World-Class Quality

Using a Process Measurement Framework℠ to Successfully Achieve Measurable Results

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Tim Olson, President
Quality Improvement Consultants, Inc. (QIC)
(760) 804-1405 (Office)
Tim.Olson@qic-inc.com
www.qic-inc.com

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The Principle of Measurement

As Lord Kelvin said a century ago:

“When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science.”
Tutorial Objectives

Provide motivation for and describe the QIC Process Measurement Framework\textsuperscript{SM}.

Describe 4 real examples from industry:
1) Instrument a process
2) Instrument a project
3) Instrument an organization (e.g., Baldrige, CMM\textsuperscript{®}, CMMI\textsuperscript{SM}, etc.)
4) Instrument a complex metric (e.g., ROI)

Answer any of your questions.

Tutorial Agenda

30 Minutes  Introduction
30 Minutes  Measurement Framework Overview
30 Minutes  Example 1: Instrument a Process
30 Minutes  Break
30 Minutes  Example 2: Instrument a Project
30 Minutes  Example 3: Instrument an Organization
30 Minutes  Example 4: Instrument a Metric
30 Minutes  Questions and Answers
Who is QIC?

The mission of Quality Improvement Consultants, Inc. (QIC) is to help organizations to measurably:

- become “best-in-class” or “world-class” quality leaders in their respective markets (e.g., using benchmarking)
- improve quality and productivity (e.g., lower product defect rates, increased KSLOC per person month, etc.)
- reduce the cost of poor quality (e.g., rework, waste, scrap, etc.)

Agenda

Introduction

Process Measurement Framework SM Overview

Real Example 1: Instrument a Process

Real Example 2: Instrument a Project

Real Example 3: Instrument an Organization

Real Example 4: Instrument a Complex Metric

Some Lessons Learned

Questions and Answers
Why Are You Here?

Evolutionary vs. Revolutionary Quality Improvement

- Increased Quality & Productivity
- Company A: 20-50%
- Company B: 5-10%
- Time

*Adapted from Juran on Leadership for Quality, Juran, 1989*
Some Best-In-Class Benchmarks

<table>
<thead>
<tr>
<th>METRIC</th>
<th>WORLD-CLASS BENCHMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs of Poor Quality</td>
<td>Reduced from 33% to under 10%</td>
</tr>
<tr>
<td>Defect Removal Efficiency</td>
<td>70-90% total defects removed before test</td>
</tr>
<tr>
<td>Post-Release Defect Rate</td>
<td>Six Sigma (i.e., 3.4 defects per million)</td>
</tr>
<tr>
<td>Productivity</td>
<td>Doubled (e.g., in 5 years)</td>
</tr>
<tr>
<td>Return on Investment</td>
<td>5:1 ROI (or higher)</td>
</tr>
<tr>
<td>Schedule / Cycle Time</td>
<td>Continually reducing (e.g., 10% annually)</td>
</tr>
</tbody>
</table>

 Agenda

- Introduction
- Process Measurement Framework\textsuperscript{SM} Overview
  - Real Example 1: Instrument a Process
  - Real Example 2: Instrument a Project
  - Real Example 3: Instrument an Organization
  - Real Example 4: Instrument a Complex Metric
- Some Lessons Learned
- Questions and Answers
Goal/Question/Metric Paradigm

<table>
<thead>
<tr>
<th>PART</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>Every metric must be directed towards a measurable goal. The idea here is that there must be a good reason to be collecting the data.</td>
</tr>
<tr>
<td>Question</td>
<td>Every goal should be answered by one or more key questions. The question should be stated so that a metric(s) can clearly answer it.</td>
</tr>
<tr>
<td>Metric</td>
<td>The metric must be a quantitative entity that answers a specific question, which in turn addresses a goal or part of a goal.</td>
</tr>
</tbody>
</table>


Goal/Question/Metric (G/Q/M)

A high level summary of the G/Q/M steps are:

1. Establish the goals of the data collection.
2. Develop a list of questions of interest.
3. Establish data categories.
4. Design and test data collection form.
5. Collect and validate data.
6. Analyze data

