Predicting Software Quality Early in the Software Development Lifecycle and Producing Secure Software

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Systems & Software Technology Conference

May 18, 2011

Salt Lake City
Predicting Software Quality Early in the Software Development Lifecycle and Producing Secure Software

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Preamble

Don’t think of business as a life without greatness
Unless the distant goals of meaning, greatness, and destiny are addressed, we can’t make an intelligent decision about what to do tomorrow morning – much less set the long-term strategy of the company

First decision must be to commit to an ethical world, a civilized existence, a moral order

Nothing is more practical than for people to deepen themselves

- Peter Koestenbaum (pkipeter@ix.netcom.com)
Why Are We Here? - 1

The adverse impact of software vulnerabilities caused by defective software is far-reaching.

The defects that escape testing are exploited by hackers to launch cyber attacks.

The current method of dealing with the increasing number of cyber attacks is reactive.
We need a rapid transformation of the U.S. software industry from the current “Deliver now, fix later” culture to one capable of delivering substantially defect free code within predictable cost and schedule

This is a national high-priority need

If we continue with current methods, the U.S. taxpayer will pay billions of dollars for fixing defects in delivered products
Why are We Here? - 3

First step is to make quality the number one priority and recognize that in order to manage the software work we must learn to manage quality.

By adopting proven principles of managing knowledge work, software development quality and productivity can be increased by orders of magnitude.

The leadership challenge is to build a cohesive and rewarding team environment where most people can do much better work than they are currently doing and produce truly amazing results.
Managing Software Quality - 1

To meet schedule and cost commitments consistently, you must manage software quality.

Quality without numbers is just talk.

The common ways to manage software quality are with testing and reuse.

Testing is now relied upon and is not sufficient.

For reuse, the parts must be initially of high quality or the quality problems will be worse.
Managing Software Quality - 2

Software-intensive products typically have many defects

The three defect removal strategies
  Test, test, test
  Inspect and test
  Review, inspect and test

Time to find and fix test defects can vary from a few hours to few weeks
Managing Software Quality - 3

Quality work is more predictable

If you do not manage quality, your schedule problems will end up as quality disasters

Software professionals must be trained to make plans and negotiate commitments
To manage software product quality, we need to manage quality of the components.

Components are what developers build.

Error-prone components account for a disproportionate number of defects found in integration, system and user acceptance tests.
20% of the modules in a system typically account for 80% of the defects

It is extremely useful to know which components are likely to be error-prone in later testing so that we can take corrective actions pro-actively
Performance Metrics That Matter
Post-delivery Defects

Defect Density of Delivered Software

<table>
<thead>
<tr>
<th></th>
<th>Defect Density/KLOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMM Level 1</td>
<td>7.5</td>
</tr>
<tr>
<td>CMM Level 2</td>
<td>6.24</td>
</tr>
<tr>
<td>CMM Level 3</td>
<td>4.73</td>
</tr>
<tr>
<td>CMM Level 4</td>
<td>2.28</td>
</tr>
<tr>
<td>CMM Level 5</td>
<td>1.05</td>
</tr>
<tr>
<td>TSP</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Performance Metrics That Matter
Early Defect Removal

Developers measure and manage the quality of their individual components and remove defects early through personal reviews and team inspections.

Include OWASP Top Ten and CWE/SANS Top 25 Most Dangerous Programming Errors in review and inspection checklists.

Developers strive to get the highest quality product into test.
Performance Metrics That Matter
AIS Federal Project Results

[Graph showing defects removed by phase for plan and actual across different project phases such as Design, Design Review, Code, Code Review, Component Test, Integration Test, System Test, and User Acceptance Test.]
Performance Metrics That Matter
Process Quality Index

PQI is a leading indicator of overall product quality

PQI gives ability to predict whether components that have been unit tested will have down-stream defects in integration, system, and user acceptance testing

Teams can take corrective action and reduce test and rework time
Performance Metrics That Matter Component Quality Profile

The above chart shows our 5 measures to achieve our quality goals:

1) Design time to Code time comparison
2) Design Review Time as a % of design time (should be 50% or greater)
3) Code Review Time as a % of code time (should be 50% or greater)
4) Compile Defects per KLOC (Compile should find less than 10 defects per KLOC)
5) Unit Test Defects per KLOC (UT should find less than 5 defects per KLOC)
Performance Metrics That Matter
AIS Federal Project Results

