CALIFORNIA STATE UNIVERSITY
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COLLEGE OF ENGINEERING
AND COMPUTER SCIENCE

Advanced Software Process

Part II: The Repeatable Process

8. Software Quality Assurance

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Course Roadmap

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Software Quality Assurance (SQA)

- Quality Management
- The Role of SQA
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Quality Management

Quality is a characteristic or attribute of something [American Heritage Dictionary, quoted from Pressman 2005].

- Measurable characteristics
- Things we can compare to known standards

- Quality
  - Quality of design

    The characteristics that designers specify for an item
  - Quality of conformance

    The degree to which the design specifications are followed during manufacturing

Quality Management

- Software quality
  - Quality of design

    Encompasses requirements, specifications, and the design of the system
  - Quality of conformance

    An issue focused primarily on implementation
- User satisfaction [Glass 1998]
  - Compliant product + good quality + delivery within budget and schedule

Quality Management

- Quality control (variation control) involves the series of inspections, reviews, and tests used throughout the software process to ensure each work product meets the requirements placed upon it.
- Quality assurance (QA) consists of a set of auditing and reporting functions that assess the effectiveness and completeness of quality control activities.

Quality Management

- The goal of QA is to provide management with the data necessary to be informed about product quality, thereby gaining insight and confidence that product quality is meeting its goals.
- Quality management (often called software quality assurance, SQA) is an umbrella activity that is applied throughout the software process.

Quality Management

- Quality management encompasses:
  - A SQA process
  - Specific QA and Quality Control (QC) tasks (including formal technical reviews and a multi-tiered testing strategy)
  - Effective SE practice (methods and tools)
  - Control of all SW work products and the changes made to them
  - A procedure to ensure compliance with software development standards (when applicable)
  - Measurement and reporting mechanisms.

Software Quality Assurance

- One of the critical challenge for any quality program is to devise a way for ordinary people to review the work of experts.
- Management properly wants the best designers to design the products, so Software Quality Assurance (SQA) cannot have them.
- The need is to focus on those SQA methods that permit the development work to be reviewed by people who are not primarily developers.

Software Quality Assurance

- The SQA role is to monitor the methods and standards the software experts use and to verify that they have properly applied their expertise.
- SQA is a valid discipline in its own right, and people can be SQA experts without being software design experts.
- This SQA expertise includes knowledge of statistical methods, quality control principles, the software process, and an ability to deal effectively with people in contentious situations.

Quality Management

- "What is not tracked is not done."
- Tracking is the role of SQA.
- Before establishing an SQA organization, it is essential to first decide how important software quality is to the organization.
- SQA is a management tool that must be properly used to be effective.
- The prime benefit of an SQA program is the assurance it provides management that the officially established process is actually being implemented.

Quality Management

- SQA ensures
  - An appropriate development methodology is in place.
  - The projects use standards and procedures in their work.
  - Independent reviews and audits are conducted.
  - Documentation is produced to support maintenance and enhancement.
  - The documentation is produced during and not after development.
  - Mechanisms are in place and used to control changes.

Quality Management

- Testing emphasizes all the high-risk product areas.
- Each software task is satisfactorily completed before the succeeding one is begun.
- Deviations from standards and procedures are exposed as soon as possible.
- The project is auditable by external professionals.
- The quality control work is itself performed against established standards.
- The SQA plan and the software development plan are compatible.

The Benefits of SQA

- The reason for concern about SW quality are compelling.

  Software has an enormous impact on almost everything we do, and this impact will only increase in the future.

  – Air traffic control
  – Air defense control
  – Weather forecast
  – Banking
  – Emergency, police

The Need for SQA

- When quality is vital, some independent checks are necessary, not because people are untrustworthy but because they are human.
- The issues with software are not whether checks are needed, but who does them and how.

The Goal of SQA

- Broadly stated, the goals of SQA are:
  - To improve software quality by appropriately monitoring both the software and the development process that produces it
  - To ensure full compliance with the established standards and procedures for the software and the software process
  - To ensure that any inadequacies in the product, the process, or the standards are brought to management's attention so these inadequacies can be fixed

The Goal of SQA

- To be effective, SQA needs to work closely with development.
- SQA need to understand the plans, verify their execution, and monitor the performance of the individual tasks.
- If the development people view SQA as the enemy, it will be hard for them to be effective.
- The key is an SQA attitude of cooperation and support.

The Role of SQA

- The people responsible for the software projects are the only ones who can be responsible for quality.
- The role of SQA is to monitor the way these groups perform their responsibilities.

SQA Responsibilities

- SQA can be effective when they report through an independent management chain, when they are properly staffed with competent professionals, and when they see their role as supporting the development and maintenance personnel in improving product quality.
- When all these conditions are met, SQA can help remove the major inhibitors to producing quality software.

SQA Responsibilities

- Review all development and quality plans for completeness
- Participate as inspection moderators in design and code inspections
- Review all test plans for adherence to standards
- Review a significant sample of all test results to determine adherences to plans
- Periodically audit SCM (Conf. Mgmt.) performance to determine adherence to standards
- Participate in all project quarterly and phase reviews and register non-concurrence if the appropriate standards and procedures have not been reasonably met

SQA Responsibilities

- Example Items for SQA Review [Table 8.1]

SQA Functions

- In establishing an SQA function, the basic organizational framework should include the following:
  - Quality Assurance (QA) practices
  - Software project planning evaluation
  - Requirements evaluation
  - Evaluation of the design process
  - Evaluation of coding practices
  - Evaluating the SW integration and test process
  - In-process evaluation of the management and project control process
  - Tailoring of Quality Assurance (QA) procedures.

