I.3 Quality Management

Quality Management System [ISO 9000]:

The organizational structure, responsibilities, procedures, processes and resources for implementing quality management

- Concerned with ensuring that the required level of quality is achieved in a software product.
- Involves defining appropriate quality standards and procedures and ensuring that these are followed.
- Should aim to develop a ‘quality culture’ where quality is seen as everyone’s responsibility.

[Sommerville2004]
Environment Characteristics

- Being contracted
- Subjection to customer-supplier relationship
- Requirement for teamwork
- Need for cooperation and coordination with other development teams
- Need for interfaces with other software systems
- Need to continue carrying out a project while the team changes
- Need to continue maintaining the software system for years

[Galin2004]
The Cost of Quality

Cost of Quality includes all costs incurred in the pursuit of quality or in performing quality related activities such as appraisal costs, failure costs and external failure costs.  
[Pressman2004]

The Quality Compromise:

We cannot wait for specifications to improve before paying attention to quality management.

We must put quality management procedures into place to improve quality in spite of imperfect specification.  
[Sommerville2004]
Scope of Quality Management

- Quality management is particularly important for large, complex systems. The quality documentation is a record of progress and supports continuity of development as the development team changes.

- For smaller systems, quality management needs less documentation and should focus on establishing a quality culture.

[Sommerville2004]
Quality Management and Software Development

[Sommerville2004]

- Standards and procedures
- Quality plan
- Quality review reports

Software development process:
- D1
- D2
- D3
- D4
- D5

Quality management process:
- Standards and procedures
- Quality plan
- Quality review reports
Quality Management Activities

(1) Quality assurance
   - Establish organisational procedures and standards for quality.

(2) Quality planning
   - Select applicable procedures and standards for a particular project and modify these as required.

(3) Quality control
   - Ensure that procedures and standards are followed by the software development team.
   - Quality management should be separate from project management to ensure independence.

[Sommerville2004]
(1) Quality Assurance

Quality Assurance [ISO 9000]:

All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy requirements for quality.

Software quality assurance [IEEE]:

1. A planned and systematic pattern of all actions necessary to provide adequate confidence that an item or product conforms to established technical requirements.

2. A set of activities designed to evaluate the process by which the products are developed or manufactured. Contrast with: quality control.
Quality Assurance

Software quality assurance is [Galin2004]:

A systematic, planned set of actions necessary to provide adequate confidence that the software development process or the maintenance process of a software system product conforms to established functional technical requirements as well as with the managerial requirements of keeping the schedule and operating within the budgetary confines.

- Quality assurance consists of the auditing and reporting functions of management [Pressman2004]
2) Quality Planning

- **Quality planning** is the process of assessing the requirements of the procedure and of the product and the context in which these must be observed.

- **Quality assurance plan** is the central aid for planning and checking the quality assurance.

[Pressman2004]
Quality Assurance Plan

- A quality assurance plan sets out the desired product qualities and how these are assessed and defines the most significant quality attributes.
- The quality assurance plan should define the quality assessment process.
- It should set out which organisational standards should be applied and, where necessary, define new standards to be used.

[Sommerville2004]
Quality Assurance Plans

- Quality assurance plan structure:
  - Product introduction
  - Product plans
  - Process descriptions
  - Quality goals
  - Risks and risk management

- Quality assurance plans should be
  - short,
  - succinct
  (If they are too long, no-one will read them)
Example: SQA Plan

- Purpose of Plan
- References
- Management
  - organization structure, SQA tasks, their placement in the process
  - roles and responsibilities related to product quality
- Documentation
  - project documents, models, technical documents, user documents.
- Standards, Practices and Conventions
- Reviews and Audits
- Test
  - test plan and procedure
- Problem Reporting and Corrective action

- Tools, Techniques and Methodologies
- Code Control
- Media Control
- Supplier control
- Records Collection, Maintenance and Retention
- Training
- Risk Management

[IEEE_Std_730-1998, Pressman2004]
Quality Control [ISO 9000]:

*The operational techniques and activities that are used to fulfil requirements for quality*

- *Quality Control* is the series of inspections, reviews and tests used throughout the development cycle to ensure that each work product meets the requirements placed upon it.

[Pressman2004]
Quality Control

- This involves checking the software development process to ensure that procedures and standards are being followed.

