PROCESS VISION

DOWN TO EARTH IT PROJECT IMPROVEMENTS

The basics of Quality Assurance

A guideline to quality assurance enforcement

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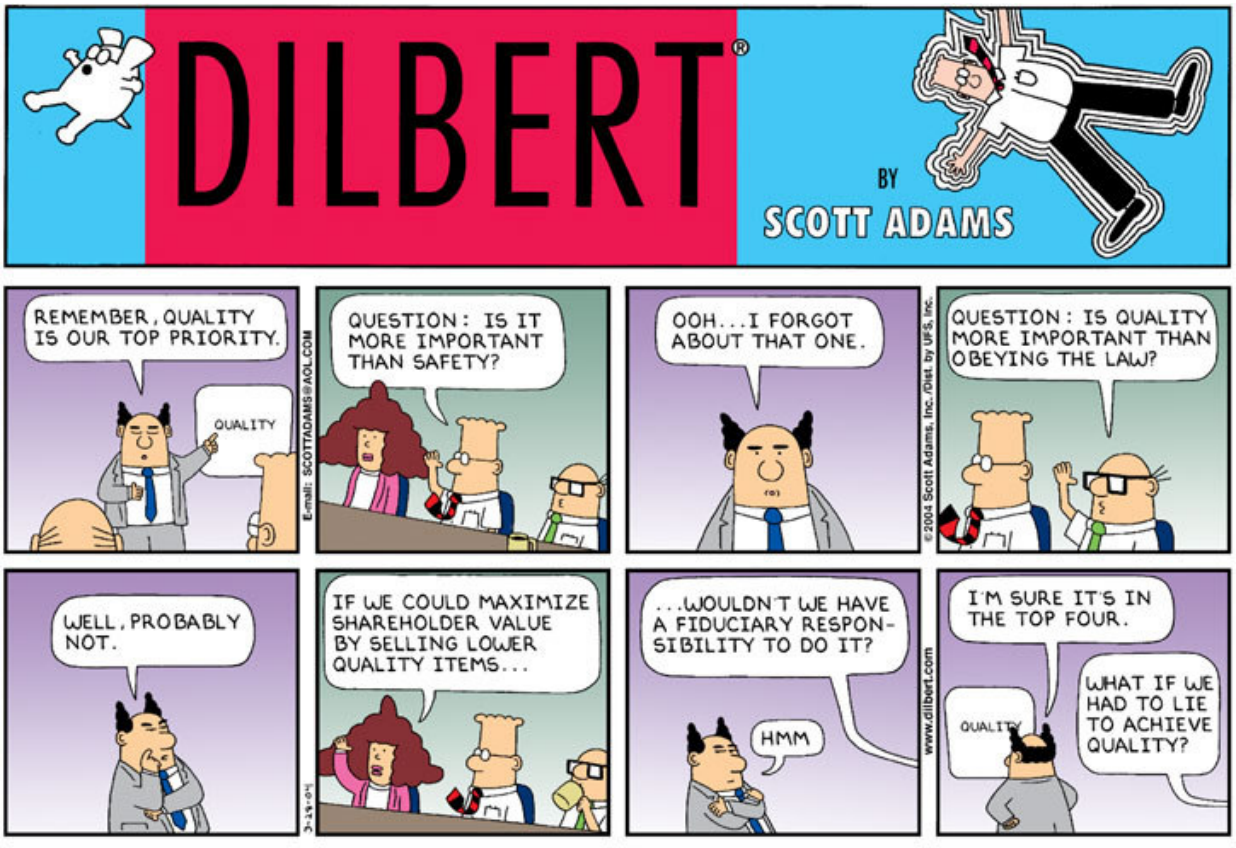
Foreword

This paper gives the basics of quality assurance. First it will explain what quality assurance is. It will discuss quality assurance plans, audits and quality systems. Finally it will discuss the deployment of processes.

The reader should have basis knowledge of project management, configuration management, inspections and (software) testing.

The light bulbs in this document indicate useful practical tips.



