Measurement Driven Project Management

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Presentation Objectives

Discuss some principles of measurement.

Explain the benefits of implementing data driven project management.

Present a QIC Process Measurement FrameworkSM.

Provide some examples of data driven project management metrics.

Discuss some measurement strategies and provide an example project measurement dashboard.

Answer any of your questions.
Agenda

Motivation

Data Driven Project Management

QIC Process Measurement Framework℠

Some Measurement Examples

Some Measurement Strategies

Summary

Questions and Answers
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.”
Evolutionary vs. Revolutionary Quality Improvement

Increased Quality & Productivity

Company A

Company B

> 20%

5-15%

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 (3.4 defects per Million Parts)</td>
</tr>
<tr>
<td>Productivity</td>
<td>Doubled (e.g., in 5 years)</td>
</tr>
<tr>
<td>Return on Investment</td>
<td>5:1 - 10:1 ROI</td>
</tr>
<tr>
<td>Schedule / Cycle Time</td>
<td>Cut in half (e.g., in 5 years)</td>
</tr>
</tbody>
</table>
Agenda

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Summary

Questions and Answers
Problem Statement

80% of all improvement efforts have no measurable results.

Most projects have limited or poor metrics to help them manage their projects.

The most common metrics are schedule and budget (which are usually inadequate).

Most organizations keep changing the schedule and budget, so that the original estimates are lost.

If an organization achieves their N+1 schedule, is that really a success?
Most projects estimate:
  • Schedule (e.g., dates)
  • Effort (e.g., hours)
  • Cost (e.g., $)

Many projects do not estimate:
  • Size (i.e., how big is the project?)
  • Defects (e.g., what is the needed quality of the product)?
Some PMI PMBOK Metrics

Planned Value (PV) = BCWS (Planned Effort)

Earned Value (EV) = BCWP (Earned Planned Effort)

Actual Value (AV) = ACWP (Actual Effort)

Schedule Performance Index (SPI) = EV/PV (ratio or %)

Cost Performance Index (CPI) = EV/AV (ratio or %)

Schedule Variance (SV) = EV - PV (in hours or cost)

Cost Variance (CV) = EV - AV (in hours or cost)

Why Size?

Size is “how big is the project”? 

For example, what is a size metric for building a house?
  - Total square feet
  - Total Finished/Unfinished square feet
  - Foundation size
  - Number of rooms (large, medium, small)

Projects with unclear or changing requirements can double in size.

Projects can track on schedule, effort, and cost, and still be in trouble.
Why Defects?

Defects help answer the question, “what is the quality of the project’s product”?

One major defect that reaches a customer can cause the project to lose money (e.g., lawsuit).

Defects can be estimated and tracked during a project.

Quality shipped to the customer can be accurately predicted ahead of time.

Measuring defects is a great way to do process improvement and defect prevention.
Why Size and Defects?

Without size, organizations don’t know:

- How big are our projects?
- Estimating may be off
- Productivity = size/effort

Without defects and size, organizations don’t know their quality:

- Defect density = defects/size
  - (During project execution)

- Product defect rate = defects/size
  - (After shipping the product to the customer)
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.
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## 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>

## 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>

## Project 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>

# 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

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Summary

Questions and Answers
Example: Project Data

**PLAN**

- **Goal - Planning**
  - Question: How many defects per phase will be generated in new products?
  - Metric: Defect Density
  - Collect: Software Size

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

**Defect Densities per Phase**

- **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

**Major Defects by Type and Class**

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

### Defect Removal Curve (Build 1)

<table>
<thead>
<tr>
<th></th>
<th>Planned</th>
<th>Actual</th>
<th>Limits Set</th>
<th>Within Limits?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Start-Up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Design</td>
<td>0.14</td>
<td>1.37</td>
<td>15%</td>
<td>978.5%</td>
</tr>
<tr>
<td>Preliminary Design</td>
<td>0.19</td>
<td>1.76</td>
<td>15%</td>
<td>926.3%</td>
</tr>
<tr>
<td>Detailed Design</td>
<td>0.26</td>
<td>0</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Code</td>
<td>0.87</td>
<td>0</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Sub-System Int. Test</td>
<td>0.112</td>
<td>0</td>
<td>15%</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Adapted from Beeson, Dennis D. and Olson, Timothy G., “Instrumenting Software Projects: A Case Study of Real World Projects”, SEPG 2001.*

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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

Improvement: Benchmarking

Before

Defect Removal Life Cycle

Minimum defect density yield from safety critical world-class processes benchmark.

Defect Removal Curve (Build 1)

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

Benmarks indicated Requirements and Design inspections could yield highest ROI from process improvement.

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QIC Process Measurement Framework<sup>SM</sup>

Some Measurement Examples

Some Measurement Strategies

Summary

Questions and Answers
# Project Metrics

<table>
<thead>
<tr>
<th>Projects</th>
<th>Size</th>
<th>Effort</th>
<th>Cost</th>
<th>Schedule</th>
<th>Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<tr>
<td>N</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Plate</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Full</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backlog</td>
<td>N+1</td>
<td></td>
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<td></td>
<td>...</td>
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</tbody>
</table>
## 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>Return On Investment</td>
<td>Risk Score</td>
</tr>
<tr>
<td>Schedule Performance Index</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUALITY</th>
<th>PRODUCTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Defect Rate</td>
<td>Size/Effort</td>
</tr>
<tr>
<td>Defect Removal Efficiency</td>
<td></td>
</tr>
<tr>
<td>Cost of Poor Quality</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>PRODUCTIVITY</th>
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</thead>
<tbody>
<tr>
<td>Size/Effort</td>
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</table>
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
How Much Do Defects Cost?

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

Defects vs. Cost

Requirements  Design  Implementation  Test  Release

TIME

COST

$1

1 DEFECTS

10 DEFECTS

100 DEFECTS
Best-in-Class Strategies

DEFECT PREVENTION

NUMBER OF DEFECTS

Req.’s Design Implementation Test Release

EARLY DEFECT DETECTION (70-90% before Test)

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Summary

Most improvement efforts have no measurable results.

Many projects do not estimate size and defects and have poor visibility into productivity and quality.

Data driven project management can provide a “metrics dashboard”:

• Performance
• Productivity
• Quality
• Risk
• ROI
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