

How to establish measurement program

Practice of CMMI implementation

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Our goals

- ❖ To understand how measurement process relates to maturity of a software development process
- ❖ To acquaint the audience with an example of CMMI-compliant measurement program

Measurement is ...

Measurement is the process by which numbers or symbols are assigned to attributes of the real world entities to describe them in accordance with clearly defined rules



Fundamentals of measurements

Causes of measurements

- ❖ People measure:
 - what they want to control, and
 - what they cannot feel by their own

“You cannot control what you cannot measure”

(DeMarco, 1982)

Problems with measurements

- ❖ Managers know enough about measurement theory, but this instrument is unnatural for management practice. Why?
Managers prefer to rely on their feelings and intuition because it is easier than making measurements
- ❖ Measuring requires strong knowledge and systematical efforts
- ❖ Measuring costs money and time



The primary reasons that metric programs fail (Howard Rubins)

- ❖ Not tied to business goals
- ❖ Irrelevant or not understood by key players
- ❖ Perceived to be unfair, resisted
- ❖ Motivated wrong behavior
- ❖ Expensive, cumbersome
- ❖ No action based on the numbers
- ❖ No sustained management sponsorship

Problems with measurements

- ❖ Measurement program success doesn't lie in "super metrics" or "super counting program" or "super charts"
- ❖ Measurement program success lies in:
 - Real business needs
 - Understanding and knowledge base
 - Organizational culture

Our professional life consist of performing, managing and improving our processes

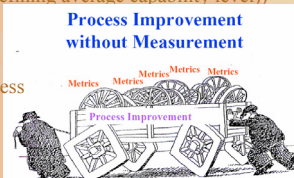
- ❖ Management – drawing the way and leading through it
- ❖ Performance – applying people's experience in accordance with managers' guideline
- ❖ Improvement – improving the management and the performance in order to get better results

How can we use measurements for:

- ❖ Management
 - To make estimations during the planning
 - To collect historical data needed for estimations
 - To assess a real situation at a given moment (and compare it with plans, goals, baselines, models, etc.)
 - To build models, baselines, relationships in order to predict future, to establish quantitative goals, to control

How can we use measurements for:

- ❖ Improvement
 - To build models, baselines, relationships in order to understand current capability
 - To elicit problems and their causes (both specific (effecting stability) and common (defining average capability level))
 - To check and assess hypotheses (proposed improvements)
 - To measure an effectiveness of implemented improvements



How can we use measurements for:

- ❖ Performance
 - It depends on a process specificity

Measurements for increasing processes capability

Main characteristics of a process with high capability

- ❖ Can achieve planned results and stated quantitative goals
- ❖ Has high level of process- and product- indexes (*high quality of work products and high effectiveness and efficiency of process activities*)
- ❖ Is clear, defined and understood by all stakeholders
- ❖ Work is performed only according to established scheme (plan, standards) and can quickly react to changes in the situation (is manageable)
- ❖ Continuously improves its capability

Evolution of capability according to CMMI

(based on work of Pfleeger and McGowan)

Level	Characteristics
Optimizing	An quantitatively managed process that focuses on continually improving the process performance through both incremental and innovative technological improvements. Process improvements that would address root causes of process variation and measurably improve the organization's processes are identified, evaluated, and deployed
Quantitatively managed	A defined process that is controlled using statistical and other quantitative techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process
Defined	A managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines, and contributes work products, measures, and other process-improvement information to the organizational process assets
Managed	A performed process that is also planned and executed in accordance with policy, employs skilled people having adequate resources to produce controlled outputs, involves relevant stakeholders; is monitored, controlled, and reviewed
Performed	A process that supports and enables the work needed to produce identified output work products using identified input work products
Incomplete	A process that is either not performed or partially performed

Capability level 0: Incomplete

- ❖ Doesn't have any GP

Capability level 1: Performed

- ❖ GP 1.1 Perform Base Practices (all SPs of the Process Area)

Capability level 2: Managed

- ❖ GP 2.1 Establish an Organizational Policy
- ❖ GP 2.2 Plan the Process (*Project Planning*)
- ❖ GP 2.3 Provide Resources (*Project Planning, Organizational Environment for Integration*)
- ❖ GP 2.4 Assign Responsibility (*Project Planning, Integrated Project Management, Integrated Teaming, Organizational Environment for Integration*)
- ❖ GP 2.5 Train People (*Organizational Training, Project Planning, Integrated Teaming, Organizational Environment for Integration*)
- ❖ GP 2.6 Manage Configurations (*Configuration Management*)
- ❖ GP 2.7 Identify and Involve Relevant Stakeholders (*Project Planning, Integrated Project Management*)
- ❖ GP 2.8 Monitor and Control the Process (*Project Monitoring and Control*)
- ❖ GP 2.9 Objectively Evaluate Adherence (*Process and Product Quality Assurance*)
- ❖ GP 2.10 Review Status with Higher Level Management