Analogy: Managing for Finance

<table>
<thead>
<tr>
<th>Managing for Finance</th>
<th>Managing for Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Planning:</strong> Setting business goals; budgeting</td>
<td><strong>Quality Planning:</strong> Setting quality goals; Estimating</td>
</tr>
<tr>
<td><strong>Financial Control:</strong> Cost control; actual vs. planned</td>
<td><strong>Quality Control:</strong> Planned vs. actual quality goals; taking action on difference</td>
</tr>
<tr>
<td><strong>Financial Improvement:</strong> Cost reduction; mergers; acquisitions</td>
<td><strong>Quality Improvement:</strong> Waste and rework reduction; eliminate &amp; prevent defects</td>
</tr>
</tbody>
</table>


The Juran Trilogy for Quality Management

* Adapted from Juran’s Quality Control Handbook, J.M. Juran, 4th Edition
SEI Initial Core Measures

<table>
<thead>
<tr>
<th>Unit of Measure</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counts of physical lines of code</td>
<td>Size, progress, reuse</td>
</tr>
<tr>
<td>Counts of staff hours expended</td>
<td>Effort, cost, resource allocations</td>
</tr>
<tr>
<td>Calendar dates</td>
<td>Schedule</td>
</tr>
<tr>
<td>Counts of software problems and defects</td>
<td>Quality, readiness for delivery, improvement trends</td>
</tr>
</tbody>
</table>


Approaches: Pros and Cons

<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal/Question/Metric</td>
<td>• Powerful paradigm</td>
<td>• Can struggle establishing meaningful goals</td>
</tr>
<tr>
<td></td>
<td>• Companies use it</td>
<td>• Hard to develop the right questions</td>
</tr>
<tr>
<td></td>
<td>• Growing success stories</td>
<td>• Difficult to tailor metrics to organizational culture</td>
</tr>
<tr>
<td></td>
<td>• Practical approach</td>
<td></td>
</tr>
<tr>
<td>Juran Quality Trilogy</td>
<td>• Powerful trilogy</td>
<td>• Not tailored to Systems/SW</td>
</tr>
<tr>
<td></td>
<td>• Proven track record in quality</td>
<td>• Not tailored to measurement in general</td>
</tr>
<tr>
<td></td>
<td>• Good strategy</td>
<td>• Big learning curve</td>
</tr>
<tr>
<td>SEI Recommended Core Measures</td>
<td>• Practical metrics</td>
<td>• Single report missing “big picture”or framework</td>
</tr>
<tr>
<td></td>
<td>• Based on applied research</td>
<td>• Numerous SEI reports can be overwhelming</td>
</tr>
<tr>
<td></td>
<td>• Based on successful organizations</td>
<td></td>
</tr>
</tbody>
</table>
Tailoring The Juran Trilogy

<table>
<thead>
<tr>
<th>PART</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>Broadened to be planning in general (e.g., project planning). Estimating goals and measurements for processes and products.</td>
</tr>
<tr>
<td>Control</td>
<td>Measuring and comparing actual performance against planned performance (e.g., plans, goals, metrics, etc.), and taking corrective action on the major differences (e.g., special causes).</td>
</tr>
<tr>
<td>Improvement</td>
<td>Broadened to be improvement in general (e.g., improving quality, productivity, performance, and competitive position).</td>
</tr>
</tbody>
</table>


QIC Process Measurement Framework™

<table>
<thead>
<tr>
<th>GOALS</th>
<th>KEY QUESTIONS</th>
<th>METRICS</th>
<th>DC</th>
<th>DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLAN</td>
<td></td>
<td>Cost, defects, effort, size, schedule, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL</td>
<td></td>
<td>Cost, defects, effort, size, schedule, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMPROVE</td>
<td></td>
<td>Cost, defects, effort, size, schedule, etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* DC = Data Collection; DS = Data Storage
Agenda

Introduction

Process Measurement FrameworkSM Overview

Real Example 1: Instrument a Process

Real Example 2: Instrument a Project

Real Example 3: Instrument an Organization

Real Example 4: Instrument a Complex Metric

Some Lessons Learned

Questions and Answers

What are In-Process Inspections?

The purpose of in-process inspections is to detect defects early in the process in order to reduce rework and costs, and to increase quality and productivity.

In-process inspection: a formal process for verifying intellectual products (in-process) by manually examining a work product, a piece at a time, by small teams of trained peers to detect defects, to ensure that the product is correct and conforms to standards, product specifications, and requirements.

-Adapted from Ebenau, Software Inspection Process, McGraw Hill, 1994
What’s the Difference?

