All Others Bring Data

CMMI® and Goal-Driven Measurement

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA  15213

Charlene Gross and Wolf Goethert
November 2007
In God We Trust, All Others Bring Data
The benefit and value of measurement comes from the decisions and actions taken in response to analysis of the data, not from the collection of the data.
Objectives

Review basic concepts of CMMI® and Goal-Driven Measurement

Provide examples of relationships between CMMI® and Goal-Driven Measurement

Describe application of measurement throughout CMMI®
Definition: CMMI-DEV, Version 1.2 (CMMI)

Non-prescriptive best practices

Infuse quality into products through the use of better processes

Focuses on improving processes from ad hoc, immature processes to disciplined, mature processes

If you can't describe what you are doing as a process, you don't know what you're doing. ---W. Edwards Deming
Basic Concepts - CMMI® Model Components

- Applies to the Project
- Applies to the Process

Specific Goals

Specific Practices

Typical Work Products

Subpractices

Generic Goals

Generic Practices

Subpractices

Generic Practice Elaborations

PROCESS AREA
Measurement and Analysis Process Area
Specific Goals

SG 1: Align Measurement and Analysis Activities

- Measurement objectives and activities are aligned with identified information needs and objectives.

SG 2: Provide Measurement Results

- Measurement results that address identified information needs and objectives are provided.
MA Specific Practices

- Establish Measurement Objectives
- Specify Measures
- Specify Data Collection Procedures
- Specify Analysis Procedures
- Communicate Results
- Store Data & Results
- Analyze Data
- Collect Data

Goal 1
Align Measurement Activities

Goal 2
Provide Results
Measurement and Analysis Supports All Other CMMI Process Areas

Measurement and Analysis

All process areas

Quality and noncompliance issues

PPQA

Processes, work products and standards, and procedures

Configuration items and change requests

Baselines and audit reports

Configuration Management

Information needs

Goal-Driven Measurement
First Law of Blissful Ignorance

"What you don't know will always hurt you."

[Robbins and Finley, 1996]
Adaptable process to identify and define measures

Begins with identifying business goals and breaking them down into manageable subgoals

Ends with a plan for implementing well-defined measures and indicators that support the goals
Goal-Question-Metric (GQM)

What are our business goals?
â Improve customer satisfaction by reducing defects

What do we want to achieve in order to satisfy our business goals?
â Reduce post-delivery defects to “N” per KLOC

What questions will help us plan & manage progress toward our goal?
â Where are defects introduced & removed?
â How effective are peer reviews?

What measures are necessary to answer these questions?
â Defects detected in peer review, testing ...
â Defect categorization, rework time ...

[Basili 88, Basili 89, Rombach 89]
Goal-Driven Measurement Process Model

Goal(s)

Questions

Indicators

Measures

Goal(s)

Question 1    Question 2    …    Question n

Reporting Periods

Total SLOC

Planned

Actual

Weeks

Number

Module

Trouble Reports

Size    Effort    …    Defects    Milestone Dates

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Types of Indicators

Goal

Success criteria

Strategy to accomplish goal

Tasks to accomplish goal

Success indicators

Hint: Task Completion Does Not Equal Success

Impact

Analysis indicators

Progress indicators

For project manager

Roll-up for higher management

Types of Indicators

Analysis indicators

Tasks to accomplish goal

Task 1
Task 2
Task 3
Task n

Success indicators

Progress indicators

Strategy to accomplish goal

Goal

Success criteria
Goal-Driven Measurement – GQ(I)M Steps

1. Clarifying Questions
   - Restated Goal

2. Subgoals by Perspective
   - Perspective 1
   - Perspective n

3. Strategies & Activities
   - Determine Strategy & Activities
   - Assess impact of strategy
   - Prioritize strategy
   - Strategy 1
     - Activity 1
     - Activity 2
   - Strategy 2
   - Strategy n

4. Operationalize Goal Statement

5. Success Criteria

6. Success Indicators

7. Progress Indicators
   - Activity Performed & Adopted
   - Activity is working

8. Analysis Indicators
   - Reporting Practice

9. Reporting Practice
   - Tasks
   - Functions
   - Complete Test Cases

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Cross Reference Matrix

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Applying Goal-Driven Measurement – GQ(I)M Steps -3

Identify Actions Needed to Implement Your Measures

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**Typical Planning tasks**

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**Data Elements**

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**Planning Tasks**

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**Analysis & Diagnosis**

Action Plans
One accurate measurement is worth a thousand expert opinions. ---Admiral Grace Hopper
Mapping CMMI Measurement and Analysis to Indicator Template

Measurement & Analysis

Indicator Template
- Date
- Indicator Name/Title
- Objective
- Questions
- Visual Display

