Bridging the Gap between Business Strategy and Software Development

Victor R. Basili

University of Maryland
and
Fraunhofer Center - Maryland
Why Measurement?

“What is not measurable make measurable”.

Galileo Galilei

“A science is as mature as its measurement tools.”

Louise Pasteur

“If you can’t measure it, you can’t manage it.”

Peter Drucker
Why do Organizations Measure?

**Understanding the Business**
- Baseline models and relationships
- Critical factors affecting the business

**Managing Software Projects Based on Quantitative Evidence**
- Planning and estimating
- Tracking actual values versus estimates
- Decision-making

**Guiding Improvement**
- Baselining
- Prioritizing
- Assessing
- Packaging of Experience
Example Measurement Data

Resource Data:
- Effort by activity, phase, type of personnel
- Calendar time
- Total cost of ownership

Change/Defect Data:
- Changes and defects by various classification schemes

Process Data:
- Process definition and conformance
- Domain understanding

Product Data:
- Product characteristics
  - logical, e.g., application domain, function
  - physical, e.g., size, structure
- Usage and context information, e.g., design method used
Problems with Measurement

Problems
- Too much irrelevant data often collected
- Data incomplete, redundant, low quality or invalid
- More effort spent collecting data than analyzing data
- Data is not analyzed in the right environment
  (no context or influencing factors considered)

Consequences
- Unnecessary effort
- Wrong conclusions can be drawn
- Discouraging for people collecting/analyzing data
- Not sufficient pay-off for the cost

Goal-oriented Measurement
Internal and External Stakeholders have Goals

Stakeholder Stakeholder Stakeholder

Goal Goal Goal Goal

Conflict? Conflict?
The GQM Structure

- What should be measured?
- Measurement Goal
  - Question
  - Metric
- Measurement Goal
  - Question
  - Metric
- Measurement Goal
  - Question
  - Metric
- Measurement Goal
  - Question
  - Metric

- How should it be interpreted?

What should be measured?

Measurement Goal

Question

Metric

Measurement Goal

Question

Metric

Measurement Goal

Question

Metric

Measurement Goal

Question

Metric

Copyright © Fraunhofer CESE & Fraunhofer IESE 2007
Measurement and other Quality Initiatives

GQM
- Works with all initiatives
- Enhances capabilities with respect to measurement
Generating a Measurement Goal

Consider the following situation:

Organization’s customers reporting too many failures and most of which should have been caught during system test (**Business Goal**)

It is considering adopting a new system test process (a risk and expense) and wants to try the new system test process on a pilot project to determine if it is doable and more effective than what it has been doing (**Software Goal**)

The organization has data on the number of faults identified by the system test process and the number released to the field for various products. It uses a waterfall type life cycle process, ... (**Context**)

To make an informed decision it must define the new test process, determine if it is being followed, characterize how well the process is identifying faults, and compare it to what they were doing before (**Measurement Goal**)
# Template to Define GQM Goals and Example

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Object</strong></td>
<td>Process, product, other experience model</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Characterize, evaluate, predict, motivate, improve</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>cost, correctness, defect removal, changes, reliability, user friendliness, ...</td>
</tr>
<tr>
<td><strong>Viewpoint</strong></td>
<td>user, customer, manager, developer, corporation, ...</td>
</tr>
<tr>
<td><strong>Context</strong></td>
<td>Problem factors, people factors, resource factors, process factors, ...</td>
</tr>
</tbody>
</table>

Measurement goals may be defined for any object, for a variety of reasons, with respect to various models of quality, from various points of view, relative to a particular environment.
Goal/Question/Metric Approach
Defect Slippage Model

Goal:
Analyze the system test process for the purpose of evaluation with respect to defect slippage from the point of view of the organization ...

Defect Slippage Model:
Let $F_c = \text{the ratio of faults found in system test to the faults found after system test on this project.}$

Let $F_s = \text{the ratio of faults found in system test to the faults found after system test in the set of projects used as a basis for comparison.}$

Let $Q_F = F_c / F_s = \text{the relationship of system test on this project to faults as compared to the average the appropriate basis set.}$
Goal/Question/Metric Approach
Interpretation of Defect Slippage Model

if $QF > 1$ then
    method better than history
    check process conformance
    if process conformance poor
        improve process or process conformance
    check domain understanding
    if domain understanding poor
        improve object or domain training

if $QF = 1$ then
    method equivalent to history
    if cost lower than normal then method cost effective
    check process conformance

if $QF < 1$ then
    check process conformance
    if process conformance good
    check domain understanding
    if domain understanding good
        method poor for this class of project
Goal Derivation Concepts we have Discussed so far