SQA Functions

- Sample SQA Tasks by Program Phase [Table 8.2]

SQA Reporting

- The one simple rule on SQA reporting is that it not be under the software development manager.
- SQA should report to a high-enough management level to have some chance of influencing priorities and obtaining the resources and time to fix the key problems.
- Reporting level, however, is a trade-off.
- Since there is no simple solution that meets all needs, a specific reporting level decision should be made for each organization.

Launching the SQA Program

- The essential first step in establishing an SQA function is to secure top management agreement on its goals.
  - Since the senior managers must resolve all major SQA issues, they must agree in advance on the basis for doing so.
  - If they do not, SQA cannot be effective.

Launching the SQA Program

- Eight steps for launching an SQA program:
  - Initiate the SQA program
  - Identify SQA issues
  - Write the SQA plan
  - Establish standards
  - Establish the SQA function
  - Conduct training and promote the SQA program
  - Implement the SQA plan
  - Evaluate the SQA program

Launching the SQA Program

- In producing the SQA plan, a statistically sound sampling approach is essential.
- It is generally not practical for SQA to review every development action or product item, so the plan should identify the sampling system that will most effectively use the available SQA resources.

Launching the SQA Program

- Possible sampling methods
  - Ensure that all required design and code inspections are performed, and participate (possibly as monitor) in a selected set
  - Review all inspection reports and analyze those outside of established control limits
  - Ensure that all required tests are performed and test reports produced
  - Examine a selected set of test reports for accuracy and completeness
  - Review all module test results and further study the data on those modules with test histories that are outside of established control limits

The SQA Plan

Each development and maintenance project should have a Software Quality Assurance Plan (SQAP) that specifies its goals, the SQA tasks to be performed, the standards against which the development work is to be measured, and the procedures and organizational structure.

The SQA Plan

- Software Quality Assurance Plan (SQAP)
  - Purpose
  - Reference documents
  - Management
  - Documentation
  - Standards, practices, and conventions
  - Reviews and audits
  - SW configuration management
  - Problem reporting and corrective action
  - Tools, techniques, and methodologies
  - Code control
  - Media control
  - Supplier control
  - Records collection, maintenance, and retention

The SQA Plan

- The section on standards, practices, and conventions specifies a minimum content of:
  - Documentation standards
  - Logic structure standards
  - Coding standards
  - Commentary standards

The SQA Plan

- Suggested SQAP Documentation [Table 8.3]
  - The SW Requirements Specification
  - The SW Design Description
  - The SW Verification and Validation Plan
  - The SW Verification and Validation Report
  - User Documentation
  - Other

The SQA Plan

- The Software Quality Assurance Plan (SQAP) section on reviews and audits should describe both technical and the managerial reviews and audits to be conducted.
  - The IEEE standard includes the items shown in Table 8.4.

The SQA Plan

- Examples of SQAP Reviews and Audits [Table 8.4]
  - Software Requirements Review
  - Preliminary Design Review
  - Critical Design Review
  - Software Verification and Validation Review
  - Functional Audit
  - Physical Audit
  - In-Process Audits
  - Managerial Reviews

SQA Considerations

- Many SQA organizations fail to have much impact on software quality.
- Common reasons to fail:
  - SQA organization are rarely staffed with sufficiently experienced or knowledgeable people.
  - The SQA management team is often not capable of negotiating with development.
  - Senior management often backs development over SQA on a large percentage of issues.
  - Many SQA organizations operate without suitably documented and approved development standards and procedure.
  - Software development groups rarely produce verifiable quality plans.

SQA People

- Getting good people into SQA is one of the most difficult problems software managers face.
- One effective solution is to require that all new development managers be promoted from SQA.
- This would mean that potential managers would spend six months to a year in SQA before being promoted into management back in their home departments.
  - Extreme measure, but effective

SQA People

- For SQA to be effective, they much have good people and full management backing.

Independent Verification and Validation

- In DoD contracts, it is often common to have a separate Independent Verification and Validation (IV&V) organization involved.
- Its role is to provide an independent monitor of the development or maintenance organization's performance.
- While there can easily be confusion regarding the relative roles of IV&V and SQA, the distinction should be clear.

Independent Verification and Validation

- Development management uses SQA to monitor its own organization and to ensure that established standards and procedures are followed.
- IV&V does essentially the same thing for the customer.
- One of the important IV&V role is to ensure that the customer's needs are adequately reflected in the work.

Independent Verification and Validation

- Another important difference between IV&V and SQA is that IV&V can and should capitalize on the existence of SQA.
- If SQA is working effectively, IV&V need not duplicate its work, and if it is not, IV&V must not try to replace it.
- Their role is to highlight this shortcoming and to get it fixed

Independent Verification and Validation

- The crucial role of IV&V is to ensure that the right skills and attitudes are in place.
- While they should also review the standards and procedures, they must look beyond them to see if a first-class SW engineering job is being done and if the key risks and feasibility issues are being addressed.

Independent Verification and Validation

- SQA and IV&V Activities [Table 8.5]
  - DeMillo has studied the performance of several DoD contractors on the respective roles of SQA and IV&V.
  - SQA is more involved in the internal working of the contracting organization, while IV&V tends to look more at application-related issues.

References

Humphrey, Watts S., *Managing the Software Process*, The SEI Series in Software Engineering, Addison-Wesley, 1989. (29th Printing, May 2003) (ISBN 0-201-18095-2)