- There are two approaches to quality control
  - Quality reviews;
  - Automated software assessment and software measurement.
Quality Control

Objective:
- minimize the produced defects
- increase the product quality

Implementation approaches:
- Fully automated
- Entirely manual
- Combination of automated tools and human interactions
Quality Control

Quality control includes a **feedback loop** to the process:
- provide management with the necessary data about product quality.
- gain the insight and confidence of product quality

Two types of quality control:
- **Quality design**: the characteristics that designers specify for an item (includes: requirements, specifications, and the design of the system).
- **Quality of conformance**: the degree to which the design specification are followed. It focuses on implementation based on the design.

[Pressman2004]
Quality Assurance System

- *Quality assurance system* is the organizational structure, responsibilities, procedures, processes and resources for implementing quality management.

[Pressman2004]
Process and Product Quality

- The quality of a developed product is influenced by the quality of the production process.
- This is important in software development as some product quality attributes are hard to assess.
- However, there is a very complex and poorly understood relationship between software processes and product quality.

[Sommerville2004]
Process-based Quality

- There is a straightforward link between process and product in manufactured goods.

- More complex for software because:
  - The application of individual skills and experience is particularly important in software development;
  - External factors such as the novelty of an application or the need for an accelerated development schedule may impair product quality.

- Care must be taken not to impose inappropriate process standards - these could reduce rather than improve the product quality.
Process-based quality

- Define process
- Develop product
- Assess product quality
- Improve process
- Quality OK (Yes: Standardise process, No: Improve process)
Practical Process Quality [Sommerville2004]

- Define process standards such as how reviews should be conducted, configuration management, etc.
- Monitor the development process to ensure that standards are being followed.
- Report on the process to project management and software procurer.
- Don’t use inappropriate practices simply because standards have been established.
I.4 Components of a SQA System

(1) Pre-project components
(2) Software project life cycle components
(3) Infrastructure components for error prevention and improvements
(4) Management SQA components
(5) SQA standards, system certification and assessment components
(6) Organizing for SQA – the human components and considerations guiding construction of organization’s SQA system
(1) Pre-project Components

Pre-project

- Contract reviews
- Development and quality plans

(see Chapter II and III)
(2) Project Life Cycle Components

Development
- Reviews
- Expert opinions
- Software testing
- Assurance of the quality of external participants’ work

Maintenance
- Software maintenance components

(see Chapter II and III)
(3) Infrastructure Components

- Procedures and work instruction
- Templates and checklists
- Staff training, retraining and certification
- Preventive and corrective actions
- Configuration management
- Documentation control

(see Chapter IV)
(4) Management SQA Components

- Project progress control
- Software quality metrics
- Software quality costs

(see Chapter V)
(5) Standards, Certification, Assessment

- Project process standards
- Quality management standards

Objectives:
- Utilization of international professional knowledge
- Improvement of coordination with other organizations’ quality systems
- Objective professional evaluation and measurement of the organization’s SQA achievement

(see Chapter VI)
(6) Organizing for SQA

- Management’s role in SQA
- The SQA unit
- SQA trusties
- SQA committees
- SQA forums

(see Chapter I.5)
The Software Quality Shrine

(1) Pre-project SQA components

- Contract review
- Project Development plan and Quality Plan

(2) Project Life Cycle SQA components

- Formal Design Reviews
- Peer Reviews
- Experts Opinion
- Software Testing
- Software Maintenance
- SQA of External Participants

(3) Quality Infrastructure components

- Procedures
- Supporting Devices
- Training Instruction
- Preventive Actions
- Configuration Management
- Documentation Control

(4) Quality Management

- Project Progress Control
- Software Quality Metrics
- Software Quality Costs
- Quality Management Standards

(5) Standards

- Project Process Standards

(6) Organizational Base – Human components

- Management
- SQA Unit
- SQA Trustees
- SQA Committees
- SQA Forums

[Galinsky2004]
I.5 Organizing for SQA

(1) Pre-project SQA components
- Contract review

(2) Project Life Cycle SQA components
- Formal Design Reviews
- Peer Reviews
- Experts Opinion
- Software Testing
- Software Maintenance

(3) Quality Infrastructure components
- Procedures
- Supporting Devices
- Training
- Instruction
- Preventive Actions
- Configuration Management
- Documentation Control

(4) Quality Management
- Project
- Progress
- Control
- Software
- Quality
- Metrics
- Software
- Quality
- Costs
- Quality
- Management
- Standards
- Project
- Process
- Standards

(5) Standards

(6) Organizational Base – Human components
- Management
- SQA Unit
- SQA Trustees
- SQA Committees
- SQA Forums

