Integrated Measurements for CMMI®

Gary Natwick
Harris Corporation

Where are we?

Welcome to Florida

We are here
Government Communications Systems Division

- $1.8B in Sales
- 8,000 Employees
- ISO 9001:2000
- CMMI® Level 3

DoD Programs

Civil Programs

National Programs

Strategic Management and Business Development

Homeland Security Programs

Harris Technical Services Corporation

Process Improvement At GCSD

60% Reduction in Defects
225% Improvement in Productivity

Integrated Measurements for CMMI® PSM Users’ Group Conference

Gary Natwick - 3
24-28 July 2006
Why We Measure

- Characterize
  - Gain understanding of integrated processes, products, and resources
  - Establish baselines for future comparisons
- Evaluate
  - Measurement indicators show when projects and processes are drifting off track, so they can be brought back under control
  - Assess achievement of quality goals and impacts of technology and process improvements on products and processes
- Predict
  - Predictive measures are also the basis for trending, so estimates for cost, time, and quality can be updated based on current evidence
  - Gain an understanding of relationships among processes and products for future prediction
- Improve
  - Identify roadblocks, root causes, inefficiencies, and other opportunities for improving product quality and process performance
  - Measures of current performance to compare against and judge whether or not improvement actions are working as intended and what the side effects may be

Goal-Driven Measurements

- Project Management
  - Planning, estimating, monitoring, and controlling project: costs, schedules and quality
- Process Improvement
  - Providing baseline data, measuring trends, tracking root causes of problems and defects, and identifying and implementing changes for process improvement
- Organizational Vision
  - Effectively applying unified end-to-end integrated processes and methods encompassing proven and emerging standards/approaches for the purpose of delivering high-quality cost competitive system solutions to our customers
Goal-Question-Metric (GQM)

**Business Goals**
What are our business goals?
- Improve customer satisfaction by reducing defects

**Measurement Goals**
What do we want to achieve in order to satisfy our business goals?
- Reduce post-delivery defects to “N” per KLOC

**Questions**
What questions will help us plan & manage progress toward our goals?
- Where are defects introduced & removed?
- How effective are peer reviews?

**Metric**
What metrics are necessary to answer these questions?
- Defects detected in peer reviews, testing...
- Defect categorization, rework time...

The question is **not**:
What metrics should I use?

Rather:
What do I want to know or learn?
Why are we collecting the data?
How do we use the data?

Integrated Measurement Process

- **Planning**
  - Metrics used to support quantitative management
  - Planned and/or expected performance in the metrics including any required goals and/or control limits
  - Variance implication and corrective action for metrics falling outside control limits
  - Source and collection mechanism of the measurement data
  - Responsible persons for collection, analysis, reporting, and managing

- **Collection**
  - Occurs at the periodic intervals defined in the project plans and is monitored for completeness, integrity and accuracy
  - Primary source for actual data is in the accounting systems used to manage the project (e.g., financial management, configuration management, change management, risk management)
  - Data is input into the division standard metric tool each period
**Integrated Measurement Process**

- **Analysis**
  - Metrics are communicated graphically for a clear and easily understood message.
  - Better to have many graphs than it is to have many messages on one graph.
  - Metrics are indicators that give warnings of problems associated with issues.
  - An issue may be tracked with several metrics using different measures.
  - Trend-based metrics when expected or planned values change regularly over time to determine whether the performance implied is achievable.
  - Limit-based metrics when expected or planned values remain relatively constant over time to determine whether the performance crosses its established bounds.

- **Reporting**
  - Quantitative management decisions are communicated to project team members, management and customers.
  - Integrated into the management process and occurs as soon as possible after analysis has been completed to assure that there is time for corrective action.
  - Metric’s falling outside the control limits are reviewed and corrective actions are recorded and tracked to closure.

**Integrated Engineering Metrics**

- **Frames** display one or more metrics.
- **Control Panels** display one or more frames.
- **Reports** contain one or more control panels.

- **Metrics** are composed of measures.
- **Measures** are units of measurement.
Frames

Integrated Project Compliance

- Performance
- Progress
- Cost and Schedule
- Resources
- Software Performance
- Electrical Performance
- Mechanical Performance
- System I&T Performance
- Peer Reviews
- Management
**Electrical Engineering Performance**

- **Electrical Size EAC - Plan**: Plan - 5000, URE - 5000
  - Actual: 5100
- **Electrical Size EAC - Goals**: Goal - 5000, URE - 5000
  - Actual: 5100

