability or aesthetics.

Measuring Product Quality

Stating the requirements in a clear, concise, and testable fashion is only part of achieving product quality. It is also necessary to identify the measures and criteria that will be used to identify the desired level of quality and determine if it has been achieved. Measures describe the method used to capture the data used to assess quality, while criteria defines the level or point at which the product has achieved acceptable (or unacceptable) quality.

Measuring the product quality of an executable artifact is achieved using one or more measurement techniques, such as:

- reviews / walkthroughs
- inspection
- execution

Different metrics are used, dependent upon the nature the quality goal of the measure. For example, in reviews, walkthroughs, and inspections, the primary goal is to focus on the function and reliability quality dimensions. Defects, coverage, and compliance are the primary metrics used when these measurement techniques are used. Execution however, may focus on function, reliability, or performance. Therefore defects, coverage, and performance are the primary metrics used. Other measures and metrics will vary based upon the nature of the requirement.

Measuring Process Quality

The measurement of Process Quality is achieved by collecting both knowledge and achievement measures.

- The degree of adherence to the standards, guidelines, and implementation of an accepted process.
- Status / state of current process implementation to planned implementation.
- The quality of the artifacts produced (using product quality measures described above).

Measuring process quality is achieved using one or more measurement techniques, such as:

- progress - such as use cases demonstrated or milestones completed
- variance - differences between planned and actual schedules, budgets, staffing requirements, etc.

- product quality measures and metrics (as described in Measuring Product Quality section above)

Quality Management in Agile Approaches

From one source:
In agile approaches cross-functional team implement QA to:

- Verify quality of the product after each iteration
- Incorporate the review feedback in next iteration

Quality control tools are:

- Burn down charts
- Root cause analysis

From another source:
Agile methods improve control. Frequent delivery of working code means progress is objectively measurable:

- More chances for sponsor/stakeholders to provide early feedback to redirect project priorities where necessary
- Misunderstandings are surfaced earlier

Quality Metrics are more rigidly tracked:

- defect injection rate per iteration
- number of outstanding defects sorted by severity

Short iterations demand automated testing tools to perform regression tests and gather, track, and report on results metrics. Frequent builds demand more focus on quality

From third source:
Good Behavior – Quality Product

XP practices for quality code:

- Extensible code
- Maintainable Code
- Testable (Tested) Code
- Understandable code
- Consistent practices

- Pairing, Peering, Coaching, etc.

Used Literature

- Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fourth Edition
- Herman Steyn, “A Framework for Managing Quality on System Development Projects”, http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=4599741&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F4591409%2F4599598%2F04599741.pdf%3Farnumber%3D4599741
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