[Galinst04]
The SQA framework

Legend

- Line of authority line for SQA issues
- Flow of Forum’s recommendations line

[Galín2004]
The SQA Framework: Participants

Managers
- Top management executives, especially the executive in charge of SQA
- Software development and maintenance department managers
- Software testing department managers
- Project managers and team leaders of development and maintenance projects
- Leaders of software testing teams

Testers
- Members of software testing teams

SQA professionals and interested practitioners
- SQA trustees
- SQA committee members
- SQA forum members
- SQA unit team members
a) Management

Overview:

- Top management’s quality assurance activities
- Software quality policy
- The executive in charge of software quality
- Management review
- Department management responsibilities for quality assurance processes
- Project management responsibilities for quality assurance
TOP Management Responsibilities

- Assure the quality of the Company’s software products and software maintenance services.
- Communicate the importance of product and service quality in addition to customer satisfaction to employees.
- Assure full compliance with customer requirements.
- Ensure that SQA objectives are established and accomplished.
- Initiate planning and oversee implementation of changes to adapt the SQA system to changes related to the organization's clientele, competition and technology.
- Intervene directly to resolve crisis situations and minimize damages.
- Ensure availability of resources required by SQA systems.

[Galin2004]
SQ Policy Requirements

- **Quality policy** refers to the basic aims and objectives of an organization regarding quality as stipulated by the management.

**Conformity to the organization purpose and goals**

**Commitment to:**

- General software quality assurance concepts
- The quality standards adopted by the organization
- Allocate adequate resources for software quality assurance
- Continuous improvement of the organizations quality and productivity
Responsibilities (Executive in Charge)

- **Responsibility** for preparation of an annual SQA activities program and budget
- **Responsibility** for preparation of SQA system development plans
- **Overall control** of implementation of the annual SQA regular activities program and planned SQA development projects
- **Presentation** and advocacy of SQA issues to executive management

[GalIn2004]
Management Reviews

Def.: Management review is the name given to the periodic meeting convened to allow executives to obtain an overview of their organization’s software quality issues.

Typical items:
- Periodic performance reports, including quality metrics
- Customer satisfaction feedback
- Follow up reports for SQA annual regular activity program and SQA development projects
- Summary of special quality events related to customers, suppliers, subcontractors, etc.
- Review of significant findings of internal and external quality audits as well as special surveys
- Identification of new software quality risks and unsolved pre-existing risks
- Recommendations for software quality management improvements.

[Galin2004]
Management Reviews: Objectives

- **Assess** achievement of quality objectives set for the organization’s software quality management system.

- **Initiate** updates and improvements of the software quality management system and its objectives.

- **Outline directions** for remedying major SQA deficiencies and software quality management problems.

- **Allocate** additional resources to the software quality management system. [Galin2004]
Department Responsibilities (1/2)

The quality system-related responsibilities:

- **Preparation** of the department’s annual SQA activities program and budget, based on recommended SQA unit program.

- **Preparation** of the department’s SQA systems development plans, based on recommended SQA unit plan.

- **Control** of performance of the department’s annual SQA activities program and development projects

- **Presentation** of the department's SQA issues to the executive in charge of software quality.  
  
  [Galin2004]
Department Responsibilities (2/2)

Project-related responsibilities

- **Control** of compliance to quality assurance procedures in the department's units
- **Detailed** follow up of contract review results and proposal approvals
- **Review** of unit performance of planned review activities; approval of project documents and project phase completion
- **Follow up** of software tests; approval of project's software products.
- **Follow up** of progress of software development project schedules and budget deviations. Advise and support project managers in resolving difficulties.
- **Follow up** of quality of maintenance services
- **Detailed follow up** of project risks and their solutions
- **Follow up** of project's compliance with customer requirements and customers satisfaction.
- **Approval** of large software change orders and significant deviations from project specifications.

[Galin2004]
Project Management Responsibilities

Professional hands-on tasks:
- **Preparation** of project and quality plans and their updates.
- Participation in joint customer-supplier committee
- **Close follow up** of project team staffing, including recruitment, training and instruction.

Management tasks The follow up issues:
- Performance of review activities and the consequent corrections, including participating in some reviews.
- Software development and maintenance units’ performance with respect to development, integration and system test activities, corrections and regression tests and acceptance tests.
- Software installation in customer sites and the running-in of the software system by the customer.
- SQA training and instruction of project team members.
- Schedules and resources allocated to project activities.
- Customer requests and satisfaction.
- Evolving project development risks, application of solutions and control of results.

