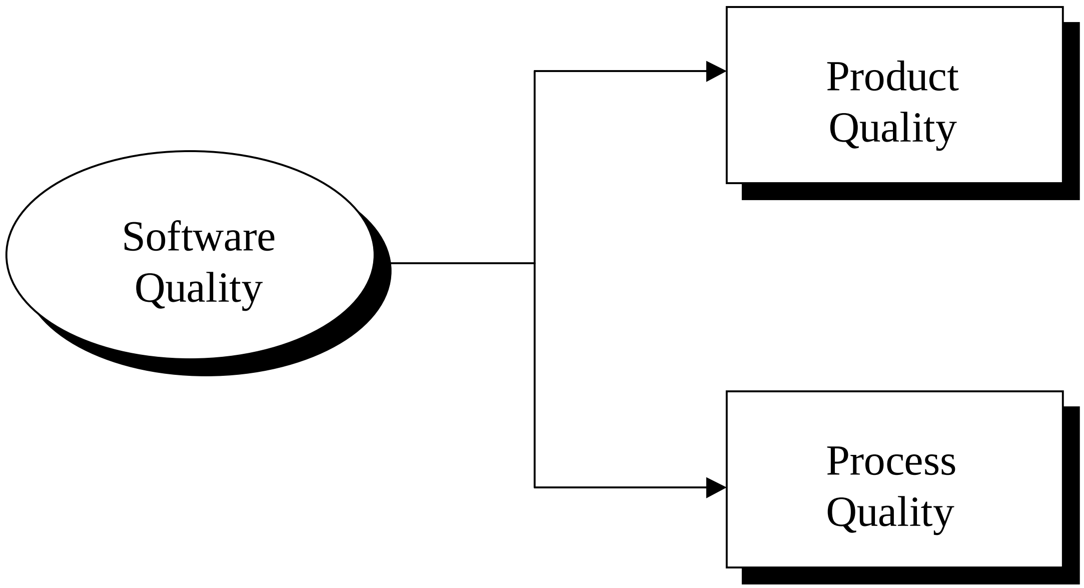
# Aims of the LHCb Architecture Review

## Outline Of Talk

- Software quality…some principles
- Architecture Review Goals
- Scenarios
- Software Architecture Analysis Method (SAAM)
- Questionnaires and checklists
- Conducting the review in practice
  - preparation
  - participation
  - documents to be reviewed
  - the inspection itself
  - output of the review

# Software Quality




•documents
•designs
•code
•tests

•techniques
•tools
•people

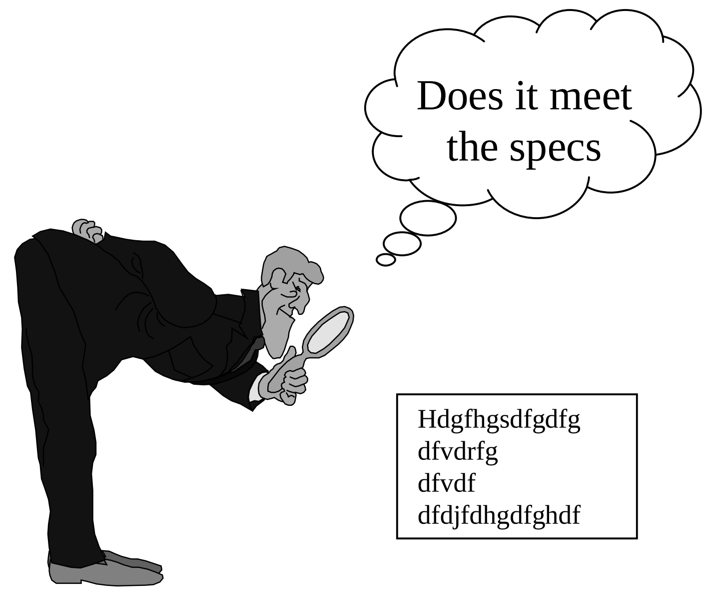
- ❑ Different stakeholders see quality in different terms :
  - ➢ End user …do job better, faster, easier
  - ➢ Developer …few defects, error free at delivery
  - ➢ Maintainer …understandable, testable, modifiable
- ❑ You can't achieve quality unless you specify it

