Software Quality Engineering:

Testing, Quality Assurance, and Quantifiable Improvement

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Chapter 14. Inspection

- Basic Concept and Generic Process
- Fagan Inspection
- Other Inspection and Related Activities
- Other Issues

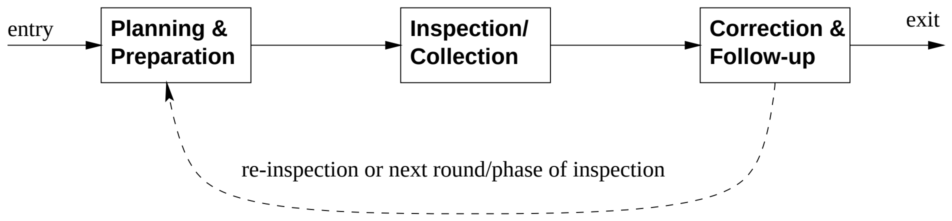
QA Alternatives

- Defect and QA:
  - ▷ Defect: error/fault/failure.
  - ▷ Defect prevention/removal/containment.
  - ▷ Map to major QA activities
- Defect prevention:
  Error blocking and error source removal.
- Defect removal:
  - ▷ Inspection – this chapter.
  - ▷ Testing, etc.
- Defect containment: Fault tolerance and failure containment (safety assurance).

Inspection as Part of QA

- Throughout the software process
  - ▷ Coding phase: code inspection
  - ▷ Design phase: design inspection
  - ▷ Inspection in other phases and at transitions from one phase to another
- Many different software artifacts:
  - ▷ program code, typically
  - ▷ requirement/design/other documents
  - ▷ charts/models/diagrams/tables/etc.
- Other characteristics:
  - ▷ People focus.
  - ▷ Not waiting for implemented system.
  - ▷ Complementary to other QA activities.

Generic Inspection Process



- Generic process/steps: Fig 14.1 (p.238)

1. Planning and preparation (individual)

2. Collection (group/meeting)

3. Repair (followup)

Inspection Process Variations

- Overall planning:
  - ▷ who? team organization/size/roles/etc.
  - ▷ what? inspection objects
  - ▷ objectives?
  - ▷ number/coordination of multiple sessions?
- Technique
  - ▷ for preparation (individual inspection)
  - ▷ for collection
- What to do with defects?
  - ▷ always: detect and confirm defects
  - ▷ classify/analyze defects for feedback?
- Use of post-collection feedback?

Fagan Inspection

- General description
  - ▷ Earliest, Fagan at IBM
  - ▷ Lead to other variations
  - ▷ Generic process and steps

- Six steps of Fagan inspection:
  1. Planning
  2. Overview (1-to-n meeting)
  3. Preparation (individual inspection)
  4. Inspection (n-to-n meeting)
  5. Rework
  6. Follow-up

- Mapping to generic inspection process in Fig 14.1 (p.238)

Fagan Inspection

1. Planning
   - ▷ Entry criteria: what to inspect
   - ▷ Team size: about 4 persons
   - ▷ Developers/testers from similar projects
   - ▷ Effectiveness concerns (assumptions)
   - ▷ Inspectors not authors

2. Overview
   - ▷ Author-inspectors meeting
   - ▷ General background information
     – functional/structural/info., intentions
   - ▷ Assign individual tasks:
     – coverage of important areas
     – moderate overlap

Fagan Inspection

3. Preparation or individual inspection
   - ▷ Independent analysis/examination
   - ▷ Code as well as other document
   - ▷ Individual results:
     - – questions/guesses
     - – potential defects

4. Inspection (generic: collection)
   - ▷ Meeting to collect/consolidate individual inspection results
   - ▷ Team leader/meeting moderator (1)
   - ▷ Reader/presenter: summarize/paraphrase for individual pieces (assignment)
   - ▷ Defect identification, but not solutions, to ensure inspection effectiveness
   - ▷ No more than 2 hours
   - ▷ Inspection report

Fagan Inspection

5. Rework
   - ▷ Author's response
   - ▷ Defect fixing (solutions)

6. Follow-up
   - ▷ Resolution verification by moderator
   - ▷ Re-inspection?

- Fagan inspection in practice
  - ▷ Widely used in industry
  - ▷ Evaluation studies
  - ▷ Variations and other inspections

Fagan Inspection: Findings

- Importance of preparation:
  - ▷ Most defect detected
  - ▷ Meetings to consolidate defects
  - ▷ $\Rightarrow$ alternatives focusing on preparation.

- Other important findings:
  - ▷ Important role of the moderator
  - ▷ Team size and #sessions tailored to env.
  - ▷ Prefer systematic detection techniques to ad-hoc ones
  - ▷ More use of inspection feedback/analysis

Other Inspection Methods

- Variations to Fagan inspection:
  size/scope and formality variations.