[Galin2004]
b) The SQA Unit

Overview:
- Activities
- Responsibilities
- Tasks performed by the head of the SQA unit
- SQA sub-unit tasks related to the project life cycle
- SQA sub-unit infrastructure operations tasks
- SQA sub-unit audit and certification tasks
- SQA sub-unit support tasks
- SQA sub-unit standards and procedures: Development and maintenance tasks
- SQA sub-unit information system tasks
SQA Unit Tasks

- Quality assurance planning oversight, record keeping, analysis and reporting
- Participates in the development of the projects software process
- Reviews software engineering activities to verify compliance with the defined software process.
- Audits designated software work products to verify compliance with those defined as part of the software process.
- Ensures that deviations in software work and work products are documented and handled according to a document procedure.
- Records any noncompliance and reports to senior management.

[Pressman2004]
Unit: Organizational Structure

Head SQA Unit

SQA Operations
- Project Life Cycle SQA
- SQA Infrastructure Operations
- Internal and Certification SQA Audits

SQA Development and Maintenance
- SQA Standards and Procedures
- SQA Support
- SQA Engineering
- SQA Information Systems
SQA Unit Head Tasks (1/2)

Planning tasks
- Preparation of proposals for the Unit’s annual activity program and budget.
- Planning and updating the organization’s software quality management system and recommended annual SQA activities programs for the software development and maintenance departments.
- Preparation of recommended SQA systems development plans for the software development and maintenance departments.

Management tasks
- Management of SQA team's activities.
- Monitoring implementation of the SQA activity program.
- Nomination of team members, SQA committee members and SQA trustees.
- Preparation of special and periodic status and performance reports.

[Galín2004]
SQA Unit Head Tasks (2/2)

Contacts with customers and other external bodies and the executive in charge of software quality

- Serving as the customer’s address for software quality issues of software products and services supplied
- Representation of the organization before external bodies regarding software quality issues
- Drafting the management review reports
- Raising SQA organizational issues and preparing requested material for top management’s consideration

SQA professional activities

- Participation in project joint committees
- Participation in formal design reviews
- Review and approval of deviations from specifications
- Consultation to project managers and team leaders
- Participation in SQA committees and forums

[Galıń2004]
Life Cycle Tasks (Sub-Units)

Project life cycle control tasks
- Follow up of development and maintenance teams’ compliance with SQA procedures and work instructions
- Approval or recommendation of software products (design reports and code).
- Monitoring delivery of software maintenance services to internal and external customers
- Monitoring customer satisfaction (surveys, etc.) and maintaining contact with customer’s SQA representatives

Participation tasks participation in:
- Contract reviews
- Preparation and updating of project development and project quality plans
- Formal design reviews
- Subcontractors’ formal design reviews
- Software testing, including customer acceptance tests
- Software acceptance tests of subcontractors’ software products
- Installation of new software products

[Galin2004]
Infrastructure Tasks (Sub-Units)

- Publication of updated versions of procedures, work instructions, templates, checklists, etc., with their circulation.
- Training and instruction to new and current staff and SQA trustees regarding SQA procedures, work instructions, new and revised procedures, development tools and methods, etc.
- Monitoring and supporting implementation of new and revised SQA procedures.
- Follow up of staff certification activities.
- Proposal of subjects requiring preventive and corrective actions.
- Follow up of configuration management activities.
- Follow up of compliance with documentation procedures and work instructions.

[Galin2004]
Types of Audits (in or by SW Org)

- Internal audits
- Audits of subcontractors and suppliers to evaluate their SQA systems
- External audits performed by certification bodies
- External audits performed by customers who wish to evaluate the SQA system prior to accepting the organization as a supplier

[Galin2004]
Audits and Certifications (Sub-Units)

- Preparation of annual programs for SQA audits
- Performance of SQA audits
- Follow up of corrections
- Preparation of periodic summary reports
- Collection of data on the performance of the audited organization from internal and external sources
- Periodic evaluation of the audited organization
- Coordination of the external audit's contents and schedule
- Preparation of documents as specified by external auditors
- Instruction of the audited teams and performance of preparations for external audits
- Participation in the audit

[Galin2004]
Support Tasks (Sub-Units)

- Preparation of project development plans and project quality plans
- Staffing review teams
- Choice of development methodologies and tools that reflect the accumulated failure experience
- Choice of measures to solve identified software development risks
- Choice of measures to solve schedule delays and budget overruns
- Choice of SQA metrics and software costs components
- Use of SQA information systems

[Galin2004]
Standard and Procedures (Sub-Units)

- Prepare an annual program for development of new procedures and procedure updates
- Responsibility for development of new procedures and procedure updates, including participation in appropriate committees and forums
- Follow up of developments and changes in SQA and software engineering standards; introduction of additional relevant procedures and changes
- Initiation of updates and adaptations of procedures in response to changes in professional standards, including adoption or deletion of standards applied by the organization.

