

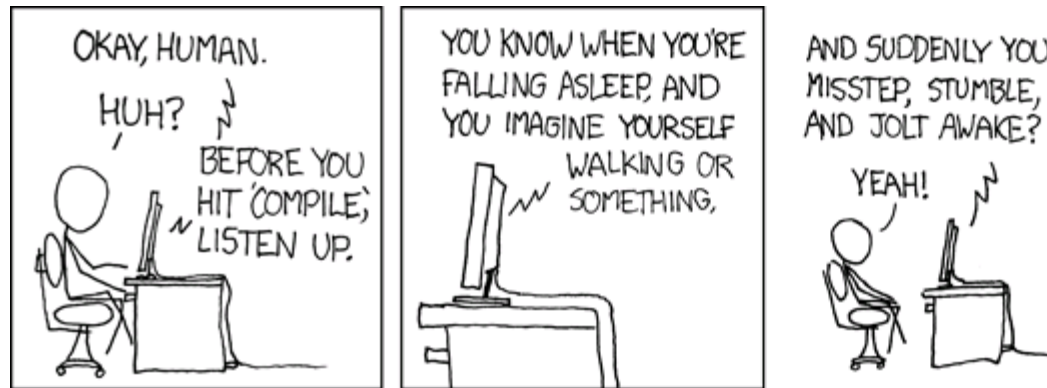
Analysis of Software Artifacts

Inspection

Jonathan Aldrich

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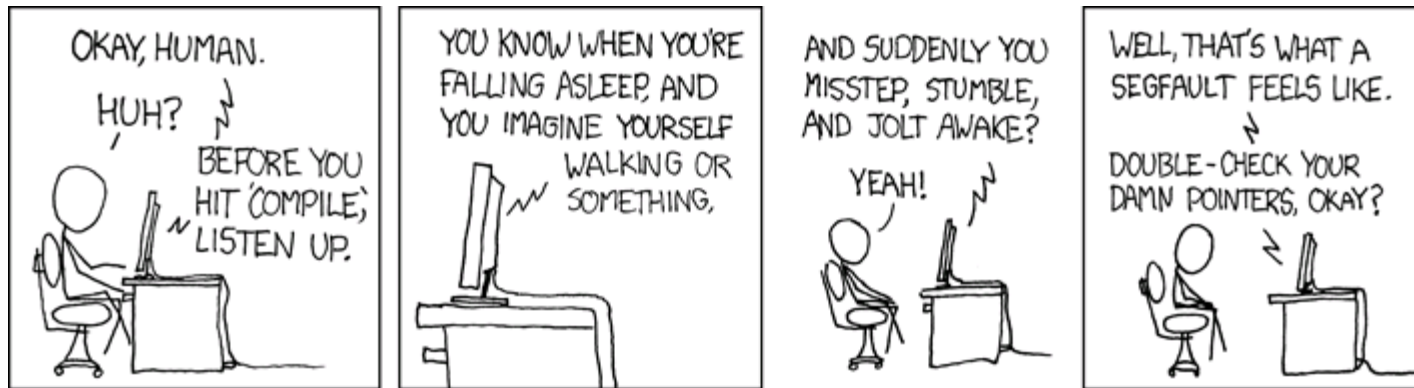
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Inspection – The Big Questions

- 1. What is inspection?**
 - And what are the benefits?
- 2. When are inspections better than testing?**
 - What kind of attributes?
 - What is the typical experience of firms with inspection?
- 3. Are there different kinds of inspections?**
 - What are the relative benefits of each?
- 4. Who are the inspection participants?**
 - Roles played and their benefits
- 5. How is the inspection process accomplished?**
 - What are summary guidelines for the meetings?
- 6. What gets inspected?**
 - And when to do inspections?

Software Inspections

1. What are software inspections (reviews)?

- Meetings (real or virtual) during which designs and code are reviewed by people other than the original developer.
- What are the benefits of inspections?
 - New perspective
 - Finding defects may be easier for people who haven't seen the artifact before and don't have preconceived ideas about its correctness
 - Knowledge sharing
 - Regarding designs and specific software artifacts
 - Regarding defect detection practices
 - Find flaws early
 - Can dramatically reduce cost of fixing them
 - During detail design – even before code is written
 - Or code that does not yet have a test harness
 - Or code in which testing has found flaws but root causes are not understood
 - Reduce rework and testing effort
 - Can reduce overall development effort

Source material
Peer Reviews in Software: A Practical Guide.
Karl E. Wieggers.
Additional material from William Scherlis.