# Quality - as measured by the user

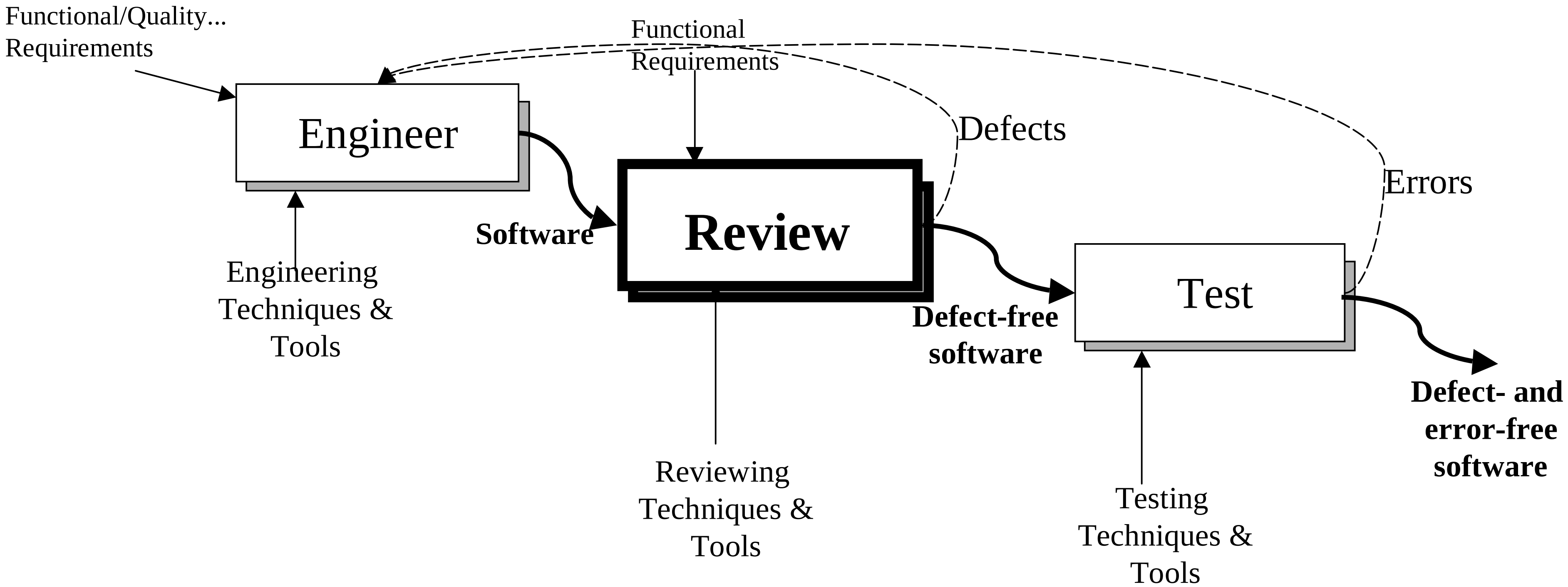
| | |
|---|---|
| **Correctness** | does software do what its supposed to? |
| Efficiency | how many resources are needed? |
| **Expandability** | how easy is it to expand software? |
| **Flexibility** | how easy is it to change it? |
| Integrity | how secure is it? |
| **Interoperability** | does it interface easily? |
| **Maintainability** | how easy is it to repair? |
| Manageability | is it easily managed? |
| Portability | how easy is it to transport? |
| **Usability** | how easy is it to use? |
| Reliability | how often will it fail? |
| **Reusability** | is it reusable in other systems? |
| Safety | does it prevent hazards? |
| Survivability | Can it survive during failure? |
| **Verifiability** | can it be tested? |

# What is a review ?

- A Review is one of three steps in quality life-cycle
  - Step 1 : ***Engineer*** **-** build-in quality
  - Step 2 : ***Review*** **-** shake out major defects
  - Step 3 : ***Test*** **-** eradicate remaining errors



# What is a Review ?




**N.B. Software means Design + Code**

# Architecture Review Goals

- Evaluate early  and carefully before it becomes a blueprint for software
- Input to review is the description of the architecture
  - assignment of functionality, nature of interfaces
  - exact contents depend on, or will determine, what aspect is to be assessed e.g.
    - performance - ***task and communication structure***
    - modifiability - ***component structure*** and ***work assignments***
- Point out places where architecture fails to meet requirements and show alternative designs that would work better.
- Determine where finer-grain depictions of architecture are needed
- Ensure consistency across entire system
- Disseminate ideas on what constitutes a good architecture
    - better understanding, deeper insights on architecture
- Determine whether can proceed to next stage of development
- Reapply - put in regular use

# Review Techniques - Scenarios

- Quality attributes don't have a meaning in isolation but only within a context
- Context based evaluation is most effective - use scenarios
- Each scenario is a brief description of a single interaction of a stakeholder with a system
  - e.g. operator : "I want to change background colour on all windows to blue"
- Evaluation process revolves around characterising an architecture in terms of how well it supports those scenarios that represent the stakeholders' overriding concerns.
- The total number of scenarios must be manageable, so they must be chosen carefully. Need a selection process
  - brainstorming
  - refine and select - mark, cluster by subject, rank, merge or delete

# Software Architecture Analysis Method (SAAM) -I

- 1 - Develop scenarios
  - illustrate kind of **functions** system must support
  - illustrate kinds of **changes** you anticipate will be made to system
  - capture all important **uses** of system
  - capture all important **users** of system
  - capture all important **qualities** system must satisfy
  - Is each design module correlated with a scenario?
  - Is each major requirement correlated with a scenario?
- 2 - Describe candidate architecture
  - use well understood notation (by reviewers as well)
  - **static** - must cover computation and data components, and their connections
  - **dynamic** - must cover behaviour with time

