Level 3 Measurement

Purpose of measurement is to provide information that improves decision making in time to affect the business or mission outcome.

Organization standardization drives the characteristics of Level 3 measurement activities:
- based on the standard processes, defined processes, and life cycle models
- cover the significant attributes of all life cycle phases
- includes standard set of measures
- stored in organization’s measurement repository

Corrective action is proactive, using objective action triggers.
**Level 3 - Earned Value - 1**

Cost Variance (CV) is the difference between actual and budgeted costs (BCWP - ACWP)

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Cost Variance (CV) is the difference between actual and budgeted costs (BCWP - ACWP)
Level 3 - Defect Trends

Status of Severity 1 Defects

<table>
<thead>
<tr>
<th>Date</th>
<th>New</th>
<th>Open (Including New)</th>
<th>Worked off During the Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/30/98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/8/98</td>
<td></td>
<td></td>
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<tr>
<td>5/15/98</td>
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<tr>
<td>5/20/98</td>
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<tr>
<td>5/27/98</td>
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<td>6/3/98</td>
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<td>6/10/98</td>
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<td>6/17/98</td>
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<td>6/24/98</td>
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<td>7/1/98</td>
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<td>7/8/98</td>
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<td>7/15/98</td>
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<td>7/22/98</td>
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<td>7/29/98</td>
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<td>8/5/98</td>
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<td>8/12/98</td>
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<td>8/19/98</td>
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<td>8/26/98</td>
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<td>9/2/98</td>
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<td>9/9/98</td>
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<tr>
<td>9/16/98</td>
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<tr>
<td>9/23/98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/30/98</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Open Last Week = 30
Closed This Week = 10
New This Week = 27
Upgraded = 0
Downgraded = 4
New This Week = 37

Level 3 - Defect Densities

<table>
<thead>
<tr>
<th>Cl</th>
<th>Size (KSLOC)</th>
<th>Defects</th>
<th>Defect Density (Defects/KSLOC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>44</td>
<td>48</td>
<td>1.1</td>
</tr>
<tr>
<td>B</td>
<td>32</td>
<td>60</td>
<td>1.9</td>
</tr>
<tr>
<td>C</td>
<td>36</td>
<td>36</td>
<td>1.0</td>
</tr>
<tr>
<td>D</td>
<td>28</td>
<td>33</td>
<td>1.2</td>
</tr>
<tr>
<td>E</td>
<td>34</td>
<td>42</td>
<td>1.2</td>
</tr>
<tr>
<td>F</td>
<td>15</td>
<td>46</td>
<td>3.1</td>
</tr>
<tr>
<td>G</td>
<td>9</td>
<td>30</td>
<td>3.3</td>
</tr>
<tr>
<td>Total</td>
<td>198</td>
<td>295</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Project: PSM
Data as of 30 June 95
Gap Between Levels 3 and 4

- Process fidelity is poor
- Tailoring is too loose
- Measurement culture not mature
- Few measures tracked at event/task level
- Missing and “dirty” data
- Data inconsistent across projects
- Process performance not quantified
- Cause of performance differences unknown
- Unfocused org analysis and support

Characteristics of Level 4

Establish achievable quantitative project goals for performance and product and service quality

Establish defined processes and plans that have the capability to achieve the goals

Understand, reduce, and control process variation

Statistically predict the results of primary work efforts (their process) on a regular basis

Statistically predict the project results against the goals on a regular basis

Perform corrective actions so that the goals are achieved
Level 4 Measures

![Problem Report Prediction Model](image)

- **Actual**: Red line
- **Model**: Blue line

**Average Preparation Time Spent**

- **Code Inspection ID**: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
- **Ave Hours per Reviewer**: 0.00 to 3.00
- **UCL**: Blue line
- **LCL**: Black line
- **XBAR**: Dotted line

**Level 4 - Detection/Removal Profiles**

**Defect Detection Profile**

- **Reqmts**: Light blue bar
- **Design**: Light blue bar
- **Code**: Dark blue bar
- **Unit Test**: Light blue bar
- **Integrate**: Light blue bar
- **Sys Test**: Light blue bar
- **Del 90 Days**: Light blue bar

*Source: Kan, 1995*
Goals – Stepping Stone or Stumbling Block?

