Quality Assurance: Test Development & Execution

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Introduction: Ian King

- Manager of Test Development for
  - Windows CE Base OS (kernel, core drivers, file systems)
  - Compilers (x86, ARM, MIPS, SH4)
  - Diagnostics (debugger, connectivity, tools)
- Previous projects at Microsoft:
  - MSN 1.x online service, Site Server 3.0, TransPoint online service, Speech API 5.0
- Previously: business analyst, Pacific Telecom

Implementing 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

Test Categories

- Functional
  - Does it work?
- Performance
  - How fast/big/high/etc.?
- Security
  - Access only to those authorized
- Stress
  - Working stress
  - Breaking stress – how does it fail?
- Reliability/Availability

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
  - Too many serial dependencies?

Test planning

- What will I test?
  - Valid, invalid, error conditions, environmental, stress, perf, security, etc.
- How will I test it?
  - API tests, ‘black box’ tests, fault injection, code inspection, inference
- How will I implement those tests?
  - Manual, automated

Manual Testing

- Definition: test that requires direct human intervention with SUT
- Necessary when:
  - GUI is tested element
  - 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
- Advantage: tests can exercise features similar to customers' code
- 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 high-level 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

Advanced Tools: Modeling

- Example: AsmL
  - Model behavior as set of states and transitions
  - Even multithreaded code is inherently serial
  - Stochastic elements can be explicit
- Advantage: test design before code is written
- Advantage: test the *test code*
- Disadvantage: creation and maintenance overhead

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
  - CPU ‘eater’
  - Data Channel Simulator
- Reliably reproduce environment
  - Source control tools
  - Consistent build environment
  - Disk imaging tools

Test Monkeys

- Generate random input, watch for crash or hang
- Typically, ‘hooks’ UI through message queue
- Primarily catches “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 do I do once I find one?

- Bug tracking is a valuable tool
  - Ensures the bug isn’t forgotten
  - Highlights recurring issues
  - Supports formal resolution/regression process
  - Provides important product cycle data
  - Can support ‘higher level’ metrics, e.g. root cause analysis
  - Valuable information for field support

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?
- Collateral information: return values/output, debugger, etc.
- Environment
  - Test platforms must be reproducible
  - “It doesn’t do it on my machine”

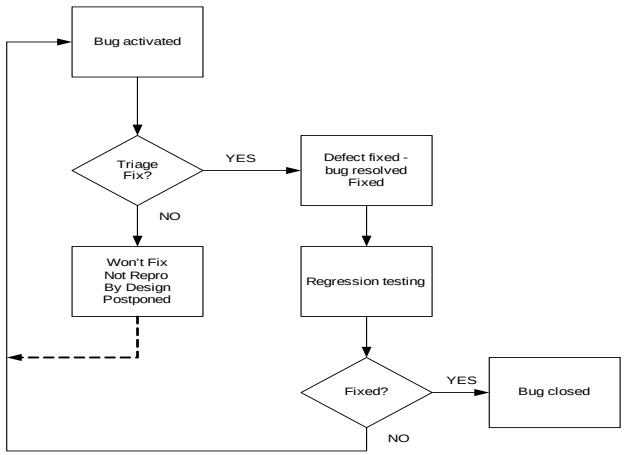
Tracking Bugs

- 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

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 - blocking
  - 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 all product tests
  - Automation can make this feasible!

Dogfood

- “So good, we eat it ourselves”
- Advantage: real world use patterns
- Disadvantage: impact on productivity
- At Microsoft: we model our customers
  - 50K employees
  - Broad range of work assignments, software savvy
  - Wide ranging network (worldwide)

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
  - Known defects, even crashing bugs
  - Known conflicts with previous version
  - Setup/uninstall not completed
- Goals
  - Review of feature set
  - Review of API set by technical consumers

When can I ship?

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