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Definitions & acronyms

Audit	An independent examination of a work product or a set of work products to assess compliance with processes, specifications, standards, contractual agreements or other criteria.
Assessment	An audit that (if successful passed) can lead to certification. E.g. a CMM assessment or an ISO assessment.
Work product	An in-between deliverable of a project. For example a requirements document, a test plan, software code.
QA	Quality Assurance
QC	Quality Control
CMM	Capability Maturity Model
PI	Process Improvement
FDA	Federal Drugs Association
Quality System	Set of procedures, guidelines, templates etc. that define the agreed and committed way of working in an organization
Process Owner	A person ultimate responsible for a process defined in the Quality System
Base lined	Archived and under version control
QS	Quality System

References

[CMMI] CMMI for systems engineering/software engineering, CMU/SEI-2000-TR-028

[QC] The basics of software quality control, Process Vision, 2004

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1.INTRODUCTION

1.1 Definition of Quality Assurance

[CMMI] gives the following definition:

> "Provide staff and management with objective insight into the processes and associated work products
>
> - Objectively evaluating performed process, work products and services against the applicable process descriptions, standards and procedures
> - Identifying and documenting noncompliance issues
> - Providing feedback to project staff and managers on the results of the quality assurance activities
> - Ensuring that noncompliance issues are addressed"

So, quality assurance handles not only about the processes (the way of working in a project) alone but also about the work products of a project (plans, requirements, designs, code).
It must also be done objectively, so that has an impact on the way quality assurance is embedded into an organization. We will look into that aspect in section 2.1 .

1.2 Scope of Quality Assurance

The scope of QA concerns the whole project and its associated processes:

Project Management

- Planning & Tracking
- Risk Management
- Training

Supplier Management

Requirements Management

Product Engineering

- Requirements Engineering
- Designing
- Coding
- Testing
- Integrating

Product Reviews

Configuration Management

1.3 Quality Assurance versus Quality Control

Quality Assurance is not the same as reviewing (inspection) or testing a product.
Reviewing and testing is called Quality Control (see [QCl]) and the difference between QC and QA is depicted in the figure below.

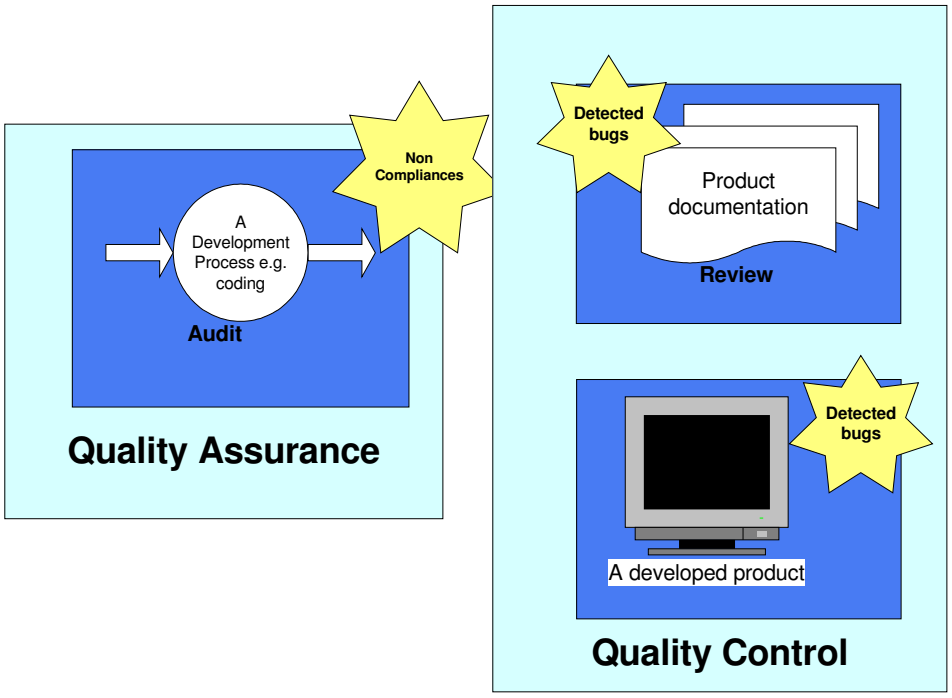


Figure 1 Difference between QA and QC

	Quality Assurance	**Quality Control**
Task	Verify if product is developed according agreed way of working.	Verify if product is developed according agreed requirements.
Responsibility	QA is NOT responsible for quality of product.	QC is responsible for quality of product
Who	Independent person	Project staff (testers, inspectors)
How	Audits	Inspections / Tests

1.4 Quality Assurance versus Process Improvement

Quality Assurance and Process Improvement are very closely related, but they are definitely not the same. In projects, QA officers also perform process improvement but it is a different role. The picture below explains it.