**Business Goals:** What the organization wishes to accomplish to maintain business success

**Software Goals:** What the software organization needs to accomplish to satisfy the organizational goals

**Measurement Goals:** Goals that can be measured and interpreted

**Interpretation Model:** A model that checks whether a measurement goal is achieved (and in consequence contributes to the achievement of related software and business goals)

**Context Factors:** Environment variables that change the kind of models and data that can be used
Problems Establishing a Software Measurement Program

Building an Effective Software Measurement Program is difficult. It requires support for:

- **Defining and integrating** the organization’s top level corporate goals with its software goals
- **Mapping** the software goals to data, maximizing use of existing data
- **Evolving** the goals and data collected as the organization matures
- **Storing and retrieving** goals, data, and interpretations in context from an experience base

It involves **observation, experience facilitation, collaboration, decision making, analysis and synthesis** about goals, contexts, and assumptions.

It assumes an **organizational structure** that sustains the process and learns.

**Most organizations fall short** of putting together a successful program.
So what do we need?

Where is goal definition and data definition and analysis support needed?

**Definition** of business goals

**Mapping** of business goals onto and strategies and software goals

**Mapping** of software goals onto measurement scenarios and goals

**Mapping** of all levels of goals onto models (defining focuses interest)

**Mapping** of models onto *existing data*

**Interpretation** of data based upon goals

**Presentation** of data to various stakeholders

How is the measurement process embedded in the organization?

**Organization Structure**

Integrate many projects into a single measurement framework

e.g., Experience Factory, SEPG/Measurement group.

**Data Collection and Interpretation Procedures**

By project aggregate up to central group

By central group
Measurement Gap

Business/Organizational Level

Vision and Strategy

To achieve our vision, how will we sustain our ability to change and improve?

Innovation/Growth

To satisfy our stakeholders and customers what business processes must be excel at?

Customer

To achieve our vision, how should we appear to our customers?

Business process

To satisfy our stakeholders and customers what business processes must be excel at?

Financial

To succeed financially, how should we appear to our stakeholders?

Measurement Gap

Goals

Questions (Indicators & Influencing factors)

Metrics

Data Collection

Goals Attainment

Answers

Measurement

SOFTWARE DEVELOPMENT & MAINTENANCE

Copyright © Fraunhofer CESE & Fraunhofer IESE 2007
Why do we want the connection?

Because:
Software development and measurement activities should be justified in terms of larger business objectives
Data from software measurement must influence higher-level decisions
An analysis rationale is needed that is meaningful at all levels

In order to:
clarify and harmonize goals and strategies
communicate business goals throughout an organization
align software goals to a strategy
monitor the deployment strategy
obtain feedback about a strategy and business goals
Closing the Measurement Gap

**Business Goals**, e.g. Improve Customer Satisfaction, Lower Production Costs, Reduce Time to Market

**Strategies** define tradeoffs to identify specific Software goals that contribute to achieving the Business Goal

**Software Goals**, e.g. Improve System Test Effectiveness, Increase User Involvement in Development

Software goals are carried out using **scenarios** to define measurement goals

**Measures** are derived from measurement goals to interpret higher level goals

**Linkages**

**GQM + Strategies**

Copyright © Fraunhofer CESE & Fraunhofer IESE 2007
Basic Business Goal Types

**Growth goals:** acquire new projects with current competencies areas; expand existing projects set; evolve existing competencies, build new competencies

**Success goals:** deliver good products to customers; control costs; shrink schedule; Increase profits; getting corporate visibility (awards etc.), building core competency

**Maintain principle (internal) goals:** transparency, employee satisfaction, controlled risk, learning environment → measure to assure no decrease

**Specific focus goals:** make helpdesk more efficient, predict if proposal effort has a good ROI
Defining The Right Goals
Goal Derivation Concepts

- Business Goal
- Strategy Decision
- Software Goal
- Scenario Template
- Measurement Goal
- Context/A
- ssumption

GQM

- refined by
- restricted by
- interpret by
- GQM

Object: Review process
Purpose: Improve the review process
Quality: Review efficiency
Viewpoint: QA manager
Context: A review process of Company XY

What's the efficiency of the review process?
What influences the efficiency?
Found defects per reviewer per hour
Human Factors?
Technical Factors?
average years of experience in reviews
# pages of reviewed document
# figures of reviewed documents
# found defects
sum of review time of all reviewers
# reviewers

