Rapidly Achieving Measurable ROI Using Early Defect Detection

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Presentation Objectives

“Raise the standard”: describe best-in-class early defect detection and measurable results.

Provide motivation for performing early defect detection.

Describe early defect detection principles, and describe a best-in-class early defect detection process.

Describe how to estimate and measure ROI using defect dollarization.

Answer any questions.
Agenda

Why use Early Defect Detection?

World-Class Early Defect Detection

What are In-Process Inspections?

Defect Dollarization and ROI

Summary

Questions and Answers
Industry Standard
Cost Ratio to Fix a Defect

Defects cost less to fix when detected earlier in the process.

Defects cost:
- $1 when detected during the Requirements phase.
- 10-20X more when detected during Design.
- 80-100X more when detected during Implementation.

Cost increases exponentially as defects are detected further into the process.

TIME
Requirements  Design  Implementation  Test  Release

COST

DEFECTS
EDD Shortens the Schedule

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

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World-Class Strategies

DEFECT PREVENTION

NUMBER OF DEFECTS

Req.’s Design Code Unit Test Test Release

EARLY DEFECT DETECTION (70-90% before Test)

## Best-In-Class EDD Benchmarks

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>WORLD-CLASS BENCHMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs of Poor Quality (COPQ)</td>
<td>Reduced from 33% to under 10% (Goal: Cut COPQ in half in 5 years)</td>
</tr>
<tr>
<td>Defect Removal Efficiency</td>
<td>70-90% defect removal before test</td>
</tr>
<tr>
<td>Post-Release Defect Rate</td>
<td>Six Sigma (3.4 defects per million)</td>
</tr>
<tr>
<td></td>
<td>Software Benchmark: 0.01 Defects per KSLOC)</td>
</tr>
<tr>
<td>Productivity</td>
<td>Doubled (e.g., in 5 years at ~20% a year)</td>
</tr>
<tr>
<td>Return on Investment</td>
<td>5:1 - 15:1 ROI</td>
</tr>
<tr>
<td>Schedule / Cycle Time</td>
<td>Reduced by 10-25% (e.g., per year)</td>
</tr>
</tbody>
</table>
## EEVVA Model

<table>
<thead>
<tr>
<th>EEVVA</th>
<th>Review Purpose/Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>Communication; Raise Issues (e.g., Walkthroughs)</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Raise issues; Consensus (e.g., Peer Reviews)</td>
</tr>
<tr>
<td>Verification</td>
<td>Verify req.s; Remove defects (e.g., Inspections)</td>
</tr>
<tr>
<td>Validation</td>
<td>Meet user needs (e.g., User Groups)</td>
</tr>
<tr>
<td>Assurance</td>
<td>Product and process assurance (e.g., Audits)</td>
</tr>
</tbody>
</table>

Example EDD Strategy: Defect Removal Efficiency (DRE)

EDD Strategies

Use the EEVVA Model to ensure that all reviews have a clear objective.

Use multiple EDD processes to achieve early defect detection and track defects to closure (e.g., CM, Peer Reviews, Inspections, Walkthroughs, Audits, Early Testing, etc.)

Requirements are critical documents. Formally inspect all requirement documents to remove as many defects as possible.

Formally inspect all high risk designs and code to remove as many defects as possible.

Other documents (e.g., design, code) may be peer reviewed and/or sampled.
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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.

## 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>Goal</td>
<td>Identify defects</td>
<td>Reach consensus</td>
<td>Reach consensus</td>
</tr>
<tr>
<td>State of Work Product</td>
<td>Final draft</td>
<td>Work in progress</td>
<td>Work in progress</td>
</tr>
<tr>
<td>Process/Measurements</td>
<td>Formal/Required</td>
<td>Informal/None required</td>
<td>Informal/None required</td>
</tr>
<tr>
<td>Checklists/Error Detection</td>
<td>Required/Defects classified</td>
<td>Not required/Not required</td>
<td>Not required/Not required</td>
</tr>
<tr>
<td>Participants</td>
<td>Moderator; Reader; Recorder; Author; Inspectors</td>
<td>Author; Reviewers</td>
<td>Author; Reviewers</td>
</tr>
<tr>
<td>Process Owner</td>
<td>Moderator; Independent verification</td>
<td>Author</td>
<td>Author</td>
</tr>
</tbody>
</table>
Inspection Process Model

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

World-Class Characteristics

Some world-class EDD characteristics are:

• Well-Defined process (e.g., roles)
• Process models (e.g., Role/Flow, ETVX, SADT)
• Well-Defined measurements
  – Internal metrics (e.g., preparation rate)
  – External metrics (e.g., productivity)
• Data driven checklists
• Tailored to the organization and to the projects
• Data analysis, statistics, and reliability
• Interfaces to other processes (some examples):
  – Configuration Management
  – Defect Prevention

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EDD ROI Assumptions

According to industry data, in-process inspections average about 7:1 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 *5-20 hours* to fix and verify per defect.

Once a defect is identified, in-process inspections take about *0.5-1 hours* to fix and verify per defect.
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)?
Key ROI Metrics

Key ROI metrics to compare verification processes:

- Total percentage of project (effort or cost)
- Work product size by phase (e.g., total pages, KSLOC, etc.)
- Number of defects (total and by phase)
- Defect density (e.g., defects per page or KSLOC)
- Effort (person hours) per page or KSLOC
- Effort per defect (fully loaded processes)
- Effort per defect (after defect is identified)
- Defect removal efficiency (DRE)
- ROI = Cost Reduction/Investment (annually)
Simple ROI Example

Calculate ROI using defect dollarization for 100 similar small projects (100 projects per year).

Defect ratio is 10X (0.5 hours to fix defect early in the process and 5 hours to fix a defect in test). **NOTE**: 10X is usually the best case. Many times it is 15X or 20X.

Our simple example will assume no previous EDD, and 75% defect removal efficiency after installing EDD.

Our example will assume $100,000 was spent on EDD training.
Example Pre-EDD (0% DRE): Defect Dollarization

Estimated 100 projects annually *

[100 defects * 5 hours] * $100 = $5,000,000

Example Post-EDD (75% DRE): Defect Dollarization

100 programs annually * [25 defects * 5 hours] * $100 = $1,250,000

100 projects annually * [75 defects * .5 hours] * $100 = $375,000

Average 7:1 ROI

Pre-EDD (100 Projects):
- 100 defects * 5 hours = 500 hours (50,000 hours)
- 500 hours * $100 = $50,000 ($5,000,000)

Post-EDD (100 Projects):
- 75 defects * 0.5 hours = 37.5 hours (3,750 hours)
- 37.5 hours * $100 = $3,750 ($375,000)
- 25 defects * 5 hours = 125 hours (12,500 hours)
- 125 hours * $100 = $12,500 ($1,250,000)

**Investment**: $475,000 ($100K Training + EDD Process)

**Return**: $5,000,000 - $1,725,000 = $3,275,000

**ROI**: $3,275,000 / $475,000 = 7:1 (100 Projects Annually)
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Most of industry “tests in quality”, and testing in quality is expensive.

Early defect detection saves money, improves productivity, and reduces cycle time.

Best-in-class results are defect removal efficiency of 70-90% before testing.

In-Process inspections average 7:1 ROI which can be realized in less than 6 months.

Early defect detection and defect prevention are world-class strategies.
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