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Inspections</th>
<th>Reviews</th>
<th>Walk-throughs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>Identify defects</td>
<td>Reach consensus</td>
<td>Reach consensus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raise issues</td>
<td>Raise issues</td>
</tr>
<tr>
<td><strong>State of Work</strong></td>
<td>Final draft</td>
<td>Work in progress</td>
<td>Work in progress</td>
</tr>
<tr>
<td><strong>Product</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Process/Measurements</strong></td>
<td>Formal/Required</td>
<td>Informal/None required</td>
<td>Informal/None required</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Checklists/Error</strong></td>
<td>Required/Defects</td>
<td>Not required/Not</td>
<td>Not required/Not</td>
</tr>
<tr>
<td><strong>Detection</strong></td>
<td>classified</td>
<td>required</td>
<td>required</td>
</tr>
<tr>
<td><strong>Participants</strong></td>
<td>Moderator; Reader;</td>
<td>Author; Reviewers</td>
<td>Author; Reviewers</td>
</tr>
<tr>
<td></td>
<td>Recorder; Author;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inspectors</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Process Owner</strong></td>
<td>Moderator;</td>
<td>Author</td>
<td>Author</td>
</tr>
<tr>
<td></td>
<td>Independent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>verification</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inspection Process Model

1. Meeting Notice
2. Defect List
3. Defect Summary
4. Summary Report

**Inspection Roles**

**Author** - individual responsible for the work product, and for correcting any defects.

**Moderator** - ensures that the inspection process is followed, and that the other inspectors perform their responsibilities throughout the inspection process.

**Recorder** - records and classifies all the defects detected at the inspection meeting, and assists the moderator in preparing inspection reports.

**Inspector** - detects defects in the work product (all inspection team members are inspectors).

**Reader** - leads the team through the work product in a complete and logical fashion.

---

**Example: Inspection Metrics**

<table>
<thead>
<tr>
<th>Inspection Measurements</th>
<th>Example Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Size</td>
<td>50 pages (Requirements Document)</td>
</tr>
<tr>
<td>Total Defects</td>
<td>50 Total Defects (50 pages * 1 defect per page)</td>
</tr>
</tbody>
</table>
| Total Cost              | • $2,500 to inspect document (50 pages * $50 a page)  
                           • $50 average cost per defect ($2,500/50 defects) |
| Total Effort            | • 50 person hours of effort (1 hour per page * 50 pages)  
                           • 1 hour average effort per defect (50 hours/50 defects) |
| Schedule                | • Average preparation rate of 10 pages per hour=5 hours  
                           • Average meeting rate of 10 pages per hour=5 hours  
                           • 5 hours/2 hour meetings is approximately 3 meetings  
                           • Schedule = 1 calendar week |
## Example: Planning

<table>
<thead>
<tr>
<th>Goal</th>
<th>Key Questions</th>
<th>Basic Metrics</th>
<th>Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Plan and Estimate within 10% of Actuals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use historical data</td>
<td>1a). How much will the inspections cost? How much will defects cost?</td>
<td>Based on Work Product Size:</td>
<td>Inspection Database</td>
</tr>
<tr>
<td></td>
<td>1b). How many defects will there be?</td>
<td>1a). Average <strong>cost</strong> per page (e.g., $50.00 per page). Average cost per defect (e.g., $50 per defect).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1c). How much effort will the inspection take? per defect?</td>
<td>1b). <strong>Defect</strong> density (e.g., average 1 defect per page)</td>
<td>Inspection Database</td>
</tr>
<tr>
<td></td>
<td>1d). How long will the inspections take?</td>
<td>1c). Average <strong>effort</strong> per page (e.g., 1 hour per page). Average effort per defect (e.g., 1 hour per defect).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1e). How big is the work product?</td>
<td>1d). Inspection <strong>Schedule</strong> (based on average preparation rate and average meeting rate and 2 hour limit duration per meeting)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1e). Total work product <strong>size</strong> in pages (e.g., 100 page design document).</td>
<td>Inspection Database</td>
</tr>
</tbody>
</table>