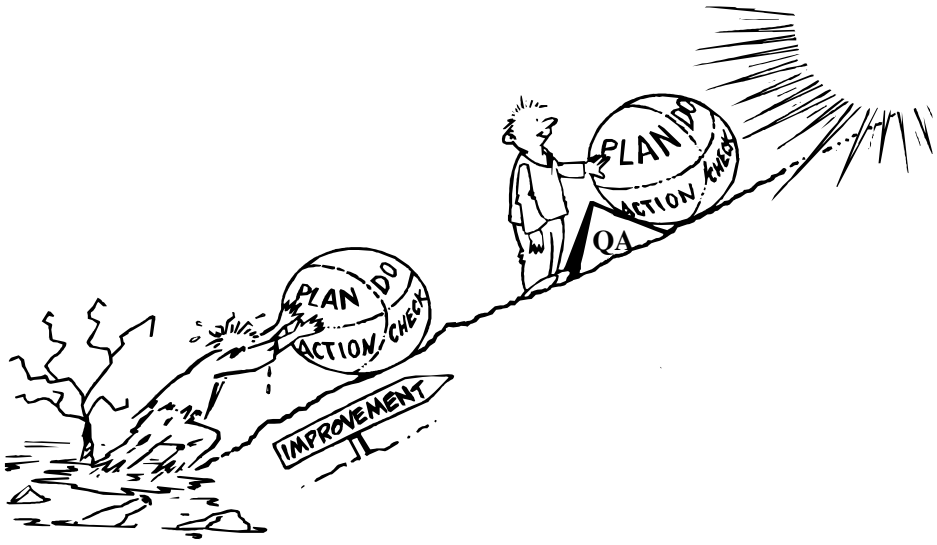


Figure 2 Difference between QA and PI

Whenever an organization wants to improve there processes for whatever reason, there is always a current situation. The role of the process improver is to get the organisation to the desired situation.

However, people always tend to fall back into their "old habits". Quality Assurance is the instrument that keeps the PI ball from not falling back.

	Quality Assurance	**Process Improvement**
Task	Check if existing processes are followed (continuous deployment)	Create / adapt processes and give initial deployment
Scope	Improvements not main task, merely for a single project	Improvements for whole department or more than one project
Who	Quality Officer	Process Improvement teams
How	Embedded in development project	Separate improvement projects

2.THE PEOPLE BEHIND QA

2.1 Place of QA in an organization

"Objective" is the keyword for Quality Assurance. The most common way of getting this objectiveness is making the QA officer independent from the project manager. Below an example organization is given.