Goals need to include specification of measures and analyses that will be used to judge whether the goals will be / are achieved

Goals need to be expressed quantitatively or objectively
  • not all goals are quantifiable

Goals need to cover a unified set of measures

Goals need to be negotiated with the stakeholders
  • fact-based and data-based negotiations
  • what the project will achieve

Goals represent an agreement with the stakeholders on the measured result that will be achieved
  • a commitment!

Setting Level 4 Goals

Flow-down of organizational goals to projects is not required for Level 4, but project quality goals are required

Project quality goals should measure in same dimensions as the organization’s goals, but they do not have to satisfy the organizational values
Characteristics of Level 5

Organization understands its critical business issues or areas of concern

Organization establishes the quantitative performance and quality improvement goals

Organization establishes the infrastructure and defines the strategy for systematically pursuing improvements

Improvements are pursued, identified, evaluated, piloted, and deployed to achieve the improvement goals

Three categories of process improvements
- defect and problem prevention improvements
- continuous capability improvements (individual and team)
- planned innovations

Level 4 versus Level 5 Goals

Level 4 and 5 projects need a stable base to succeed
- requirements, process, budget, schedule, staff, resources, commitments, and performance and quality goals
- credible analyses that show these are consistent

Achieving organizational improvement ("stretch") goals is the responsibility of those who set them
- goal “flow-down” to projects can be a dangerous strategy
- the organization determines how to achieve the goals, then ...
- changes to project goals are negotiated based on facts and data
Setting Level 5 Goals

1. Define project goals
2. Set project requirements, process, commitments, plans, and goals
3. Business and internal factors
4. Project requirements and objectives
5. Establish organization’s goals
6. Standard processes, organization’s PCBs, project PPBs
7. Pilot/evaluate candidate changes
8. Negotiate project goals
9. Plan deployment
10. Deploy goals and improvements
11. Perform project work
12. Products and services

TRW Systems

A leading global integrator of complex systems
- based on information technology and systems engineering expertise
- integrated solutions: architecture, development and sustainment

Many customers and markets in transformation
Six Sigma – a cornerstone of our transformation
Global Business Presence

- 50 States
- 34 Countries
- 15,000 Employees
- 2001 sales of $3.1B

TRW Systems Business Mix

- Markets
  - Defense 45%
  - Civil 32%
  - Commercial 6%

- Contract Type
  - Fixed Price 18%
  - Time & Materials/Fixed Rate 16%

- 2001 sales of $3.1B
- 15,000 employees
- Solutions for clients range from architecture to development and sustainment
Six Sigma Methodologies

D- Each project must have a business case and sponsor
M- You can’t manage what you don’t measure
A- Solve the problem, not the symptoms
I- Push for innovations, breakthrough thinking
C- Who is accountable for making the fix stick?

Design New Products and Processes that meet customer needs

Improve Existing Processes so that outputs meet customer requirements

Control and manage Cross-Functional Processes to meet business goals

Enterprise-Wide Process Improvement

ISO 9001
- Six Sigma
- Business Measures
- Voice of the Customer
- DMAIC
- DFSS
- Methods and Tools
- Change Management
- Process Management

CMMI

- ISO 9001 provides a quality management discipline for all project and functional areas
- Six Sigma provides a comprehensive framework for ensuring process improvements support corporate goals
- CMMI ensures use of industry best practices in software and systems engineering
Using Six Sigma with CMMI

For individual processes:
- CMM/CMMI identifies what activities are expected
- Six Sigma identifies how activities might be improved (more efficient, more effective, …)