## Example: Control

<table>
<thead>
<tr>
<th>Goal</th>
<th>Key Questions</th>
<th>Basic Metrics</th>
<th>Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure and track actual data against estimated data</td>
<td></td>
<td>Measure actual data against estimated data:</td>
<td></td>
</tr>
<tr>
<td>Take action on major differences (Greater than 10%)</td>
<td></td>
<td>2a). Actual average <strong>cost</strong> per page vs. estimated. Actual average <strong>cost</strong> per defect vs. estimated.</td>
<td>Derived Form</td>
</tr>
<tr>
<td></td>
<td>2b). What do the inspections cost? per defect?</td>
<td>2b). Total number of <strong>defects</strong>. Actual defect density vs. estimated.</td>
<td>Summary Form</td>
</tr>
<tr>
<td></td>
<td>2c). How many defects are there? What is the quality?</td>
<td>2c). Actual average <strong>effort</strong> per page vs. estimated. Actual average <strong>effort</strong> per defect vs. estimated.</td>
<td>Summary Form</td>
</tr>
<tr>
<td></td>
<td>2d). How much effort do the inspections take? per defect?</td>
<td>2d). <strong>Schedule</strong>: Percentage of actual inspections completed vs. estimated.</td>
<td>Summary Form</td>
</tr>
<tr>
<td></td>
<td>2e). How many pages have been inspected?</td>
<td>2e). <strong>Size</strong>: Total pages inspected to date vs. estimated.</td>
<td>Summary Form</td>
</tr>
</tbody>
</table>
Example: Improvement

<table>
<thead>
<tr>
<th>Goals</th>
<th>Key Questions</th>
<th>Basic Metrics</th>
<th>Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Improve Inspection Effectiveness</td>
<td>4a) How effective is the inspection process?</td>
<td>4a) Defect-removal efficiency; Average cost and effort per defect</td>
<td>All defect databases</td>
</tr>
<tr>
<td>• Improve inspection process based on data</td>
<td>4b) What defects did the inspections miss in the testing phase(s)?</td>
<td>4b) Defects in test and/or SCM databases</td>
<td>Test Database; SCM Database</td>
</tr>
<tr>
<td></td>
<td>4c) What are the vital few defect categories that cause 80% of all defects?</td>
<td>4c) Pareto analysis of total defects in defect categories (per work product,</td>
<td>All defect databases</td>
</tr>
<tr>
<td></td>
<td>4d) What is the 20% of the work product that causes 80% of the defects?</td>
<td>by phase, etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4d) Defect location (from Defect List). Advanced: also related to software</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>complexity measures).</td>
<td></td>
</tr>
</tbody>
</table>

Agenda

Introduction

Process Measurement Framework℠ Overview

Real Example 1: Instrument a Process

Real Example 2: Instrument a Project

Real Example 3: Instrument an Organization

Real Example 4: Instrument a Complex Metric

Some Lessons Learned

Questions and Answers
# Example: Planning

<table>
<thead>
<tr>
<th>Goal</th>
<th>Key Questions</th>
<th>Basic Metrics</th>
<th>Data Collection</th>
</tr>
</thead>
</table>
| 1. Plan and Estimate within 10% of Actuals | 1a. How much will the project cost?  
1b. How many defects will there be?  
1c. How much effort will the project take?  
1d. How long will the project take?  
1e. How big is the project? | Based on Work Product Size:  
1a. Project cost (e.g., derived from effort).  
1b. Defect density (e.g., defects per KSLOC)  
1c. Effort (total hours) for the project (e.g., based on hours per WBS).  
1d. Project Schedule (e.g., based on project WBS).  
1e. Total project size (e.g., LOC, FP, modules, objects, screens, reports, etc.). | Organizational Cost Database  
Defect Database  
Time Tracking Database  
Project Plan |

<table>
<thead>
<tr>
<th>1. Use historical data</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

# Example: Control

<table>
<thead>
<tr>
<th>Goal</th>
<th>Key Questions</th>
<th>Basic Metrics</th>
<th>Data Collection</th>
</tr>
</thead>
</table>
| 2. Control | What is the project status?  
2a. Is the project on budget? Per WBS?  
2b. What is the quality of project?  
2c. How much effort does the project take? Per WBS?  
2d. What is the schedule status?  
2e. How many pages have been inspected? | Measure actual data against estimated data:  
2a) Actual cost vs. estimated.  
Actual cost (e.g., cost performance index or CPI). Also CPI per WBS element.  
2b) Actual defects vs. estimated.  
2c) Actual average effort per page vs. estimated. Actual average effort per WBS vs. estimated.  
2d) Schedule: Actual WBS completed vs. estimated (e.g., schedule performance index or SPI).  
2e) Size: Total pages inspected to date vs. estimated. | Project Status Report (PSR)  
Defect DB; PSR  
PSR; Time Tracking DB  
PSR; MS Project; Excel Spreadsheet  
PSR |
Example: Improvement