**Electrical Engineering Staffing - CCA**

- **Plan**: Actual: 5000
- **Plan - 45% Actual**: 5500

**Electrical Engineering Staffing - TPCA/AMIE**

- **Plan**: Actual: 5000
- **Plan - 45% Actual**: 5500

**Electrical Defect Severity**

- **Plan**: Actual: 5000
- **Plan - 45% Actual**: 5500

**Electrical Engineering Process Issues/Actions**

- **Gates**: Issues/Actions

**Electrical Engineering Process Issues/Actions**

- **Pins**: Issues/Actions

**Mechanical Engineering Performance**

- **ME Defects - EOC State**: Defects: 10, EOC State: 5000
  - Defects: 10, EOC State: 5000
  - Total EOC: 10, Actual: 5000

- **ME Defects - EOC State**: Defects: 10, EOC State: 5000
  - Defects: 10, EOC State: 5000
  - Total EOC: 10, Actual: 5000

**ME - ECOs per Drawing**

- **Plan**: Actual: 5000
  - Actual: 5000

**ME - Issues per Drawing**

- **Plan**: Actual: 5000
  - Actual: 5000

**Integrated Measurements for CMMI® PSM Users’ Group Conference**

**Gary Natwick**

24-28 July 2006
Measuring Process Compliance

- Integrated Process Foundation
  - Organizational requirements
    - Process Model compliance (CMMI®)
  - Integration and collaboration across functional organizations
  - Disciplined repeatable processes with objective criteria
    - Entry/exit criteria, inputs, outputs, verification, measures
  - Planning each process, and tracking against plan
    - Tailoring standard processes and assets
  - Budgets, schedules, resources
  - Managing established baselines
  - Managing Stakeholder involvement
  - Measuring progress and improvement
**Integrated Process Manual**

**Program Management Processes**

- Program Planning
- Estimation
- Program Monitoring and Control
- Supplier Acquisition & Management
- Change Management

- Proposal Development
- Requirements Analysis
- System Architecting/Design
- Design
- Code and Unit Test
- Fabrication and Assembly
- Product Integration
- Verification
- Validation
- Production
- Field Support

- Requirements Management
- Risk Management
- Configuration and Data Management
- Program Metrics
- Decision Analysis and Resolution
- Peer Review
- Design Review
- Quality Assurance
- Integrated Logistics Support

**Organizational Processes**

- Process Improvement
- Training
- Division Metrics

**Program Life-Cycle Processes**

**Program Support Processes**

**Program Management Processes**

- **Customer Requirements / RFP**
  - Establish Technical Baseline
  - Scope of work

- **Supplier Product**
  - Supplier Agreement
  - Historical Data and Models
  - IPM Division Metrics process

- **IPM Supplier Acquisition & Management process**
  - Scope of work
  - Estimates

- **IPM Program Planning process**
  - IPM Estimation process
  - Baseline Change

- **IPM Program Monitoring & Control process**
  - Contract Baseline

- **All IPM Processes**
  - Plans
  - Re-plan

- **All IPM Processes**
  - Status
  - Corrective Action
### Program Life-Cycle Processes - 1

#### Key Products

<table>
<thead>
<tr>
<th>Life-Cycle Phase</th>
<th>Baseline</th>
<th>Milestones / Reviews</th>
<th>Key Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>Proposal Baseline</td>
<td>Proposal Baseline</td>
<td>Proposal Plans (P)</td>
</tr>
<tr>
<td>System Requirements</td>
<td>Requirements</td>
<td>Requirements</td>
<td>Sys Arch (P)</td>
</tr>
<tr>
<td>Functional Baseline</td>
<td>Functional</td>
<td>Functional</td>
<td>Operational Threads / Use</td>
</tr>
<tr>
<td>- Allocated Design</td>
<td>- Allocated Design</td>
<td>- Allocated Design</td>
<td>Sys Arch Design</td>
</tr>
<tr>
<td>- Developed Configuration</td>
<td>- Developed Configuration</td>
<td>- Developed Configuration</td>
<td>Interface Defn</td>
</tr>
<tr>
<td>Fab. Code, Integration</td>
<td>Fab. Code, Integration</td>
<td>Fab. Code, Integration</td>
<td>Data Package</td>
</tr>
<tr>
<td>Verification</td>
<td>Verification</td>
<td>Verification</td>
<td>Traceability</td>
</tr>
</tbody>
</table>

### Program Life-Cycle Processes - 2

- **IPM Production and Field Support processes apply only to the extent required by contract**
  - May be not applicable
  - May implement revisions to the baseline products
  - May involve other life cycle processes
    - Requirements, design, implementation
- **IPM Production Process**
  - Produce and deliver multiple systems
- **IPM Field Support Process**
  - Site installation
  - Operations support
  - Engineering services
### Integrated Compliance Approach