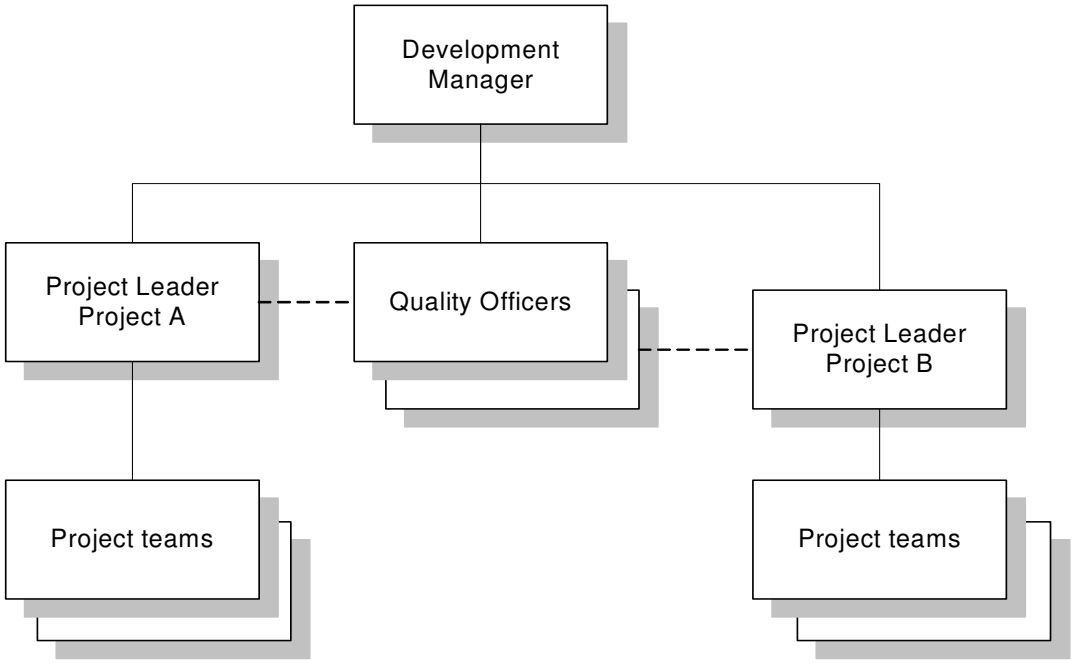


Figure 3Example of QA in organization chart

The above organization chart shows that the direct boss of QA is the development manager[1] NOT project leader. So, the QA reports to the development manager and informs the project leader.

In an open, quality-minded organization, people within the project team can perform QA tasks. However, these people must be trained in QA and must have an independent reporting channel toward the department.


It is possible that a QA officer has several projects for which he is QA officer. This gives overhead in swapping. On the other hand, it gives sharing of best practices amongst these projects. For a CMM level 2 organization, 1 full-time QA officer for a project with 20 to 30 team members is a good optimum.

[1] Dependent on the organization, the direct boss of the QA can also be a department manager

2.2 Quality Assurance Officer

2.2.1 Responsibilities and tasks

A QA officer has two main roles: the supporting role and the signaling role.

Supporting role

- Review all plans (project, test & integration, configuration management) and high level specifications (user requirements, system requirements)
- Deploy processes, standards, templates and checklists.
- Help improve way of working, so project runs effectively and efficiently
- Be the mirror of the project manager/team leader
- Give (extreme) support in writing QA plans

Signaling role

- Audit actual way of working (best way: QA officer from other project to assure independency)
    - Write audit plan
    - Execute the audit plan
    - Monitor processes and signal possible improvements
    - Inform project (leader) of any findings and deviations.
    - Report to department manager.
    - Escalate non compliance's
- Deploy the QA plan
- Measure on process and product to give insight in quality of both

What is **not** the task of a Quality Officer?

- Project administrator role
    - Review metric administrator
    - Writer of minutes of project meetings
    - Moderator for all reviews
    - CR/PR metric administrator
    - Maintainer of planning/tracking sheets
    - Maintainer of documentation status overview
- Writer/Inventor/Improver of procedures / processes (PI role)

Both are different roles in the organization. Of course, a person can have the role of QA and PI and project administrator but then it is agreed upon by all stakeholders and the person has allocated time in its planning for these tasks.

A quality officer should at all times have the task of helping the project being as efficient and effective as possible by stretching the boundaries of the processes as much as possible. Processes are only there to help you; they should never be a burden. But the stretching goes as far as is allowed by for example external limitations (e.g. obeying FDA rules) or internal rules (CMM compliance).


As Quality Officer, know what your role is. Balance between the supportive role and signaling role. Before you know it, you do a lot of (for the project very useful) administrative tasks, but you do not have time anymore to signal

problems. Write an activity plan that describes your activities for the project, together with the estimated spent time on these tasks. Agree this plan with the project leader and work according this plan.

2.2.2 Personal skills

- Strong communicative skills
  - Presenting before groups
  - Writing
  - Bi-directional
- Able to stand up to a project leader
- Helicopter view
- Sensitive for environmental problems
- Pro-active
- Able to switch supporting role versus signaling role
  - You can 'hire' external auditor for the signaling role
- Knowledge of company standards and regulations, processes and procedures
- Knowledge of external standards and regulations such as CMM(i), IEEE, ISO and FDA.
- Some years of development experience helps a lot
  - Programmer
  - Tester
  - Team / Project leader

The matrix below shows what happens if the balance between project leader (PL) and quality officer (QA) is not in place.

	Strong QA
QA helps reducing project risks	Best combination
Weak PL	*Strong PL*
Project has high risk factor	QA becomes administrator
	Weak QA

2.2.3 Escalation

There are 2 forms of escalation:

1. The quality officer escalates towards the department manager. This happens when the project does not work according agreed way of working. The reason can be that the quality officer and project leader do not come to an agreement how to solve this problem. It can also happen that the project leader is not capable (out of his scope) of solving the problem.
2. A project member escalates towards the quality officer. This happens when the project member sees that his team- or project leader does not work according the agreed plan and the project member sees that this endangers the quality of the product. For example, a code review is skipped due to time pressure while an inexperienced developer wrote that code.