<table>
<thead>
<tr>
<th>Goals</th>
<th>Key Questions</th>
<th>Basic Metrics</th>
<th>Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Improve Project Quality • Improve verification processes based on data</td>
<td>4a) How effective are the verification processes?</td>
<td>4a) Defect-removal efficiency; Average cost and effort per defect</td>
<td>All defect databases</td>
</tr>
<tr>
<td></td>
<td>4b) What defects did the verification processes miss?</td>
<td>4b) Defects found late in the process: test, CM databases, or customer discovered defects</td>
<td>Test Database; CM Database</td>
</tr>
<tr>
<td></td>
<td>4c) What are the vital few defect categories that cause 80% of all defects?</td>
<td>4c) Pareto analysis of total defects in defect categories (per work product, by phase, etc.)</td>
<td>All defect databases</td>
</tr>
<tr>
<td></td>
<td>4d) What is the 20% of the defect categories that causes 80% of the defects?</td>
<td>4d) Defect location (from Defect List). Advanced: also related to complexity measures.</td>
<td>All defect databases</td>
</tr>
</tbody>
</table>

Example: Managing Quality

**Quantitative Goals:** Setting goals to Plan, Control, & Improve defect removal

**Plan:**
- Defect Removal Curve: Setting defect removal curve per development phase

**Control:**
- Defect Removal Curve: Actual vs planned; Taking action when set limits are exceeded

**Improve:**
- Defect Prevention: Pareto and root cause analysis of common defects
Control: Project Quality Tracking

Defect Removal Curve (Build 1)

<table>
<thead>
<tr>
<th>Process</th>
<th>Planned</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>0.19</td>
<td>0.87</td>
</tr>
<tr>
<td>Design</td>
<td>0.26</td>
<td>0</td>
</tr>
<tr>
<td>Design</td>
<td>0.14</td>
<td>1.37</td>
</tr>
<tr>
<td>Design</td>
<td>1.76</td>
<td>0.112</td>
</tr>
</tbody>
</table>

Track defect removal taking corrective action when acceptable limits exceeded

SPC of Product Defect Removal

BEFORE
- Defect density average now within benchmark inspection data for embedded mission or life critical software
- Preparation rate and defect density analysis show rates are within benchmarked data
- Defect density still not in process control

AFTER
- Analysis indicates Quantitative Management & Inspection Processes have increased preparation rate and improved defect removal

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Some Lessons Learned

Questions and Answers

Data Driven Project Management

Using data driven project management, projects should measure (at a minimum):
- Cost
- Defects
- Effort
- Schedule
- Size

Benefits include being able to measure:
- Performance
- Productivity
- Quality
- ROI

A data driven “project management dashboard” helps projects to ensure they are on track.
Example Metrics Dashboard

<table>
<thead>
<tr>
<th>PERFORMANCE</th>
<th>ROI</th>
<th>RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Performance Index</td>
<td>Schedule Performance Index</td>
<td>Return On Investment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUALITY</th>
<th>PRODUCTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Defect Rate</td>
<td>Defect Removal Efficiency</td>
</tr>
</tbody>
</table>

Project Metrics

<table>
<thead>
<tr>
<th>Projects</th>
<th>Size</th>
<th>Effort</th>
<th>Cost</th>
<th>Schedule</th>
<th>Defects</th>
</tr>
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<tr>
<td>1.</td>
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</tbody>
</table>

Plate Full

Backlog

N+1

...
Organizational Improvement

Strategic Action Planning should identify measurable organizational objectives. For example:

- Compliance (e.g., Government requirements)
- Industry Standards (e.g., Baldrige, CMMI℠, ISO, etc.)
- Market Share
- Performance (e.g., CPI, SPI)
- Productivity
- Quality
- ROI
- Time to market

Best-in-Class Strategies

DEFECT PREVENTION

EARLY DEFECT DETECTION (70-90% before Test)

Improvement: Benchmarking

Before

Defect Removal Life Cycle

- Minimum defect density yield from safety critical processes benchmark.

After

Defect Removal Curve (Build 1)

Defect density yields from safety critical world-class processes benchmark.


Agenda

- Introduction
- Process Measurement FrameworkSM Overview
- Real Example 1: Instrument a Process
- Real Example 2: Instrument a Project
- Real Example 3: Instrument an Organization
- Real Example 4: Instrument a Complex Metric
- Some Lessons Learned
- Questions and Answers
How Much Do Defects Cost?

Defects cost less to fix when detected earlier in the process

![Graph showing the cost of defects increasing exponentially as they are found later in the process.]

