Quality Assurance: Test Development & Execution

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Implementing Testing

Test Schedule

- Phases of testing
  - Unit testing (may be done by developers)
  - Component testing
  - Integration testing
  - System testing
  - Usability testing

What makes a good tester?

- Analytical
  - Ask the right questions
  - Develop experiments to get answers
- Methodical
  - Follow experimental procedures precisely
  - Document observed behaviors, their precursors and environment
- Brutally honest
  - You can't argue with the data

How do test engineers fail?

- Desire to "make it work"
  - Impartial judge, not "handyman"
- Trust in opinion or expertise
  - Trust no one – the truth (data) is in there
- Failure to follow defined test procedure
  - How did we get here?
- Failure to document the data
- Failure to believe the data

Testability

- Can all of the feature's code paths be exercised through APIs, events/messages, etc.?
  - Unreachable internal states
- Can the feature's behavior be programmatically verified?
- Is the feature too complex to test?
  - Consider configurations, locales, etc.
- Can the feature be tested timely with available resources?
  - Long test latency = late discovery of faults

What color is your box?

- Black box testing
  - Treats the SUT as atomic
  - Study the gazinta's and gozouta's
  - Best simulates the customer experience
- White box testing
  - Examine the SUT internals
  - Trace data flow directly (in the debugger)
  - Bug report contains more detail on source of defect
  - May obscure timing problems (race conditions)

Designing Good Tests

- Well-defined inputs and outputs
  - Consider environment as inputs
  - Consider 'side effects' as outputs
- Clearly defined initial conditions
- Clearly described expected behavior
- Specific – small granularity provides greater precision in analysis
- Test must be at least as verifiable as SUT

Types of Test Cases

- Valid cases
  - What should work?
- Invalid cases
  - Ariane V – data conversion error (http://www.cs.york.ac.uk/hise/safety-critical-archive/1996/0055.html)
- Boundary conditions
  - Fails in September?
  - Null input
- Error conditions
  - Distinct from invalid input

Manual Testing

- Definition: test that requires direct human intervention with SUT
- Necessary when:
  - GUI is present
  - Behavior is premised on physical activity (e.g. card insertion)
- Advisable when:
  - Automation is more complex than SUT
  - SUT is changing rapidly (early development)

Automated Testing

- Good: replaces manual testing
- Better: performs tests difficult for manual testing (e.g. timing related issues)
- Best: enables other types of testing (regression, perf, stress, lifetime)
- Risks:
  - Time investment to write automated tests
  - Tests may need to change when features change

Types of Automation Tools: Record/Playback

- Record "proper" run through test procedure (inputs and outputs)
- Play back inputs, compare outputs with recorded values
- Advantage: requires little expertise
- Disadvantage: little flexibility - easily invalidated by product change
- Disadvantage: update requires manual involvement

Types of Automation Tools: Scripted Record/Playback

- Fundamentally same as simple record/playback
- Record of inputs/outputs during manual test input is converted to script
- Advantage: existing tests can be maintained as programs
- Disadvantage: requires more expertise
- Disadvantage: fundamental changes can ripple through MANY scripts

Types of Automation Tools: Script Harness

- Tests are programmed as modules, then run by harness
- Harness provides control and reporting
- Advantage: tests can be very flexible
- Disadvantage: requires considerable expertise and abstract process

Types of Automation Tools: Verb-Based Scripting

- Module is programmed to invoke product behavior at low level – associated with 'verb'
- Tests are designed using defined set of verbs
- Advantage: great flexibility
- Advantage: changes are usually localized to a given verb
- Disadvantage: requires considerable expertise and abstract process

Test Corpus

- Body of data that generates known results
- Can be obtained from
  - Real world – demonstrates customer experience
  - Test generator – more deterministic
- Caveats
  - Bias in data generation
  - Don't share test corpus with developers!

Instrumented Code: Test Hooks

- Code that enables non-invasive testing
- Code remains in shipping product
- May be enabled through
  - Special API
  - Special argument or argument value
  - Registry value or environment variable
- Example: Windows CE IOCTLs
- Risk: silly customers….