Capability level 3: Defined

- ❖ GP 3.1 Establish a Defined Process (*Organizational Process Definition, Organizational Process Performance, Integrated Project Management*)
- ❖ GP 3.2 Collect Improvement Information (*Organizational Process Focus, Organizational Innovation and Deployment, Integrated Project Management, Measurement and Analysis*)

Capability level 4: Quantitatively managed

- ❖ GP 4.1 Establish Quantitative Objectives for the Process (*Organizational Process Performance, Quantitative Project Management*)
- ❖ GP 4.2 Stabilize Subprocess Performance (*Quantitative Project Management*)

Capability level 5: Optimizing

- ❖ GP 5.1 Ensure Continuous Process Improvement (*Organizational Process Focus, Organizational Innovation and Deployment*)
- ❖ GP 5.2 Correct Root Causes of Problems (*Causal Analysis and Resolution*)

Relationship of metrics and capability

(based on work of Pfleeger and McGowan)

Level	Characteristics
Optimizing	Requires additional measurements needed for eliciting problems and their common causes (defining average capability level), checking and assessing hypotheses (proposed improvements), assessing an effectiveness of implemented improvements
Quantitatively managed	Requires additional measurements for eliciting problems and their specific causes (effecting stability), for establishing quantitative goals
Defined	Requires additional measurements needed for building models, baselines, relationships
Managed	Requires making estimations during the planning, storing historical data for estimations, measurements of a real situation at given moments
Performed	Requires specific measurements that depends on process performance specificity
Incomplete	Doesn't require any measurements

Measurements for Improvement: CMMI

- ❖ Process areas based on measurements: *Measurement and Analysis, Organizational Process Focus, Organizational Process Performance, Quantitative Project Management, Organizational Innovation and Deployment, Project Planning, Project Monitoring and control, Integrated Project Management, Risk Management, Decision Analysis and Resolution, Causal Analysis and Resolution*
- ❖ Generic practices based on measurements: *Collect Improvement Information, Objectively Evaluate Adherence, Monitor and Control the Process, Collect Improvement Information, Objectively Evaluate Adherence*

An example of a measurement program

Measurement program sections

1. Establish and maintain measurement process
2. Establish measurement goals
3. Establish questions, goal satisfaction indicators and metrics (scale, precision)
4. Plan for metrics collection (metric, responsible person, date, period, method, form)
5. Plan for metrics processing and analyzing (metric, responsible person, date, method, form)
6. Plan for metrics distribution and using (metric, stakeholder, date, form, decisions)
7. Assess measurement program effectiveness

Measurement program sections

- ❖ Establish and maintain measurement process:
 - Establish specific goals and practices of the process: how to establish measurement goals and appropriate metrics, how to collect, process, analyze, store, protect, distribute and use data
 - Establish an Organizational Policy in measuring
 - Plan the Process (create measurement program)
 - Provide Resources (people and specific instruments)
 - Assign Responsibility (for establishing measurement goals, metrics, for collection, processing, analyzing, storing, protecting, distributing and using data)
 - Train People (CMMI, process, methods)
 - Manage Configurations (create measurement database)
 - Identify and Involve Relevant Stakeholders
 - Monitor and Control the Process
 - Objectively Evaluate Adherence
 - Review Status with Higher Level Management

Determining what to measure: *GQ(I)M approach*

1. Express the overall **goals** of your organization
2. Generate **questions** answers to which may help you determine if your goals are met
3. Generate **indicators** that signalize you about goal satisfaction
4. Analyze each question / indicator from the perspective of **measurements** needed to answer it

Business goals

(balanced scorecard: finance level)

1. For projects of Type 1: *income per one employee must be at least \$X per month*
2. For projects of Type 2: *income must grow up to Y% of overall organization income*
3. For projects of Type 3: *income must grow up to Z% of overall organization income*

Business goals

(balanced scorecard: client level)

1. For projects of Type 1: *reliable partner (precise estimations, stable processes), high effectiveness (number of functionalities per time), high quality (defect rate), strong time constrains*
2. For projects of Type 2: *reliable partner (strong process based on generally admitted practices: ISO9001:2000 & CMMI)*
3. For projects of Type 3: *high product quality (proposed solution corresponds to business), strong time constrains*

Business goals

(balanced scorecard: processes level)

- ❖ To increase a precision of estimations made during planning
- ❖ To increase process stability
- ❖ To decrease operational cycle
- ❖ To increase quality of requirements
- ❖ To decrease number of defects
- ❖ To increase correspondence of proposed solutions to business

Measurement goals

- ❖ To give our managers understanding if they have achieved stated goals? (or are achieving?)