[Galin2004]
Engineering (Sub-Units)

- Testing quality and productivity aspects with respect to new development tools and new versions of currently used development tools
- Evaluation of quality and productivity of new and improved development and maintenance methods
- Development of solutions to difficulties confronted in application of currently used software development tools and methods
- Development of methods for measuring software quality and team productivity
- Provision of technological support to CAB committees during analysis of failures and formulation of solutions
Information Systems (Sub-Units)

- Development of SQA information systems for software development and maintenance units for:
  - Collection of activity data.
  - Processing of information delivered by the units: periodic reports, lists, exception reports, queries and estimates of software quality metrics and software quality costs.
- Updating of SQA information systems
- Development and maintenance of the organization's SQA Intranet/Internet site

[Galin2004]
SQA Unit Plan

- Evaluations to be performed
- Audits and reviews to be performed
- Standards that are applicable to the project
- Procedures for error reporting and tracking
- Documents to be produced by the SQA group
- Amount of feedback provided to software project team
c) SQA Trustees

Unit-related tasks:
- Support their colleagues' attempts to solve difficulties in the implementation of SQA procedures and work instructions
- Help their unit manager in performing his or her SQA tasks Promote compliance and monitor implementation of SQA procedures and work instructions by colleagues
- Report substantial and systematic non-compliance events to the SQA unit
- Report severe software quality failures to the SQA unit

Organization-related tasks
- Initiate changes and updates of organization-wide SQA procedures and work instructions
- Initiate organization-wide improvements of development and maintenance processes and applications for solutions to recurrent failures observed in their units
- Identify organization-wide SQA training needs and propose an appropriate training or instruction program

[Galin2004]
d) SQA Committees

**Permanent committees** commonly deal with:
- SCC (software change control),
- CA (corrective actions),
- Procedures,
- Development of method, tools and quality metrics.

**Ad-hoc committees** commonly deal with specific cases:
- Updates of a specific procedure,
- Analysis and solution of a software failure,
- Elaboration of software metrics for a targeted process or product,
- Updating software quality costs,
- Data collection methods for a specific issue.

[Galín2004]
e) SQA Forums

SQA forums typically focus on:

- SQA procedures improvements and implementation
- Quality metrics
- Corrective actions – analysis of failure and success cases
- Quality system issues – development and implementation of new tools
- Quality line management problems – daily operational software quality problems

Members of an open forum may include:

- SQA unit members
- SQA trustees
- Software development and maintenance staff
- SQA and software engineering consultants/experts
- Customer representatives

[Galin2004]
Other Relevant Structures

- Requirements Control Board
  - All requirement changes must be formally reviewed and approved
- Software Control Board
  - All design changes must be formally reviewed and approved
- Interface Control Board
I.6 Discussion & Summary

- General quality definitions of quality are not sufficient in practice. Thus, software quality is described by specific **quality models** which determine the „causal relationship from intangible quality views to tangible software measures“ [ISO/IEC 9126]

- We cannot wait for specifications to improve before paying attention to quality management. We must **put quality management procedures into place** to improve quality in spite of **imperfect specification**.

- Quality management activities consist of **quality assurance**, **quality planning**, and **quality control**.
Discussion & Summary

- The quality of a developed **product** is influenced by the quality of the production **process**. This is important in software development as some product quality attributes are hard to assess. However, there is a very complex and poorly understood relationship between software processes and product quality.

- The main instrument for quality is the **software quality assurance system**.

- **Components** of a software quality assurance system for the pre-project phase, each life cycle phase, management, infrastructure, standardization, and organization exist.

- Organizing for SQA involves mainly the management, SQA Unit, SQA Trustees, SQA Committees, and SQA Forums.
I.7 Bibliography (1/4)


I.7 Bibliography (2/4)


N524 - Guidance on ISO 9001:2000 Sub-clause 1.2 'Application'
N544 - Guidance on the Concept and Use of the Process Approach for management systems
N630 - Guidance on Outsourced Processes
Bibliography (3/4)


http://www.cse.dcu.ie/essiscope/sm2/9126ref.html  


Bibliography (4/4)