Escalation is always the last thing to do: if you escalate every week then this mechanism will not be effective anymore. Always try to resolve the problem with the help of others before jumping to escalation.

3.QUALITY SYSTEMS

3.1 What is a quality system?

A quality system (QS) is a set of documents that together form the description of the way of working of an organization. What are these documents? The following table lists the possible type of documents that are part of a QS.

Process description	Documentation of a process. Contains the description, flow, responsibilities, roles and metric of a process. E.g. change control process description.
Procedure	If a process is to written out in more detail one or more procedures are used. They contain activities in time of the process. E.g. archiving documents procedure.
Standard	Rules of a particular process that must be followed. E.g. C coding standards
Guideline	Rules of a particular process that are advisable to follow. E.g. a requirements modeling guidelines.
User Manual	Description of usage of certain (software) tooling. E.g. COM user guide.
Template	Standard prewritten form of a document type (e.g. specification, design) to be used as startup for writing a new document. To be used as a guideline NOT as a standard. E.g. a software design template.
Checklist	List of the most important issues of a process to be used as a help. E.g. review moderators checklist.
Form	Administrational help to document an instance of a process. E.g. a review form is filled in for every executed review.
Training material	Documented information used for training purposes of a process. E.g. a review course
Frequently Asked Questions	Description of questions and answers frequently asked by the users of a process. E.g. C++ FAQ.
Quick Reference	Issues of a process in a nutshell. E.g. Change control tool flow on A4 format.

Table 1 Quality System Items

3.2 Managing a quality system

A quality system is handled the same way as a software application. It is under configuration management; it contains documents with authorized status; it has a process change control board (process CCB); if you want to change anything you must issue a CR/PR; it has releases and versions.

3.3 Criteria for a good quality system

First lets look at some examples of bad quality systems:

1. Too many layers (levels): each organizational levels has its own QS
2. Too thick: everything is written down up to every nitty gritty detail
3. Not visible: hidden in a cabinet in thick manuals
4. Not readable: written by people that have never worked in development
5. Not up-to-date: no checking mechanism in place too keep it up-to-date
6. Inconsistent: no overall coordination on all procedures
7. Incomplete
8. Nobody feels responsible for a process
9. Not deployed: no one took care of presenting it nor explaining it nor checking if it being used

Solutions for above problems are:

1. Entrance via one point (e.g. a process list) giving all necessary information for a project. Multi-views: project leader different view on system than developer
2. Procedures are checklist-like (A4) descriptions.
3. Visible via intranet, hardcopies and wallpapers.
4. Written with the help of key persons in projects
5. Active CCB that checks via Quality Officers if quality system is still the practice
6. One overall QS coordinator (chair of CCB) who checks consistency on every change in the QS.
7. QS CCB must take project evaluations into consideration to see if QS lacks important processes.
8. Process owners are in place
9. Continuously deployment (see section 6) and auditing (see section 4).

4.PROJECT AUDITS

The most powerful tool of a quality officer is a project audit.