Using templates

Goal

- ❖ Goal:
- ❖ Questions: ❖ Answers-causes-solutions (Indicators):
- ❖ Metrics:
- ❖ Measurement activities: (for example, setting definitions, holding experiments)

Measurement questions, indicators, metrics

Goal: to increase a precision of estimations

- ❖ Which estimations are used during planning? (*cost, effort, duration*)
- ❖ What does “precision of estimation” mean? (*correspondence of planned values with real ones*)
- ❖ What is the current level of it? (*planned to real value ratio*)
- ❖ On what factors does estimation precision depend? (*estimation method and its suitability to the environment, precision and quantity of historical data, people competence and experience in estimating, processes stability*)
- ❖ How can we increase a precision of estimations made during the planning? (*to choose an estimation method that is most suitable to the organizational environment, to increase precision and quantity of historical data, to train experts, to increase process stability*)

Measurement questions, indicators, metrics

Goal: to increase a precision of estimations

- ❖ How to choose an estimation method that is most suitable to the organizational environment? (*carry out an experiment: try to use several methods and estimate their precision*)
- ❖ How to increase precision of historical data? (*establish common set of historical data for all projects (depending on estimation method), establish unified definitions for each metric, establish procedure for checking collected data*)

Metrics and measurement activities

Goal: to increase a precision of estimations

- ❖ Measure: estimated and real – cost, effort, duration
- ❖ Count planned to real value ratio (for cost, effort, duration)
- ❖ Provide experiment: try to use several methods and estimate their precision
 - for size estimation: functional points, LOC
 - for efforts estimation: COCOMO II, up-down, down-up, expert conclusion
- ❖ Establish common set of historical data for all projects (depending on chosen estimation method)
- ❖ Establish unified definitions for each historical data
- ❖ Establish procedure for checking collected historical data

Measurement questions, indicators, metrics

Goal: to increase stability of development & integration processes

- ❖ What does “process stability” mean? (*variation of process parameters from established limit*)
- ❖ What processes are more unstable now? (*compare variation of process parameters*)
- ❖ On what factors does it depend? (*level of standardization, management control and response, specific causes*)
- ❖ How to increase stability? (*to standardize the processes, to increase management control, to remove specific causes*)

Measurement questions, indicators, metrics

Goal: to increase stability of development & integration processes

- ❖ How to increase management control? (to control correspondence with project plan, to control correspondence with similar projects (baselines) and make corrective actions)
- ❖ What projects' characteristics should coincide to consider projects as similar? (product size, project complexity, team size, domain, technologies used)
- ❖ What parameters are significant for comparing similar projects? (resource usage schedule (people, money), effort distribution (by type of activities), productivity (actual work at given point))

Metrics and measurement activities

Goal: to increase stability of development & integration processes

- ❖ Measure: product size, complexity, team size, domain, technologies used in each project
- ❖ Measure: resource usage schedule (people, money), effort distribution (by type of activities), productivity (actual work at given point)

Using templates Metric

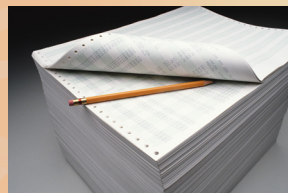
- ❖ Metric:
- ❖ Who is responsible for gathering:
- ❖ How to gather:
- ❖ Format:
- ❖ When (how often):
- ❖ Whom (where):

Metric template

- ❖ Metric: *team size*
- ❖ Who is responsible for gathering: *project manager*
- ❖ How to gather: *count all specialists participated in project (if one specialist was substituted by another one you should count only one)*
- ❖ Format: *project profile form*
- ❖ When (how often): *during the project*
- ❖ Whom (where): *to quality department (PDB specialist)*

Using templates Indicator

- ❖ Indicator:
- ❖ Goal:
- ❖ Questions:
- ❖ Whom:
- ❖ When (how often):
- ❖ Format:
- ❖ Metrics:
- ❖ Algorithms:
- ❖ Who is responsible for analysis:
- ❖ Interpretation:
- ❖ Solutions:



What is good data?

- ❖ Are they correct? *Correctness means that the data were collected according to the exact rules of definition of the metric*
- ❖ Are they accurate? *Accuracy refers to the difference between gathered data and the actual value*
- ❖ Is their precision enough? *Precision deals with the number of decimal places needed to express the data*
- ❖ Are they consistent? *Data should be consistent from one measuring device or person to another, without large differences in value*
- ❖ Are they associated with a particular activity or time period? *To know exactly when the data were collected they should be time-stamped*
- ❖ Can they be replicated?

Some advices on how to succeed in measurement program

Some advise how to succeed in measurement program

- ❖ Use business-goals driven program
- ❖ Start from something easiest
- ❖ Regularity
- ❖ Use clear process for gathering, processing, analyzing, distribution, storing data
- ❖ Train people
- ❖ Use pilot implementation
- ❖ Use specific tools for facilitation



Questions