**Example – Project Planning in CMMI**

<table>
<thead>
<tr>
<th>SG 1 Establish Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 1.1 Estimate the Scope of the Project</td>
</tr>
<tr>
<td>SP 1.2 Establish Estimates of Project Attributes</td>
</tr>
<tr>
<td>SP 1.3 Define Project Life Cycle</td>
</tr>
<tr>
<td>SP 1.4 Determine Estimates of Effort and Cost</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SG 2 Develop a Project Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 2.1 Establish the Budget and Schedule</td>
</tr>
<tr>
<td>SP 2.2 Identify Project Risks</td>
</tr>
<tr>
<td>SP 2.3 Plan for Data Management</td>
</tr>
<tr>
<td>SP 2.4 Plan for Project Resources</td>
</tr>
<tr>
<td>SP 2.5 Plan for Needed Knowledge and Skills</td>
</tr>
<tr>
<td>SP 2.6 Plan Stakeholder Involvement</td>
</tr>
<tr>
<td>SP 2.7 Establish the Project Plan</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SG 3 Obtain Commitment to the Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 3.1 Review Subordinate Plans</td>
</tr>
<tr>
<td>SP 3.2 Reconcile Work and Resource Levels</td>
</tr>
<tr>
<td>SP 3.3 Obtain Plan Commitment</td>
</tr>
</tbody>
</table>

Could fully meet CMMI goals and practices, but still write poor plans

Six Sigma can be used to improve planning process and write better plans

CMM/CMMI and Six Sigma Comparison

Both use same tools and methods

CMM/CMMI adds organizational focus to 6σ work

Benefits of 6σ activities increase with maturity level

<table>
<thead>
<tr>
<th>Level</th>
<th>Focus</th>
<th>Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Full toolset used to make continuous improvements</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Statistics used to stabilize and predict performance</td>
<td>Process must be stabilized before making improvements</td>
</tr>
<tr>
<td>3</td>
<td>Simple tools applied to standardized processes</td>
<td>Large variation in performing standardized processes</td>
</tr>
<tr>
<td>2</td>
<td>Simple tools applied to problems within projects</td>
<td>Projects use different processes</td>
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</table>
## Six Sigma and Level 4 Lessons

<table>
<thead>
<tr>
<th>Typical Six Sigma</th>
<th>Level 4 Six Sigma</th>
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</thead>
<tbody>
<tr>
<td>Business justification for Six Sigma projects must substantiate improvement</td>
<td>Achieve stable and predictable results – don’t perturb current capability</td>
</tr>
<tr>
<td>Quantified business case</td>
<td>Level 3 capability numbers are myth – business improvement case fiction</td>
</tr>
<tr>
<td>Short duration projects – 4 to 6 months or less</td>
<td>Demonstrating stable and predictable process takes considerable time</td>
</tr>
<tr>
<td>Full power of Six Sigma assumes a well-defined, consistent process</td>
<td>Level 3 organizations use Six Sigma to shore up Level 3 for Level 4</td>
</tr>
</tbody>
</table>

## Overall Lessons Learned

Level 3 metrics, measurement processes, and goal setting are generally inadequate for Levels 4 and 5

Six Sigma is an enabler for higher maturity

- focus on data, improvement paradigm
- tying improvements to business goals
- tools and methods support the Level 4/5 analysis tasks

CMM/CMMI practices provide a framework for focusing Six Sigma projects

Basic quality management tools (without Six Sigma overhead) are useful and effective at lower maturity levels
## Contract Information

<table>
<thead>
<tr>
<th>Charlie Weber</th>
<th>Rick Hefner</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:Charles.Weber@teraquest.com">Charles.Weber@teraquest.com</a></td>
<td><a href="mailto:Rick.Hefner@trw.com">Rick.Hefner@trw.com</a></td>
</tr>
<tr>
<td>TeraQuest Metrics, Inc.</td>
<td>TRW</td>
</tr>
<tr>
<td>P.O. Box 200490</td>
<td>One Space Park R2/2144</td>
</tr>
<tr>
<td>Austin, Texas, USA 78720</td>
<td>Redondo Beach, CA 90278</td>
</tr>
<tr>
<td>512-219-9152 (phone)</td>
<td>310-812-7290</td>
</tr>
<tr>
<td>512-219-0587 (fax)</td>
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</tr>
</tbody>
</table>

Site address:
12885 Research Boulevard
Austin, Texas, USA 78750

TeraQuest Web site:
[http://www.teraquest.com](http://www.teraquest.com)