4.1 Audit Process

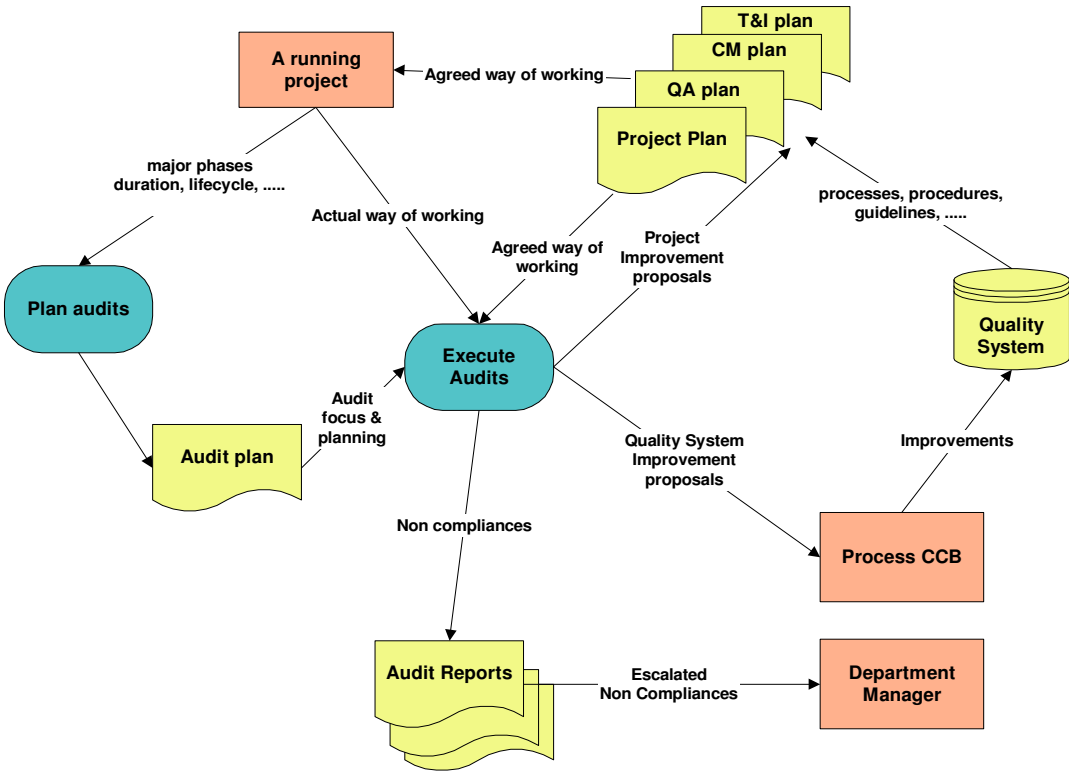


Figure 4 Audit process

4.1.1 Plan audits

First step is the planning of the audits. The audit plan contains all planned audits and the focus of each audit. Section 4.2 gives more detail on the content of an audit plan. Dependent on the phase of a project, the focus shifts from e.g requirements management to testing.

Perform the following steps

1. Derive from project plan
   - Major phases / milestones / deliveries
   - Project duration
   - Used development life cycle, e.g. waterfall, V-model or incremental
2. Plan the audits
   For example
   1. Before a major delivery
   2. Before change of phase (e.g. start design phase, start test phase)

3. Give every audit a focus
   Focus examples
   - How are the plans deployed? Do they work according the plans
   - How are the processes deployed? Do they work accordingly
   - Documentation status and content quality
   - Change control (CR / PR handling, Change Control Board)
   - Quality of the Product Reviews
   - Communication within the project
   - Commitment of the project (members)
   - Obedience to external regulations (CMM, FDA, ISO)
   - Inter project deliverables (from development to test team)


Don't be afraid to change focus, if necessary or plan an extra audit, if necessary.

4.1.2 Execute audits

Audits check whether the project follows its plans. In the plans the agreed way-of-working including procedures and guidelines are documented. The difference is that the plans do not contain the actual processes, procedures and guidelines anymore. They merely refer to these items and the plans describe the tailoring on these items.

For instance, a tailoring of a review process could be that the project never has review meetings for low-level product documentation such as module level documentation. In stead these reviews are completely handled by electronic mail.

Precondition is, that this tailoring is allowed by the QS and that these tailoring rules are documented in the QS.

The audit compares this to the actual way-of-working.

Output

1. A process is following according agreed way-of-working and is effective and efficient. A remark is noted on the audit report, no action needed.
2. A process is following according agreed way-of-working but is not effective and/or efficient: this lead to project improvement proposals for the plans. The auditor tracks them down to closure.
3. A process is not followed according agreed way-of-working but should have been followed: this lead to a non-compliance documented in an audit report. If the project does not agree to solve the non-compliance or if the non-compliance is not solved within the agreed time frame, the non-compliance is escalated towards the discipline manager: he decides on the issue. The auditor tracks the non-compliance down to closure.
4. a department improvement proposal for those items from the QS that are not effective and/or efficient.

Section 4.3 contains the content of an audit report.