Inspections vs. Testing

2. What attributes are well-handled by inspections but not testing?

- Characteristics of code
 - Maintainability, evolvability, reusability
- Other properties tough to test
 - Scalability, efficiency
 - Security, integrity
 - Robustness, reliability, exception handling
- Requirements, architecture, design documents
 - Cannot “execute” these as a test

Experience with inspection

- Raytheon
 - Reduced "rework" from 41% of cost to 20% of cost
 - Reduced effort to fix integration problems by 80%
- Paulk et al.: cost to fix a defect in space shuttle software
 - \$1 if found in inspection
 - \$13 during system test
 - \$92 after delivery
- IBM
 - 1 hour of inspection saved 20 hours of testing
 - Saved 82 hours of rework if defects in released product
- IBM Santa Teresa Lab
 - 3.5 hours to find bug with inspection, 15-25 through testing
- C. Jones
 - Design/code inspections remove 50-70% of defects
 - Testing removes 35%
- R. Grady, efficiency data from HP
 - System use 0.21 defects/hour
 - Black box 0.28 defects/hour
 - White box 0.32 defects/hour
 - Reading/inspect 1.06 defects/hour

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 - Reading/inspect 1.06 defects/hour
- **Your mileage may vary**
 - Studies give different answers
 - These results show what is possible

Kinds of Inspections

Inspections / Formal Technical Reviews

- Participation defined by policy
 - Developers
 - Designated key individuals – peers, QA team, Review Board, etc.
- Advance preparation by participants
 - Typically based on checklists
- Formal meeting to discuss artifact
 - Led by moderator, not author
 - Documented process followed
 - May be virtual or conferenced
- Formal follow-up process
 - Written deliverable from review
 - Appraise product

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Walkthroughs

- No advance preparation
- Author leads discussion in meeting
- No formal follow-up
- Low cost, valuable for education

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There are tradeoffs among the techniques

- Formal reviews typically find more bugs
 - Ford Motor: 50% more bugs found
- But they also cost more

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Review Roles: **Moderator** and **Recorder**

4. Who are the stakeholders in inspection?

Moderator

- Organizes review
 - Keeps discussion on track
 - Ensures follow-up happens
- Key characteristics
 - Good facilitator
 - Knowledgeable
 - Impartial and respected
 - Can hold participants accountable and correct inappropriate behavior

Recorder

- Captures a log of the inspection process

Review Roles: Reader

Reader

- Presents material
 - Describes interpretation of each point
 - Discuss different interpretations by other team members
- Why should the Reader be different from the Author?
 - Reveals ambiguities
 - If author were to present, others might not mention that their interpretation was different
- Why not just ask for comments section by section?
 - Can be faster
 - Downside: does not capture differing perspectives as effectively

Review Roles: Author

Author

- Describes rationale for work
- Not moderator or reader
 - Conflict between objectivity required of moderator/reader and advocacy for the author's own work
 - Others raise issues more comfortably
- Not recorder
 - Temptation to not write down issues the author disagrees with
- Why should the Author attend? Are there downsides?

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- Why should the Author attend? Are there downsides?
 - Gain insight from others' perspectives
 - Can answer questions
 - Can contribute to discussion based on knowledge of artifact
 - Potential downside: meeting may be confrontational

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Process: Planning

5. How is the inspection process accomplished?

Planning

- Determine objectives
- Choose moderator
- Identify inspectors
 - Good to involve people with connection to artifact
 - e.g. depends on, interfaces with
- Schedule meeting(s)
 - General guideline: 150-200 SLOC/hour, or 3-4 pages/hour
- Prepare and distribute inspection package
 - Deliverable, supporting docs, checklists
 - Cross-reference specs, standards

Process

Overview meeting

- Informal meeting
- Goal: go over features, assumptions, background, context
- Optional stage
 - May be able to use paper overview or shared context

Preparation (*Why?*)

- Inspectors examine deliverable
 - Defects: cause an error in the product
 - Non-defects: improvements, clarification, style, questions
 - May want to list typos/spelling/format/style separately and not discuss during the meeting
 - Conformance to standards & specification
 - Often use checklist
- General guideline
 - prep time ~ meeting time

Process: Meeting

The Meeting

- *Reader* describes one segment at a time
 - *Inspectors* respond: defects, questions, suggestions
- *Recorder* writes down each defect, suggestion, issue
 - This is the primary deliverable
- *Moderator*
 - Avoid problem solving (*why?*), inappropriate behavior, lack of participation
 - At conclusion: prepares report with appraisal and data
- Outcomes: Appraisal of product
 - Accepted (minor changes, no follow up)
 - Accepted conditionally (minor changes, verification)
 - Reinspect following rework (major changes)
 - Inspection not completed
- Outcomes: Input on improving inspection process

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- *Variant*: reviewers make comments on electronic bulletin board
 - Cost is lower
 - Lose benefits of direct meeting (face to face, telephone)
 - Synergy - new bugs found (4%? 25%?)
 - Learning by participants
 - Communication about product

Process: Rework and Follow-up

Follow-up by author

- *Author* addresses each item
 - Ensure understanding of issue
 - Is it a defect or not? Is it a feature request or requirement change?
 - Fixes defects and makes improvements
 - Uncorrected/unverified defects go into defect tracking system
- Deliverables
 - Corrected work product
 - Response to each issue and rationale for action
- Moderator (or verifier) meets with author
 - Check resolution of issues
 - Examine corrected deliverable
- Author checks in code

