Activity Metrics

Activity Metrics Overview

- Metrics that indicate how well we are performing various activities:
  - Requirements, Design, Coding, Testing, Maintenance, Configuration Management, Quality Engineering, etc.
- Most of these are relatively crude indicators:
  - Outlier values indicate possible problems
  - Good values are not conclusive indicators of goodness
  - Most do not measure actual quality of output
    - Process quality does not necessarily imply product quality
    - Just provide detection of some kinds of problems
  - Sort of like MS-Word’s green lines to indicate grammar problems
- Many metrics can be generated by tools and don’t require additional effort or process changes
  - Cheap ways to get some additional useful feedback
  - But don’t ignore the cost of analyzing and reacting

Requirements

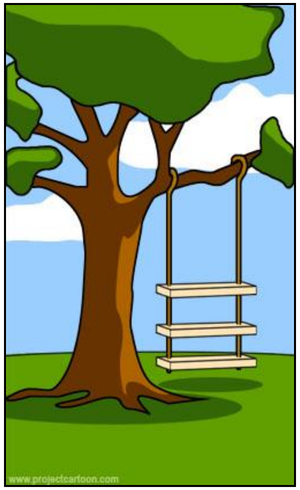
- Requirements volatility:
  - Average # of changes per requirement
  - Requirements changes grouped by source

- Requirements density:
  - Number of requirements per function point or KLOC
  - Indicator of granularity of requirements capture

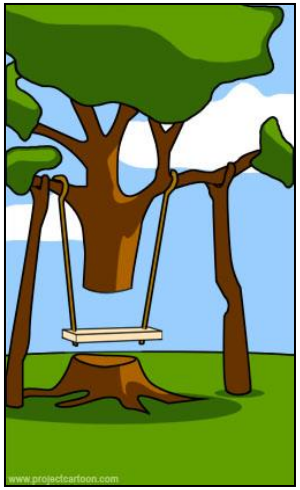
- Number of variations per use case:
  - Indicator of coverage of exception situations

- Requirements defects classification

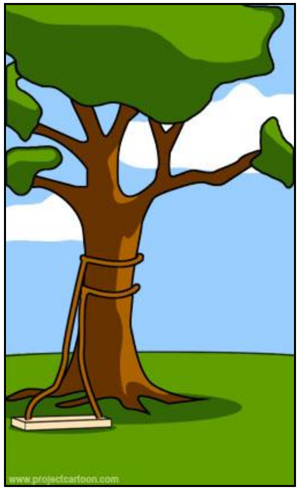
Requirements Failure



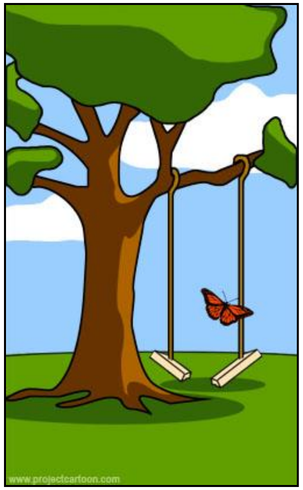
How the customer explained it



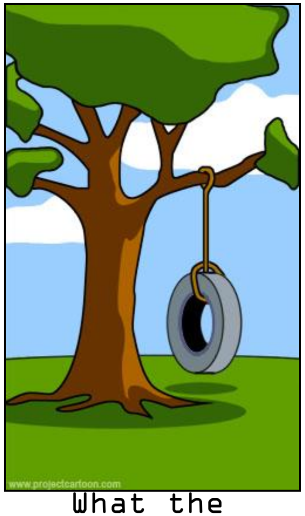
How the requirements person designed it



How the programmer wrote it



How it performed Under load



What the customer really needed

Requirements Defects Classification

- Can classify requirements defects:
    - Requirements discovery: missed requirements, misunderstood requirements
        - Indicators of elicitation effectiveness
    - Requirements errors: consistency, completeness, ambiguity, etc.
        - Effectiveness of requirements analysis & specification
    - Requirements updates and enhancements identified in design activities:
        - Effectiveness of architecture & component design practices
        - Effectiveness of requirements specification
            - Such as cases not considered
    - Customer-originated updates:
        - Can't control → opportunities for improving elicitation
- Can do this classification and removal for any of the activities
    - Same concept as DRE

Design Metrics

- Cohesion
- Coupling
- Fan-in / fan-out:
  - Number of methods called by/calling each method
  - Keep within control limits
    - Low fan-out indicates too much hierarchy
    - High fan-out indicates too many dependencies
  - Not absolute rules at all!
- Complexity

Object-Oriented Design Metrics

- Average method size: less is good
- Number of methods per class: within control limits
- Number of instance variables per class: within limits
- Class hierarchy nesting level: < 7 (guideline)
- Number of subsystem/subsystem relationships
  - Less is good? Control limits?
- Number of class/class relationships within subsystem
  - High (relative to subsystem relationships) is good – indicates higher cohesion
- Instance variable grouping among methods
  - May indicate possibility of splits

Code Complexity Metrics

- Comment density
  - Does not tell you quality of comments!
  - Are comments code smells?