- Alternative inspection techniques/processes:
  - ▷ Two-person inspection
  - ▷ Meetingless inspections
  - ▷ Gilb inspection
  - ▷ Phased inspections
  - ▷ N-fold inspections
  - ▷ Informal check/review/walkthrough
  - ▷ Active design reviews
  - ▷ Inspection for program correctness
  - ▷ Code reading
  - ▷ Code reading with stepwise abstraction

Reduced Size/Scope Inspection

- Two-person inspection
  - ▷ Fagan inspection simplified
  - ▷ Author-inspector pair
    – reciprocal: mutually beneficial
  - ▷ Smaller scale program

- Meetingless inspections
  - ▷ Importance of preparation (indiv. insp.)
    (most defects found during preparation)
  - ▷ Empirical evidence
  - ▷ 1-on-1 instead of team meetings
    (or other feedback mechanisms)

Gilb Inspection (Expanded Fagan)

- Key: A "process brainstorming" meeting
  - ▷ root cause analysis
  - ▷ right after inspection meeting
  - ▷ parallel to edit (rework)
  - ▷ aim at preventive actions/improvement
- Other characteristics
  - ▷ Clearly identified input, checklists/rules extensively used
  - ▷ Output include change request and suggested process improvement, in addition to inspected documents.
  - ▷ Team size: 4-6 people.
  - ▷ More emphasis on feedback loop: more closely resemble our SQE process (Fig 5.1, p.54)

Other Expanded Fagan Inspections

- Phased inspections
  - ▷ Expand Fagan inspection
  - ▷ Multiple phases/meetings
  - ▷ Each on a specific area/problem-type
  - ▷ Dynamic team make-up
- N-fold inspections
  - ▷ Idea similar to NVP
  - ▷ N parallel inspections, 1 moderator
  - ▷ Duplications $\Rightarrow$ cost$\uparrow$
  - ▷ Discussed in connection to NVP (Ch.16)

Informal Inspection

- Desk check (self conducted):
  - ▷ Should focus on conceptual problems
  - ▷ Use tools for problems with syntax/spelling/format/etc.
- Informal review (by others):
  - ▷ Similar to desk check, but by others
  - ▷ Benefit from independent/orthogonal views
  - ▷ Group reviews for phase transitions
- Walkthroughs:
  - ▷ More organized, but still informal
  - ▷ Leading role of author/moderator
  - ▷ Less preparation by other participants than in inspection

Formal Inspection: Code Reading

```
input($x$);
if($x > 0$) then
    $y \leftarrow x$;
else
    $y \leftarrow -x$;
output($y$);
```

```
    $y \leftarrow x$;
if($x > 0$) then
else
output($y$);
    $y \leftarrow -x$;
input($x$);
```

- Program comprehension: Fig 14.2 (p.245)
  - ▷ a program (left) and its permutation (right)
  - ▷ different effort in comprehension
  - ▷ different recall accuracy
  - ▷ experience factor (expert vs novice)

- Related to top-down design and code reading/abstraction (bottom-up)

Formal Inspection: Code Reading

- Code reading
  - ▷ focus on code
  - ▷ optional meetings
- Code reading by stepwise abstraction
  - ▷ basis: program comprehension studies
  - ▷ variation to code reading
    - – formalized code reading technique
  - ▷ top-down decomposition and bottom-up abstraction
  - ▷ recent evidence of effectiveness

Formal Inspection: ADR & Correctness

- Active design reviews (ADR)
  - ▷ Another formal inspection, for designs
  - ▷ Inspector active vs. passive
  - ▷ Author prepares questionnaires
  - ▷ More than one meeting
  - ▷ Scenario based (questionnaires)
  - ▷ Overall ADR divided into small ones
  - ▷ 2-4 persons (for each smaller ADR)

- Inspection for program correctness
  - ▷ Correctness (vs. questionnaire) of:
    - – topology (decomposition, hierarchy)
    - – algebra (equivalence of refinements)
    - – invariance (variable relations)
    - – robustness (error handling)
  - ▷ Close to formal verification

Extending Inspection: Analysis

- Inspection as analysis
  - ▷ Program/document/etc. analysis
  - ▷ Inspection as statics analysis
  - ▷ Testing as dynamic analysis

- Other analyses
  - ▷ Static: algorithm, decision table, boundary value, control flow, data flow, etc.
  - ▷ Dynamic: symbolic execution, simulation, prototyping, timing, in-field execution, etc.
  - ▷ Covered in SQE (various chapters), with pointers in Section 14.3.5.
  - ▷ Detailed reference: Wallace et al 1996 (NIST Special Publication 500-234) available online

Defect Detection Techniques

- Ad-hoc vs. systematic ones below: checklist-/scenario-/abstraction-based.

- Checklist-based inspection:
  - ▷ Similar to testing checklists (Ch.8).
  - ▷ Basic types: artifact-/property-based.

- Scenario-based inspection:
  - ▷ Similar to usage-based testing.
  - ▷ Scenarios ties multiple components.
  - ▷ More a usage/external view.
  - ▷ Suitable for OOS.

- Abstraction-based inspection: Similar to code reading with stepwise abstraction.

Implementation and Effectiveness

- Implementation support:
  - ▷ Process and communication support
  - ▷ Repository management tools
  - ▷ Defect tracking and analysis as followup
  - ▷ Still human intensive

- Effectiveness studies
  - ▷ Measurement: defect or effort
  - ▷ Defect detection technique important
  - ▷ Inspector skills/expertise also important
  - ▷ Other factors, less than unanimous
  - ▷ Many individual variations

Summary

- Key advantages:
  - ▷ Wide applicability and early availability
  - ▷ Complementary to testing/other QA
  - ▷ Many techniques/process to follow/adapt
  - ▷ Effective under many circumstances

- Key limitations:
  - ▷ Human intensive
  - ▷ Dynamic/complex problems and interactions: Hard to track/analyze.
  - ▷ Hard to automate.

- Comparison to other QA: Chapter 17.