Process: Analysis

Analysis

- Causal analysis
 - Analyze root causes of defects
- Make improvements to development and QA processes
 - Add issue to checklist
 - Change testing approach
 - Develop or purchase new static analysis
- Measuring effectiveness
 - Percentage of bugs found during inspection
 - vs. found by other means or afterwards (test, customer)
- Measuring efficiency
 - “Defects per hour”
 - Will decrease as your process improves

Meetings: Review Guidelines

- Build reviews into your schedule
 - Otherwise unexpected and viewed as intrusion
 - Recognize that reviews can accelerate schedule by reducing other V&V activities
- Keep review team small
 - General guidelines: 3-7 participants
 - 3 is minimum for formal process to work
 - Below 3, too few perspectives besides author
 - Above 7, work may be slowed by process, scheduling
 - Smaller groups for code, larger groups for other documents
 - Knowledge is spread around more, more stakeholders
 - Particular for requirements
- Find problems, but don't try to solve them
 - Typically less expensive to address 1-on-1
 - Guideline: halt solution discussion after 1-3 minutes
- Limit meetings to 2 hours maximum
 - Attention span gets lost beyond this
- Require advance preparation
 - Provides much of the value of a (formal) review

Discussion: Checklists

- What makes a good checklist?
 - Illustrate the principle with an example checklist item
- Principles
- Examples

Checklist Items from the Web

- Specification
 - Is documentation complete, including DBC or Error checking specs as appropriate?
- Design
 - Can better data structures or more efficient algorithms be used?
 - Are error messages comprehensive and provide guidance as to how to correct the problem?
 - Is there duplicate code that could be replaced by a call to a function that provides the behavior of the duplicate code?
 - Do any derived classes have common members that should be in the base class?
- Coding
 - Have all array (or other collection) indexes been prevented from going out-of-bounds?
 - Is integer arithmetic, especially division, used appropriately to avoid causing unexpected truncation/rounding?
 - Are all files closed properly, even in the case of an error?
 - Are all object references initialized before use?
 - In a switch statement, are all cases by break or return?
 - Are all objects (including Strings) compared with "equals" and not "=="?
- Style
 - Are descriptive variable and constant names used in accord with naming conventions?
 - Are there literal constants that should be named constants?
- I think the above are good examples (but not comprehensive). Sources:
 - <http://users.csc.calpoly.edu/~jdalbey/205/Resources/InspectChecklist.html>
 - <http://undergraduate.csse.uwa.edu.au/units/CITS2220/assign2/JavaInspectionCheckList.pdf>

Customizing Checklists

- What should be included in a checklist for a:
 - Operating system?
 - Online store?
 - Word processor?
 - Aircraft flight control system?
 - Real-time system?
 - Concurrent system?

Meetings: Checklists

- Benefits of checklists
 - Focus on likely sources of error
 - Form quality standard that aids preparers
 - Can bring up issues specific to a product
- Should be short
 - About seven items
 - If more, group and do multiple passes
- Focus
 - Priority issues
 - Issues unlikely to be found other ways
 - Historical problems
 - Issues specific to the document
- Start with checklist from well-known source
 - Refine based on experience
- Pitfall: overemphasis on style issues
 - It's good to find style issues in inspections, but other issues are higher priority – specification, design, correctness, security, ...

People: Social Aspects of Reviews

- Reviews are challenging
 - Authors invest self-worth in product
 - Encourages you to avoid letting others find errors
- For Authors
 - Recognize value of feedback
 - Place value in making code easy to understand
 - Don't take criticism of code personally
- For reviewers
 - Don't show off how much better/smarter you are
 - Be sensitive to colleagues
 - Bad: "you didn't initialize this variable"
 - Good: "I didn't see where this variable was initialized"

Review Pitfalls

- Letting reviewers lead the quality process
 - Attitude: “why fix this, the reviewers will find it“
 - Responsibility for quality is with author, not reviewers
 - Reviewers help
- Insisting on perfection/completion before review
 - Makes harder to accept suggestions for change
- Using review statistics for HR evaluation
 - Real world example:
 - Manager decides "finding more than 5 bugs during an inspection would count against the author" [Weigers '02]
 - Negative effects
 - Avoid submitting for inspection
 - Submit small pieces at a time
 - Avoid pointing out defects in reviews (thus missing them)
 - Holding "pre-reviews" that waste time and skew metrics

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What to Inspect

- *First*, requirements documents; *second*, design documents
 - Difficult to validate in other ways
 - May have high associated risk
 - Especially important to get right
 - Cheaper to fix earlier on in process
 - Many different perspectives are helpful
 - Need involvement of multiple stakeholders
- *Third*, critical or uncertain pieces of code
 - Security-critical code
 - Safety-critical code
- Start inspections at the earliest stages of process
 - Catch mistakes early, when easy to fix
 - Allow rest of system to be built with knowledge gained
- Sample segments when there is a large body of work
 - Consider what are good “coverage” criteria

Questions?

Resources

- Wiegiers text
 - **Peer Reviews in Software: A Practical Guide**
- A Microsoft perspective
 - <http://msdn.microsoft.com/en-us/library/cc265075.aspx>