Requirements | Design | Implementation | Test | Release

**COST**

$1

$10

$100

DEFECTS

**Inspection ROI Assumptions**

According to industry data, in-process inspections average about **3:1-12:1 ROI**.

Historically, industry tests in quality (e.g., 80% of all defects are found in test).

According to industry data, defects cost **10-20 times** more when found in test.

Once a defect is identified, testing processes can take about **5-20 hours** to fix and verify per defect.

Once a defect is identified, in-process inspections take about **0.5-2 hours** to fix and verify per defect.
World-Class Quality

How is ROI Measured?

- Adapted from Fagan, M. “Advances in Software Inspections”, IEEE Transactions on Software Engineering, July 1986

Major COQ Categories

Cost of Quality

Cost of Good Quality

- Prevention
  - Training
  - Quality Planning
  - Defect Prevention

- Appraisal
  - Inspections
  - Peer Reviews
  - Audits
  - Testing

Cost of Poor Quality

- Internal Failure
  - Rework
  - Scrap
  - Re-Testing
  - Fixing Internal Defects

- External Failure
  - Warranty
  - Returned Products
  - Fixing External Defects

$ Without Inspections
$ With Inspections

RESOURCES

Requirements
Design
Code
Unit Test
Integration & Test
Release

SCHEDULE

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World-Class Quality

Key ROI Goal/Questions/Metrics

Goal: Measure ROI (both estimated and actual)

Key Questions:

1. How much does a defect cost in each phase of the process (e.g., design vs. test vs. release)?

2. What is the defect removal rate of the verification processes for each phase (e.g., inspections, peer reviews, testing)?

3. For each project:
   - how many total defects (estimated and actual)?
   - how many total defects in each phase of the process (estimated and actual)?

ROI and Defect Dollarization

<table>
<thead>
<tr>
<th>Goal</th>
<th>Key Questions</th>
<th>Metrics</th>
<th>Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achieve 7:1 ROI</td>
<td>1. For Each Project: How much does a defect cost in each phase of the process?</td>
<td>1. Effort per defect per phase per project * hourly rate = cost per defect (for old process and new process)</td>
<td>Defect databases: Effort</td>
</tr>
<tr>
<td>Measure old process against new process using Defect Dollarization</td>
<td>2. For each Project: a) How many total defects (estimated and actual)? b) How many total defects in each phase of the process?</td>
<td>2a) Total Defects per Project (for old process and new process) 2b) Total Defects per Phase per Project (for old process and new process)</td>
<td>All defect databases</td>
</tr>
<tr>
<td></td>
<td>3. For Each Project: a) What is the defect removal rate of the verification processes? b) For each phase (e.g., inspections, peer reviews, testing)?</td>
<td>3a) Defect Removal Efficiency per Project per verification process (for old process and new process) 3b) Defect Removal Efficiency per Project per verification process per phase (for old process and new process)</td>
<td>All defect databases</td>
</tr>
</tbody>
</table>

NOTE: Old process is estimated based on actual data
Agenda

Introduction

Process Measurement Framework\textsuperscript{SM} Overview

Real Example 1: Instrument a Process

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Some Lessons Learned

Questions and Answers

Some Lessons Learned - 1

Writing “good questions” in the G/Q/M paradigm is the hardest part.

The Process Measurement Framework\textsuperscript{SM} adds more structure to the goals making the questions easier to write.

Operational definitions are required for each metric for repeatability.

There are many metrics that are derivable from the basic 5 metrics (e.g., defect density = total defects / total size).
Some Lessons Learned - 2

The Process Measurement Framework\textsuperscript{SM} is very powerful.

The Process Measurement Framework\textsuperscript{SM} should also be used with a measurement process.

Other more complex goals and metrics such as ROI or defect prevention may be also used with the Process Measurement Framework\textsuperscript{SM}.

The Process Measurement Framework\textsuperscript{SM} should be tailored to each project and organization.

Summary

The Goal/Question/Metric paradigm, the Juran Quality Trilogy, and the SEI recommended initial core measures are best practices to build upon.

The Process Measurement Framework\textsuperscript{SM} is easy to use, very powerful, and scales up to handle complexity.

The Process Measurement Framework\textsuperscript{SM} can help:
- Instrument individual processes
- Instrument projects
- Provide a measurement foundation for an organization
- Help define complex metrics
World-Class Quality

Agenda

Introduction

Process Measurement Framework℠ Overview

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Some Lessons Learned

Questions and Answers

References