- Cyclomatic complexity:
  - Number of branches/decisions
  - Number of operators / line or procedure
  - Useful to estimate complexity of software and expected error rates
    - Most applicable to method and data structure complexity

- Software science:
  - A set of equations that try to derive parametric relationships among different software parameters, and create estimates of "difficulty," expected effort, faults, etc.
  - Not really proven empirically, and of unclear value?

Historical Perspective

- Much of the early work in metrics was on code complexity and design complexity
  - Of rather limited value, since it quickly gets prescriptive about coding practices, and its outputs are indicators at best
    - Runs easily into various religious arguments
- Even now, this is what some people think of when you mention metrics
- Metrics has now moved on to measuring:
  - Customer view of product
  - Aspects that give you clearer insight into improving development
- Many practitioners have not caught up with this yet

Even So …

- What “metrics” are implied by the “code smells” that drive refactoring patterns?
- What “metrics” are implied by the need to apply design patterns and architecture styles?
- Since reuse is so important, how do you evaluate the “design quality” of a design and code base you are considering adapting to your use?

Test Metrics: Coverage

- Black box:
  - Requirements coverage: test cases per requirement
    - Works with use cases / user stories / numbered requirement
  - Equivalence class coverage
    - Extent of coverage of equivalence classes of input parameters
  - Combinations of equivalence class coverage
    - This is the real challenge

- Glass box:
  - Function coverage
  - Statement coverage
  - Path coverage

- There are tools that automatically generate coverage statistics
  - And even create test cases and scripts!

Test Progress

- S-curve
  - Histogram of number of test cases attempted / successful per week of project

- Test defects arrival rate
  - Similar to reliability growth curves

- Test defect backlog curve:
  - Cumulative defects not yet fixed
  - Shows productivity of resolving defects
  - Distinct from defect removal productivity
    - Throughput vs. delay

- Number of severe defects (crashes, freezes, wrong output, etc.) over time
  - Similar to reliability curve, but not as formal

Maintenance Metrics

- Fix backlog:
  - Age of open and closed problems
  - Backlog management index: closed rate / arrivals rate
  - Fix response time: mean time from open to closed
- Fixing effectiveness: (1 - % of bad fixes)
- Fixing delinquency: % closed within acceptable response time

Configuration Management

- Defect classification can provide insight into sources of CM problems

- Also, "Configuration Status Accounting" (CSA):
  - Tool-based cross-check of expected progress
  - As project moves through different phases or increments, would expect different documents to be generated / modified
  - CSA reports which files are being modified
    - Powerful, advanced technique
    - If pre-configured which expected modifications, can flag discrepancies
    - Can go deeper and look at extent of modifications
    - Also useful to monitor which files are modified during defect fixes, hence which regression tests need to run

Quality Engineering

- Assessment results
  - Red/yellow/green on practices in each area
    - For example, requirements, planning, CM etc.
- Classifying defects: Defects related to “not following process”
- Shape of various curves
  - For example, wide variations in estimation accuracy or defect injection rates might show non-uniform practices

In-Process Metrics

- Metrics can help us determine whether projects went well and where problems are
- Some metrics are most meaningful after the project is done, such as productivity or cycletime
- Other metrics can be used to diagnose problems while the project is in progress, or to ensure that activities are done right:
    - Most activity metrics are used as in-process metrics
    - Defect density, even DRE defect removal patterns can be used as in-process metrics, but need to be careful
    - Many metrics are not fully available until the end of project, but can monitor how the metric evolves as project proceeds
- Most in-process metrics are like dashboard gauges: out-of-range values indicate problems, but “good” values do not guarantee health

Summary

- Activity metrics help us to gauge the quality of activity execution:
  - Most are useful as indicators, but crude and inconclusive
  - Cheap to generate, so good benefit/cost
  - Don’t “work to the metrics”!

- People are constantly coming up with new ones