- Post CT Defect Count: 14
  - PQI: 0.012

- Post CT Defect Count: 8
  - PQI: 0.135

- Post CT Defect Count: 19
  - PQI: 0.034

- Post CT Defect Count: 0
  - PQI: 0.448

- Post CT Defect Count: 0
  - PQI: 0.534

- Post CT Defect Count: 0
  - PQI: 0.38
Performance Metrics That Matter
Percent Defect Free Components

When knowledge workers have been trained and know how to manage themselves, they are capable of giving early warning to management when problems arise.

A key metric is the percent of components in the product that are defect free.

Management can motivate the technical teams to strive for 100% defect free components when both parties view project success the same way.
## Performance Metrics That Matter

<table>
<thead>
<tr>
<th>Metric</th>
<th>Industry Average</th>
<th>AIS Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule deviation</td>
<td>&gt;50%</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>No. of defects in delivered product 100,000 LOC</td>
<td>&gt;100</td>
<td>&lt;15</td>
</tr>
<tr>
<td>% of design and code inspected</td>
<td>&lt;100</td>
<td>100</td>
</tr>
<tr>
<td>Time to accept 100,000 LOC product</td>
<td>10 Months</td>
<td>5 Weeks</td>
</tr>
<tr>
<td>% of defects removed prior to system test</td>
<td>&lt;60%</td>
<td>&gt;85%</td>
</tr>
<tr>
<td>% of development time fixing system test defects</td>
<td>&gt;33%</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>Cost of quality</td>
<td>&gt;50%</td>
<td>&lt;35%</td>
</tr>
<tr>
<td>Warranty on products</td>
<td>?</td>
<td>Lifetime</td>
</tr>
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</table>
Schedule Compression and Defects

<table>
<thead>
<tr>
<th>Schedule/Quality Trade-off</th>
<th>Default</th>
<th>10% Compression</th>
<th>20% Compression</th>
<th>10% Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration Mths</td>
<td>25.9</td>
<td>23.3</td>
<td>20.7</td>
<td>28.5</td>
</tr>
<tr>
<td>Defect Count</td>
<td>1,033</td>
<td>1,316</td>
<td>1,715</td>
<td>849</td>
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<tr>
<td>% Change</td>
<td>27.4%</td>
<td>66.0%</td>
<td>-17.8%</td>
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</tr>
</tbody>
</table>

Source: Donald M. Beckett and Douglas T. Putnam, STN 13-1 April 2010: Software Quality, Reliability, and Error Prediction
Adding Staff and Defects

<table>
<thead>
<tr>
<th>Staff/Quality Trade-off</th>
<th>Peak Staff 16</th>
<th>Peak Staff 32</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration Mths</td>
<td>26</td>
<td>22.6</td>
<td>-13.1%</td>
</tr>
<tr>
<td>Defect Count</td>
<td>1,043</td>
<td>1,411</td>
<td>35.3%</td>
</tr>
<tr>
<td>Effort Months</td>
<td>225</td>
<td>392.0</td>
<td>74.2%</td>
</tr>
</tbody>
</table>

Source: Donald M. Beckett and Douglas T. Putnam, STN 13-1 April 2010: Software Quality, Reliability, and Error Prediction
Deliver now, fix later - 1

Why do competent software professionals agree to delivery dates when they have no idea how to meet them?

Why do rational managers accept schedule commitments when engineers offer no evidence that they can meet the commitments?
Deliver now, fix later - 2

If it doesn’t have to work any body can deliver on time

If you want the product in the worst way, that’s how you will get it

If the situation looks truly impossible, it probably is

Schedule is what must happen; quality determines what will happen
Negotiated Commitments - Developers

When pressed for early deliveries, the responsible team members say

“I understand your requirements, I will do my utmost to meet it, but until I make a plan, I cannot responsibly commit to a date”
Negotiated Commitments - Managers

When pressed for early deliveries, the responsible managers say

“I trust you to create an aggressive and realistic plan, I will review the plan, but I will not commit you to a date that you can not meet”
What does

“FUN ON THE JOB”

Mean to you?
Contact Information

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