**Organization**
- Command Media
- Organizational Learning

**Projects**
- CMMI
- IPM
- Tailoring
- Process Compliance Evidence

**Process Compliance Evidence**

<table>
<thead>
<tr>
<th>Overview</th>
<th>A brief description of the process intent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entry Criteria</strong></td>
<td>State, Prerequisites, Criteria</td>
</tr>
<tr>
<td><strong>Exit Criteria</strong></td>
<td>State, Criteria</td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
<td>Needed work products, resources</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td>Resulting work products</td>
</tr>
<tr>
<td><strong>Required Activities</strong></td>
<td>Mandatory tasks to implement the process</td>
</tr>
<tr>
<td><strong>Measures</strong></td>
<td>Process performance against plans</td>
</tr>
<tr>
<td><strong>Organizational Improvement Information</strong></td>
<td>Metrics, reusable work products</td>
</tr>
<tr>
<td><strong>Verification</strong></td>
<td>Process compliance oversight</td>
</tr>
<tr>
<td><strong>Tailoring</strong></td>
<td>Approved tailoring, process specific</td>
</tr>
<tr>
<td><strong>Implementation Guidance</strong></td>
<td>Common implementation descriptions</td>
</tr>
<tr>
<td><strong>Supporting Documentation and Assets</strong></td>
<td>Applicable organizational references</td>
</tr>
</tbody>
</table>

**Program evidence needed to demonstrate IPM process compliance**
Process Compliance Scores

- **NY (Not Yet)**: To be appraised at a later date (i.e., the process has not yet been executed by the process and cannot be appraised).
- **NA (Not Applicable)**: Not applicable to the project (e.g., Code and Unit Test Process is not applicable to a production-type program).
- **NS (Not Scored)**: Pending an appraisal.
- **FI (Fully Implemented)**: Direct artifacts are present and appropriate. No substantial weaknesses.
- **LI (Largely Implemented)**: Direct artifacts are present and appropriate. One or more substantial weaknesses.
- **PI (Partially Implemented)**: Direct artifact is absent or inadequate. Substantiated by indirect artifact/affirmation. One or more substantial weaknesses.
- **NI (Not Implemented)**: Any situation not covered by the above.

Process Compliance Measures

- **A**: Represents overall process compliance score for program, based on lowest color score – harsh, but in keeping with CMMI standards.
- **B**: Depicts scoring distribution over all process items. More insight on the overall project score (A).
- **C**: Depicts score for each process executed or being executed by this program. 3 columns identify types of processes. In PCM, point+click on underlined acronym drills down to scoring details for the process.

Project Evidence

This page allows users to edit project evidence.

- Baseline: Rev 09 34-May06
- Project: [Project Name]
- Life Cycle: [Life Cycle]
- Support: [Support]
- Process: [Process]
- Phase: [Phase]
- Expected Artifact: [Expected Artifact]
- Project Artifact: [Project Artifact]
- Addit Location: [Addit Location]
- Comment: [Comment]
- Display Information:
  - Display Only Statement
  - Display Only Statements
  - Display Only Information
- Appraisal Overlay:
  - Filter by Appraisal Type
  - Select Appraisal
- Display Information:
  - Display All Statements
  - Display Only Statement
  - Display Only Not Yet
  - Display Only Not Score
  - Display Only Not Included
  - Display Only Not Applicable
  - Display Only Not Needed

Export Project Status
Lessons Learned - 1

• One metric doesn’t tell the whole story
  – Need an integrated and many times orthogonal views
  – Trending is key
• Project planning is key
• Data collection is the hardest
• Having standard tools is highly desirable
  – Consistency
  – User friendly
  – Easy access
• Training is a must
  – Cultural change is hard
  – Train everything, even the obvious

Lessons Learned - 2

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Relevant Entities</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Measure</td>
<td>Base Measures</td>
<td></td>
</tr>
<tr>
<td>Specification</td>
<td>Measurement Method</td>
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<tr>
<td>Section</td>
<td>Type of Method</td>
<td></td>
</tr>
<tr>
<td>Derived Measure</td>
<td>Scale</td>
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<tr>
<td>Specification</td>
<td>Type of Scale</td>
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<tr>
<td>Section</td>
<td>Unit of Measurement</td>
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<tr>
<td>Derived Measure</td>
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<td>Indicator</td>
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<td>Information Need Section</td>
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<td>Project Engineering Metrics Tool</td>
<td>Projects</td>
<td>Pre-defined Metrics</td>
</tr>
<tr>
<td>Enterprise Measurement Tool</td>
<td>SPC</td>
<td>User Defined &amp; Controlled</td>
</tr>
</tbody>
</table>

Not Just Engineering
Contact Information

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