4.1.3 Step 1: Preparation

1. Ask project for latest versions of all plans; study them on the following subjects
   Project plan
   - Major phases / milestones / deliverables
   - Estimations / planning / tracking
   - Project organisation
   - Communication structure
   - Risks
   - Training

   QA plan
   - Quality objectives
   - Used lifecycle
   - Processes to be followed

   CM plan
   - Change control process
   - Documentation / code promotion models

   T&I plan
   - Followed test strategy
   - Acceptance criteria

2. Prepare questionnaire per process per role but use it as a checklist! Below an example is given.

   Project Management process
   Role: Developer / Tester
   General knowledge of project
   Which project plans / planning's are present? Are you familiar with it (have you read them)?
   Which milestones (internal and external) and dates does the project have?
   Own planning/tasks
   Do you have a planning? (If not, why not)
   If you have, how do you report progress?
   Do you get response back from your project leader? E.g. does he ask for explanation when you fall behind schedule?
   Is your progress weekly actualized in the team or project plan?
   Do you perform tasks that are outside the activities on your planning? If so, how are they dealt with?
   Please show me your current schedule.
   Look e.g. for
   - Tasks greater than 10 days (not manageable)
   - Tasks in wrong order (e.g. test first, write test specs afterwards)
   - Forgotten tasks (e.g. review task for own documents)

   Are new activities that are scheduled for you also incorporated in the team/project plan?

3. Plan the interviews
   - Not more than 6 per day but all within one week

- 1 hour per person
- Reserve a separate room for the interviews
- Always interview project leader & team leaders, interview others (configuration manager, architect, developer, tester) dependent on the focus
- Interview "upwards": developers first, project leader last (you can verify the findings in the interview with the project leader)

4.1.4 Step 2: Interviews

1. Startup
   - Start with "confidential" enclosure
   - Explain audit process if not known
   - Ask for experience and role in project (if not known)
2. Questions
   - Focus on real problems (major risks), not on minors (beware: a major for one project can be a minor for another project and vice versa)
     Major: "Customer deliverables/milestones not clear"
     Minor: "Functional Requirements Specification version 1.0 not signed yet "
   - If possible, try to get proof: "Show me……."
   - Always check on communication
     - Between project management and team members
     - Between project and customer
3. Close down
   - Ask question "What would you change in this project if you were in charge" to get improvements
   - Thank auditee for the input

4.1.5 Step 3: Follow up

1. Write the report
   - Do not base a non-compliance on one auditees opinion only, try to get more proof
   - Don't mention names in reports but roles
   - Remember the names for rotating purpose
   - Let auditees give comment on the report before publication ("did I write anything down that is incorrect?")
2. Publish the report
   - Inform the project leader on the content of the report. Come to an agreement on actions on the findings and a resolve date per action.
   - Present a summary in project meeting
   - Communicate to project also by putting results on the wall
   - Discuss report with Development Management (DM)
   - Escalate non-compliances that project does not resolve to DM
3. Track the findings
   - Chase after non-compliances as actions
   - Keep progress of non-compliance solving via simple metric

4.2 Audit plan

You can distinguish 2 types of audit plans: on project level and on department level. You can combine both plans into one plan if this is more efficient.

4.2.1 Project level

- Scope
- Referred documents (plans, standards, …..)
- Audit planning
- Focus per audit
- Estimated time spent by auditor / auditees

4.2.2 Department level (year plan)

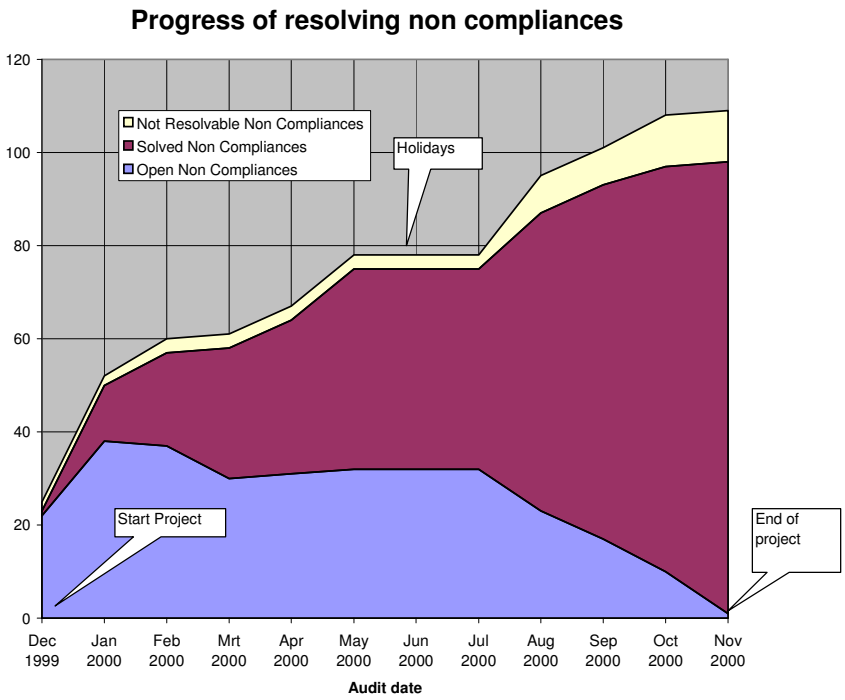
- Needed QA resources on year basis based on number and size of projects
- Needed budget based on needed QA resources