Data Reporting
- Responsibility for Reporting
- By/To Whom
- How Often

Data Storage
- Where
- How
- Security

Algorithm
- Assumptions
- Interpretation

Probing Questions
- Analysis
- Evolution

Feedback Guidelines
- X-reference

Perspective
- Input(s)
- Data Elements
- Definitions

Data Collection
- How
- When/How Often
- By Whom
- Form(s)

SP 1.1 Establish Measurement Objectives

SP 1.2 Specify Measures

SP 1.3 Specify Data Collection Procedures

SP 1.4 Specify Analysis Procedures

SP 2.1 Collect Data

SP 2.2 Analyze Data

SP 2.3 Store Data & Results

SP 2.4 Communicate Results
Goal-Driven Measurement Implementation

Supports All CMMI Process Areas

Measurement and Analysis

Goal-Driven Measurement Implementation

MA

Information needs

Process and Product Quality Assurance

PPQA

Quality and noncompliance issues

Processes, work products and standards, and procedures

Configuration Management

CM

Configuration items and change requests

Baselines and audit reports

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How Goal-Driven Measurement Supports CMMI – High Maturity Organizations
The following samples are drawn from the informative material of the PAs.

Color coding for PAs is by Maturity Level and solely for illustration of the broad application of Goal-Driven Measurement.

Yellow = Maturity Level 2 PAs
Green = Maturity Level 3 PAs
Blue = Maturity Level 4 PAs
Orange = Maturity Level 5 PAs
White = Generic Practices

Backup slides provide more detail for each PA, as well as the complete name of the PA represented.
Sample The Ways That Goal-Driven Measurement Supports PAs At All Levels - 2

Measurement assumptions, definitions, what counts, what doesn’t

Description of approach for measuring and analyzing performance data

Defined requirements for collection
Sampling The Ways That Goal-driven Measurement Supports PAs At All Levels

- Documentation of organizational and measurement objectives
  - Organizational Process Focus ML3
  - Causal Analysis and Resolution ML5
  - Organizational Innovation and Deployment ML5
  - Generic Practice 4.2 Stabilize Sub process Performance
  - Generic Practice 5.1 Ensure Continuous Process Improvement

- Information and descriptions to understand and interpret measures
  - Organizational Process Definition + IPPD ML3
  - Quantitative Project Management ML4
  - Generic Practice 2.8 Monitor and Control the Process
  - Generic Practice 3.2 Collect Improvement Information

- Definitions of measures and measurement activities
  - Verification ML3
  - Organizational Process Performance ML4
  - Quantitative Project Management ML4
  - Causal Analysis and Resolution ML5
  - Organizational Innovation and Deployment ML5
Conclusion
The Quality Of The Product Is Highly Influenced By The Quality Of The Process

GQ(1)M – How We Know That Process and Product Improvement Efforts Are Successful

CMMI – What Practices We Apply To Influence Quality Of Process And Product

Were we successful?
Customer perspective (final product)
Organizational perspective (processes)

- On time
- Within budget
- Of acceptable quality
- Does what its supposed to do
- Customers like it
Basic Concepts Summary

CMMI Version 1.2 Model Structure

- Process Area
  - Specific Goals
    - Specific Practices
      - Typical Work Products
    - Generic Practice Elaborations
  - Generic Goals
    - Generic Practices
      - Sub-practices
      - Sub-practices

Measurement and Analysis Process Area

- SG 1 Align Measurement and Analysis Activities
  - SP 1.1 Establish Measurement Objectives
  - SP 1.2 Specify Measures
  - SP 1.3 Specify Data Collection and Storage Procedures
  - SP 1.4 Specify Analysis Procedures
- SG 2 Provide Measurement Results
  - SP 2.1 Collect Measurement Data
  - SP 2.2 Analyze Measurement Data
  - SP 2.3 Store Data and Results
  - SP 2.4 Communicate Results
- Goal-Driven Measurement Process
  - Step 1: Identify your business goals
  - Step 2: Identify what you want to know or learn
  - Step 3: Identify your subgoals
  - Step 4: Identify the entities and attributes
  - Step 5: Formalize your measurement goals
  - Step 6: Identify your measurement questions & indicators
  - Step 7: Identify the data elements
  - Step 8: Define and document measures and indicators
  - Step 9: Identify the actions needed to implement your measures
  - Step 10: Prepare a plan

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Finding Additional Goal-Driven Measurement Information . . .

Organizational – Dave Zubrow, Director SEMA; Wolf Goethert, Bob Ferguson, Jeanine Siviy,

Selected Publications –


Questions
Backup Slides
SP 1.1 Monitor Project Planning Parameters

Monitor the actual values of the project planning parameters against the project plan.