# Software Architecture Analysis Method (SAAM) - II

- 3 - Classify scenarios
  - **direct** - architecture directly supports scenario
  - **indirect** - change to system needed that can be represented architecturally
  - degree of modification must be captured when evaluating a system's response to a scenario.
- 4 - Perform scenario evaluations
  - For each scenario, the changes to the architecture required to support it must be listed, and the cost of making change estimated
    - addition of a new component
    - change in specification of existing component
  - Produce summary table
    - for each scenario describe impact on architecture
    - weight degree - coarse grained e.g. major, minor; useful if comparing architectures

# Software Architecture Analysis Method (SAAM) - III

- 5 - Reveal Scenario interaction
  - reveal components that are the focus of too many changes
  - when 2 or more indirect scenarios require changes in a single component they are said to **interact** in that component.
  - Interaction of semantically unrelated scenarios shows which components are implementing semantically unrelated functions - indicates poor cohesion

# Capture Results of Review

- Scenario Summary Table

| *Scenario* | *Description* | *Direct/ Indirect* | *Changes Required* |
|---|---|---|---|
| 1. | Compare new file representations | Indirect | Mods to *diff* and *vsdiff* |
| …. | | | |

- Scenario interactions by module

| *Module* | *Number of changes* |
|---|---|
| Main | 2 |
| Algorithm factory | 7 |
| Event selector | 1 |

  - Algorithm factory
    - scenarios all of same class - good sign…functionality sensibly allocated
    - scenarios different but component can be further subdivided…OK refine arch.
    - scenarios different classes and component cannot be subdivided..too complex

# Review techniques - Questioning

- Scenario-based : such as SAAM
- Questionnaire-based : list of general and open questions that apply to all architectures
  - way architecture was generated
    - is there a project architect?
    - Is a standard description language used?
  - Details of architecture description itself
    - are user interface aspects separated from functional aspects
  - Utility is related to ease with which domain can be characterised
- Checklist-based
  - detailed set of questions after experience analysing common set of systems
  - usually domain specific
- Scenarios are usually system specific, can grow to others after experience
  - what happens when divide by zero occurs? (scenario)
  - is there error recovery code (checklist)

# Review Stages

- Preparation
  - select right people
  - circulate review documents in advance
  - individual review of documentation
- Inspection
  - questions asked and errors found should be recorded in a database
  - statistics accumulated
- Re-work
  - designers rectify defects
- Follow-up
  - verify that the rework has been done

# Preparation of Review

- Scope must be kept under control
- Firstly have architecture discovery review
  - held early, lightweight, before architectural decisions set in stone
  - expect people to be receptive to changes
- Have in mind set of specific goals, which should be enumerated
- Documents related to the project distributed before it takes place
  - need a project librarian to prepare this
- Organisational expectations
  - who will be told what as a result of review (developers, managers, reviewers)
- Need a detailed but flexible agenda for the inspection

# Present during the Inspection

- ❑ Moderator - runs the meeting
  - ➢ John
- ❑ Reader - paraphrases the design
  - ➢ Pere
- ❑ Reviewers - questions the reader when necessary
  - ➢ Christian, RD, Lassi, Vincenzo, Dirk
- ❑ Recorder - notes down details on special forms
  - ➢ Marco
- ❑ Development team - must play passive role i.e. only answer questions
  - ➢ Pavel, Markus, Florence, Andrei, Rado, Iain
- ❑ Total 14 people
- ❑ What about users of system?

# Documents to be reviewed

- Materials that describe the architecture
  - component model, assignment of functionality, definition of interfaces
  - message trace diagrams demonstrating dynamic behaviour
  - rational behind key architectural decisions taken (e.g. transient vs persistent, converters)
- A ranking of the most important (5-10) quality and functional requirements of the system
  - if required, additional attributes can be expressed but labelled as essential or desirable
- List of scenarios
  - clustered according to attribute under test
  - coverage of stakeholders interests, all aspects of model
- Any checklists or questionnaires to be used during inspection
- Descriptions of prototypes (if they exist)
  - test suitability of user interface, give feedback on performance issues
- Project Plan
  - work breakdown structure and assignment to individuals

# Review activities - I

- Understand essential functions of system and see how each function is unambiguously defined in architecture design documents.
- Make sure that there are written requirements in all key areas
- Check that system acceptance criteria exist
- To evaluate performance related and other goals need to know:
  - workload information …number of concurrent users, request rates etc.
  - execution paths, expectation of execution of each component, repetitions, protocol for contention resolution
  - environmental information
- To evaluate resource utilisation need information on
  - cpu utilisation, i/o activity, database accesses, memory usage

# Review activities - II

- To evaluate modifiability best done with questioning techniques to reveal how vulnerable architecture is to specific modifications.
- Warning signs of problems are :
  - architecture forced to match current organisation
  - top level components number more than 25
  - one requirement drives rest of design
  - architecture depends on alternatives in OS
  - proprietary components are being used where standard components would do
  - component definition comes from hardware builder
  - redundancy not needed for relaibility (e.g. 2 databases, 2 error handling components)
  - design is exception driven I.e. emphasis on extensibility and not core commonalities
  - no architect for the system

# Review Output

- Categorised and ranked issues are formally documented
- Formal report delivered to review sponsor and participants
- Review process should be documented and aggregated output of several reviews should be collected and used to devise improvements and for training.