Instrumented Code: Diagnostic Compilers

- Creates 'instrumented' SUT for testing
  - Profiling – where does the time go?
  - Code coverage – what code was touched?
    - Really evaluates testing, NOT code quality
  - Syntax/coding style – discover bad coding
    - lint, the original syntax checker
  - Complexity
    - Very esoteric, often disputed (religiously)
    - Example: function point counting

Instrumented platforms

- Example: App Verifier
  - Supports 'shims' to instrument standard system calls such as memory allocation
  - Tracks all activity, reports errors such as unreclaimed allocations, multiple frees, use of freed memory, etc.
- Win32 includes 'hooks' for platform instrumentation

Environment Management Tools

- Predictably simulate real-world situations
- MemHog
- DiskHog
- Data Channel Simulator

Test Monkeys

- Generate random input, watch for crash or hang
- Typically, 'hooks' UI through message queue
- Primarily to catch "local minima" in state space (logic "dead ends")
- Useless unless state at time of failure is well preserved!

Finding and Managing Bugs

What is a bug?

- Formally, a "software defect"
- SUT fails to perform to spec
- SUT causes something else to fail
- SUT functions, but does not satisfy usability criteria
- If the SUT works to spec and someone wants it changed, that's a feature request

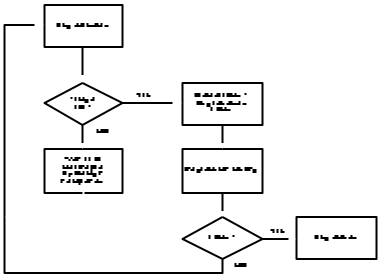
What are the contents of a bug report?

- Repro steps – how did you cause the failure?
- Observed result – what did it do?
- Expected result – what should it have done?
- Any collateral information: return values/output, debugger, etc.
- Environment
  - Test platforms must be reproducible
  - "It doesn't do it on my machine"

Ranking bugs

- Severity
  - Sev 1: crash, hang, data loss
  - Sev 2: blocks feature, no workaround
  - Sev 3: blocks feature, workaround available
  - Sev 4: trivial (e.g. cosmetic)
- Priority
  - Pri 1: Fix immediately
  - Pri 2: Fix before next release outside team
  - Pri 3: Fix before ship
  - Pri 4: Fix if nothing better to do ☺

A Bug’s Life



Regression Testing

- Good: rerun the test that failed
  - Or write a test for what you missed
- Better: rerun related tests (e.g. component level)
- Best: rerun <u>all</u> product tests
  - Automation can make this feasible!

Tracking Bugs

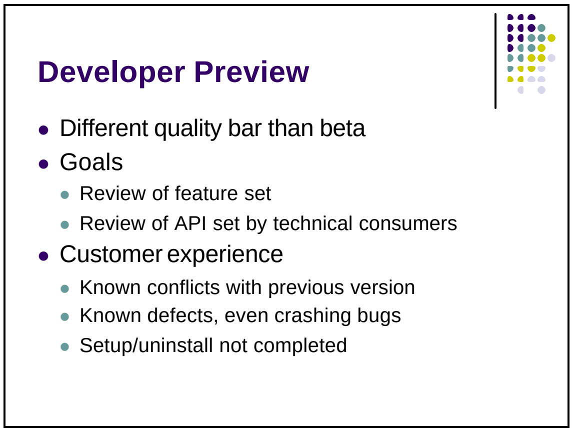
- Raw bug count
  - Slope is useful predictor
- Ratio by ranking
  - How bad are the bugs we’re finding?
- Find rate vs. fix rate
  - One step forward, two back?
- Management choices
  - Load balancing
  - Review of development quality

When can I ship?

- Test coverage sufficient
- Bug slope, find vs. fix lead to convergence
- Severity mix is primarily low-sev
- Priority mix is primarily low-pri

To beta, or not to beta

- Quality bar for beta release: features mostly work if you use them right
- Pro:
  - Get early customer feedback on design
  - Real-world workflows find many important bugs
- Con:
  - Do you have time to incorporate beta feedback?
  - A beta release takes time and resources



Developer Preview

- Different quality bar than beta
- Goals
  - Review of feature set
  - Review of API set by technical consumers
- Customer experience
  - Known conflicts with previous version
  - Known defects, even crashing bugs
  - Setup/uninstall not completed