GQ(I)M Process and Indicator Supports:

- Recording associated contextual information (e.g. assumptions, definitions, what counts and what doesn’t) to help understand the measures.
SP 1.6 Conduct Progress Reviews

Periodically review the project's progress, performance, and issues.

GQ(I)M Process and Indicator Supports:

- Description of approach for measuring and analyzing project performance data
SP 2.1 Prepare for Peer Reviews

Prepare for peer reviews of selected work products.

GQ(I)M Process and Indicator Supports:

- Record of defined requirements for collecting data during the peer review

SP 3.2 Analyze Verification Results

Analyze the results of all verification activities.

GQ(I)M Process and Indicator Supports:

- Documentation of technical performance parameters as part of measurement definition.
SP 1.1 Establish Organizational Process Needs

Establish and maintain the description of the process needs and objectives for the organization.

GQ(I)M Process and Indicator Supports:

Documentation of measurement objectives established by tying organizational objectives to the picture of success and what we need to know.
SP 3.4 Incorporate Process-Related Experiences into the Organizational Process Assets

Incorporate process-related work products, measures, and improvement information derived from planning and performing the process into the organizational process assets.

GQ(I)M Process and Indicator Supports:
  Â Documentation of how the organization's common set of measures will be analyzed
SP 1.4 Establish the Organization’s Measurement Repository

Establish and maintain the organization’s measurement repository.

GQ(I)M Process and Indicator Supports:

- Information and descriptions needed to understand and interpret the measures and assess them for reasonableness and applicability.
Integrate the project plan and the other plans that affect the project to describe the project’s defined process.

GQ(I)M Process and Indicator Supports:

- Definitions of measures and measurement activities for managing the project
SP 1.5 Manage the Project Using the Integrated Plans

Manage the project using the project plan, the other plans that affect the project, and the project’s defined process.

GQ(I)M Process and Indicator Supports:

- Documentation of approach to obtaining and analyzing the selected measures to manage the project and support the organization’s needs.
SP 1.2 Establish Process-Performance Measures

Establish and maintain definitions of the measures that are to be included in the organization’s process-performance analyses.

GQ(I)M Process and Indicator Supports:

- Selection of measures and definitions for appropriate insight into the organization’s quality and process performance
SP 1.4 Establish Process-Performance Baselines

Establish and maintain the organization's process-performance baselines.

GQ(I)M Process and Indicator Supports:

- Documentation of collection information for measures
SP 2.1 Select Measures and Analytic Techniques

Select the measures and analytic techniques to be used in statistically managing the selected sub-processes

GQ(I)M Process and Indicator Supports:

- Development of definitions of the measures and analytic techniques to be used in (or proposed for) statistically managing the sub-processes; operational definitions of the measures, their collection points in the sub-processes, and how the integrity of the measures will be determined
SP 1.1 Select Defect Data for Analysis

Select the defects and other problems for analysis.

GQ(I)M Process and Indicator Supports:

- Documentation of objectives established for measurement and analysis, specifying the measures and analyses to be performed, obtaining and analyzing measures, and reporting results.
SP 2.1 Plan the Deployment

Establish and maintain the plans for deploying the selected process and technology improvements.

GQ(I)M Process and Indicator Supports:

- Establishment of measures and objectives for determining the value of each process and technology improvement with respect to the organization's quality and process-performance objectives
SP 2.3 Measure Improvement Effects

Measure the effects of the deployed process and technology improvements.

GQ(I)M Process and Indicator Supports:

- Establishing objectives for measurement and analysis, specifying the measures and analyses to be performed, obtaining and analyzing measures, and reporting results.
GP 2.2 Plan the Process

Establish and maintain the plan for performing the process.

GQ(I)M Process and Indicator Supports:

- Identification and documentation of measurement requirements to be included in the plan for performing the process.
GP 2.8 Monitor and Control the Process

Monitor and control the process against the plan for performing the process and take appropriate corrective action.

GQ(I)M Process and Indicator Supports:

- Documentation of established measures for monitoring actual performance of the process.
GP 3.2 Collect Improvement Information

Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization’s processes and process assets.

GQ(I)M Process and Indicator Supports:

- Selection of appropriate measures to support future use and improvement of processes and process assets
GP 4.2 Stabilize sub-process Performance

Stabilize the performance of one or more sub-processes to determine the ability of the process to achieve the established quantitative quality and process-performance objectives.

GQ(I)M Process and Indicator Supports:

- Selection of process and product measures to be incorporated into the organization’s measurement repository to support process-performance analysis and future fact-based decision making
General Goal 5

GP 5.1 Ensure Continuous Process Improvement

Ensure continuous improvement of the process in fulfilling the relevant business objectives of the organization.

GQ(I)M Process and Indicator Supports:

• Identification of process improvements that would result in measurable improvements to process performance.