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)

Cost Variance

Cost ($K)

Actual cost of Work Performed (ACWP)

Budgeted cost of work performed (BCWP)

CPI = .63
(<1 over budget)

Level 3 - Earned Value - 2

Schedule Variance (SV) is the difference between budgeted cost for work performed and work scheduled (BCWP - BCWS)

Schedule Variance

Cost ($K)

Budgeted cost of work scheduled

Budgeted cost of work performed (BCWP)

SPI = .52
(<1 behind sched)
Level 3 - Defect Trends

Status of Severity 1 Defects

Level 3 - Defect Densities

Defect Density

<table>
<thead>
<tr>
<th>CI</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

Level 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

Level 3

Source: Adapted from Perdue in (Paulk et al., 1995)

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

Problem Reports

Actual

Model

Average Preparation Time Spent

Ave Hours per Reviewer

0.00 1.00 2.00 3.00

1 2 3 4 5 6 7 8 9 10

11 12 13 14 15 16 17

Code Inspection ID

Level 4 - Detection/Removal Profiles

Defect Detection Profile

Defects/KSLOC

Phase

Reqmts Design Code Unit Test Integrate Sys Test Del 90 Days

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

---

### 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%
  - Intelligence 17%

- Contract Type
  - Fixed Price 18%
  - Time & Materials/Fixed Rate 16%
  - Cost Type 66%

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

- **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

- **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?

Enterprise-Wide Process Improvement

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

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

<table>
<thead>
<tr>
<th>SG 3 Obtain Commitment to the Plan</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 3.1 Review Subordinate Plans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 3.2 Reconcile Work and Resource Levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 3.3 Obtain Plan Commitment</td>
<td></td>
<td></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>
</tr>
</tbody>
</table>
Six Sigma and Level 4 Lessons

<table>
<thead>
<tr>
<th>Typical Six Sigma</th>
<th>Level 4 Six Sigma</th>
</tr>
</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>
<td></td>
</tr>
</tbody>
</table>

**site address:**

12885 Research Boulevard  
Austin, Texas, USA 78750

**TeraQuest Web site:**

http://www.teraquest.com