Copyright © Fraunhofer CESE & Fraunhofer IESE 2007
Goal Derivation Concepts

Step 1: Select the right business goals

**Context**
Highly competitive market for class of products

**Assumption**
Improving product will increase customer loyalty

**Business Goals**
Reduce next product time to market
Increase customer satisfaction on next product
Goal Derivation Concepts

Step 2: Select the right set of strategy decisions

**Context**
- Little control over development process (too late)
- There is limited budget for process improvement

**Assumptions**
- Customer satisfaction can be measured by # of customer complaints
- Can’t make too many changes at once

**Strategy Decisions**
- Build reliability in (e.g. implement fewer defects)
- Test reliability in (e.g. remove defects by 20%)
Goal Derivation Concepts

Step 3: Select the right software goals

**Context**

There is a system test process that seems appropriate for our context

**Assumption**

Can decrease # of customer complaints by 10% by reducing customer visible defects by 20%

**Software Goals**

Improve system test effectiveness by 20%
Step 4: Select the right scenario templates and steps

**Context**
Baseline data exists on defect slippage

**Assumption**
The projects that form the baseline are relevant to the current situation
Reducing defect slippage by during system test 20% will reduce customer reported defects by at least 20%.

**Scenario Templates**
Template A – based on historical data
Template B – based on hypotheses
Example Scenario Templates

**Template A** – based on historical data
- Build a defect slippage baseline from historical data
- Apply (Test) the new system test process and compare the defect slippage to past projects to evaluate its effect

**Template B** – based on hypotheses (no historical data)
- Propose explicit hypotheses about defect slippage baselines based upon available expertise
- Apply (Test) the new system test process and compare the defect slippage to past projects to evaluate its effect
Goal Derivation Concepts

Step 5: Select the right measurement goals

A.1: Analyze representative projects in order to characterize them (build a baseline) with respect to defect slippage from the point of view of the organization.

A.2: Analyze pilot project using new system test process in order to characterize it with respect to defect slippage from the point of view of the organization.

A.3: Analyze system test process in order to evaluate it with respect to a 20% improvement in defect slippage compared to past projects from the point of view of the organization.
Step 6: Derive questions and metrics using GQM and interpret results

Apply the standard GQM approach (seen earlier)
Leads to the interpretation model (seen earlier)
Add interpretation for software goal and business goal
Business Goals to Measurement Goals

**Business Goals**
- Increase customer satisfaction
- Little control over development process
- Improving product will increase customer loyalty
- Satisfaction can be measured by # of complaints
- Can't make too many changes
- Highly competitive market for class of products

**Strategy Decisions**
- Build reliability in
- Increase reuse of reliable components
- Improve training
- Limited budget
- New system test process available
- Reducing defects 20% => complaints drop 10%

**Software Goals**
- Improve system test effectiveness
- Defect Slippage Data available on past projects
- Defect Slippage 20% => complaints drop 10%
- Baseline projects relevant

**Scenario Templates and Steps**
- If data not available but experts available
  - Estimate defect slippage by experts
- If data available
  - Analyze available projects for defect slippage baseline
  - Gather defect slippage data on current project
  - Analyze improvement results
- Baseline projects relevant

**Measurement Goals**
- Estimate current slippage
- Characterize defect slippage of baseline projects
- Characterize defect slippage of new project
- Evaluate improvement

**Context / Assumptions**
- Satisfaction can be measured by # of complaints
- Reducing defects 20% reduces complaints 10%

Copyright © Fraunhofer CESE & Fraunhofer IESE 2007
Goals may conflict with each other

**Business Goals**

- Improve Profits
- Increase Quality
- Increase Customer Satisfaction
- Reduce Time to Market

**Strategy Decisions**

- Find more defects
- Reduce Quality

- Increased costs
- Reduced rework
- Increased time to market

**Negative Impact**

- Reduced rework

**Positive Impact**

- Increased costs
- Reduced rework

Copyright © Fraunhofer CESE & Fraunhofer IESE 2007
Key Components to support the building of a software measurement program

An **experience base** of goals and scenarios that allow for the measurement program to be tailored to specific context variables and assumptions and is based upon experiences with various organizations.

A **method** that takes into account the need for:
- a goal hierarchy that allows goal choices for the needs of a particular organization and stakeholders
- dependency of goals on one another, e.g., temporal relationships
- strategies and scenarios for identifying sets of goals, recognizing which combinations of goals are needed depending upon environmental constraints
- mapping goals into existing data sets to maximize information while minimizing data collection
- the inheritance of data across multiple goals, i.e., mapping the data required from one set of goals onto others

An **expert** to help set up the measurement program in a the particular organization, including the generation of the goals, measures, data, and analysis.