4.3 Audit Report

- Scope of audit
- Referred documents (audit plans, used checklists)
- Focus of audit
- Date of audit
- Interviewed roles + duration of interviews
- Management Summary
- Non-compliances + recommended actions + action holders + resolve date
- Improvement proposals

4.4 Measurements

It is important to measure what has been done with the non-compliances. Below an example of a trend graph is shown. This metric shows a normal progress of resolving non-compliances. Each month more non-compliances are resolved, the



number of open non-compliances slowly decrease to zero and the non-resolvable non-compliances are kept to a minimum.

5. QUALITY ASSURANCE PLAN/REPORT

5.1 QA plan

At the start of a project, a Quality Assurance Plan is made.
It consists at a minimum of:

Process quality

If a Quality System exists

- Tailoring towards QS
- Extensions of QS
- Deviations of QS

If no Quality System exists

- Used engineering lifecycle
- Way of working (procedures/standards) on all process area's:
    - What life cycle is used and how are the different phases done:
        - Requirements engineering
        - Designing
        - Coding
        - Integration & Testing (can be in separate I&T plan)
    - How do we keep the project under control, how do we do:
        - Risk management
        - Estimate / plan / track our project
    - How do we perform product (documentation and code) reviews
    - How is change control on work products done (can be in CM plan)
    - How is quality assurance performed in the project
    - How is subcontracting handled
    - How is requirements management done

Product Quality Targets, e.g.

- Percentage of covered requirements (can also be in test plan)
- Percentage of code coverage per module (can also be in test plan)
- Deviations to architecture rules
- Deviations to code standard rules
- Memory leakage per module

5.2 Quality Status reports

During the project, the QA officer measures against the QA plan and reports the results back to department manager (and informs the project).
It consists of

- Deviations to the agreed processes (also measured at audits)
- Deviations to the agreed product quality targets

If a QA officer does both audits and writes Quality Status reports, it happens that the audit report and quality status reports are combined into one report.

6. DEPLOYMENT

Most difficult part of quality assurance is the deployment of the processes. Writing a process down is one thing, but actually letting people work according it is another.

The quality officer has several methods to achieve proper deployment.

First of all the preconditions have to be in order: section 3.3 gave the attributes for a good process (or quality system being a collection of processes).

6.1 Start

Next, the actual deployment starts with giving explanations of the processes to the people in the project. These presentations do not necessarily have to given by the quality officer. It is even better to let the people who have knowledge of the subject, give the presentations. E.g. let a moderator give the review process. Let a configuration manager give the change control process.

6.2 Actual usage

Now the processes are explained and clear to everybody, the actual usage must starts. In large projects, most of the time, you have lots of processes and plans. It can be very helpful for the project members to have a summary written on the wall. These A0 wallpaper posters are then pinned on the walls of every team room and in the corridors of the project. They are also useful for the quality officer to refer to during discussions/explanations of the processes during actual usage.

Audits will help the quality officer to see if the processes need fine-tuning. As a quality officer, always be aware that a process is merely a helpful instrument: in the end it is the product that must make the money not the process behind it.

About the author

Willem received his bachelor's degree in Electronics in 1985 and started working as a software developer. During the first 9 years of his career, he has worked in projects for Océ vd Grinten, Organon Technica, Philips Medical Systems and Draeger and ended up as project / team leader.
In 1997 he switched towards the quality assurance and process improvement role in multi-disciplinary projects for companies such as ASML, Philips ASA lab, Philips Medical Systems and Centric TSolve.
From 2001 onwards he started his own company Process Vision and continued to work as quality assurance / process improvement officer.
Next to that he conducts (from 2003 up to now) the quality assurance course at the Technical University of Eindhoven as part of the OOTI program.

Revision History

Date	Revision	Comment
18June 2004	01	Initial version
4 July 2005	02	Remarks of students processed
20 August 2006	03	Replaced QA/PI picture
23 July 2007	04	Remarks of students processed