SENG 407 – SOFTWARE METRICS AND MEASUREMENT
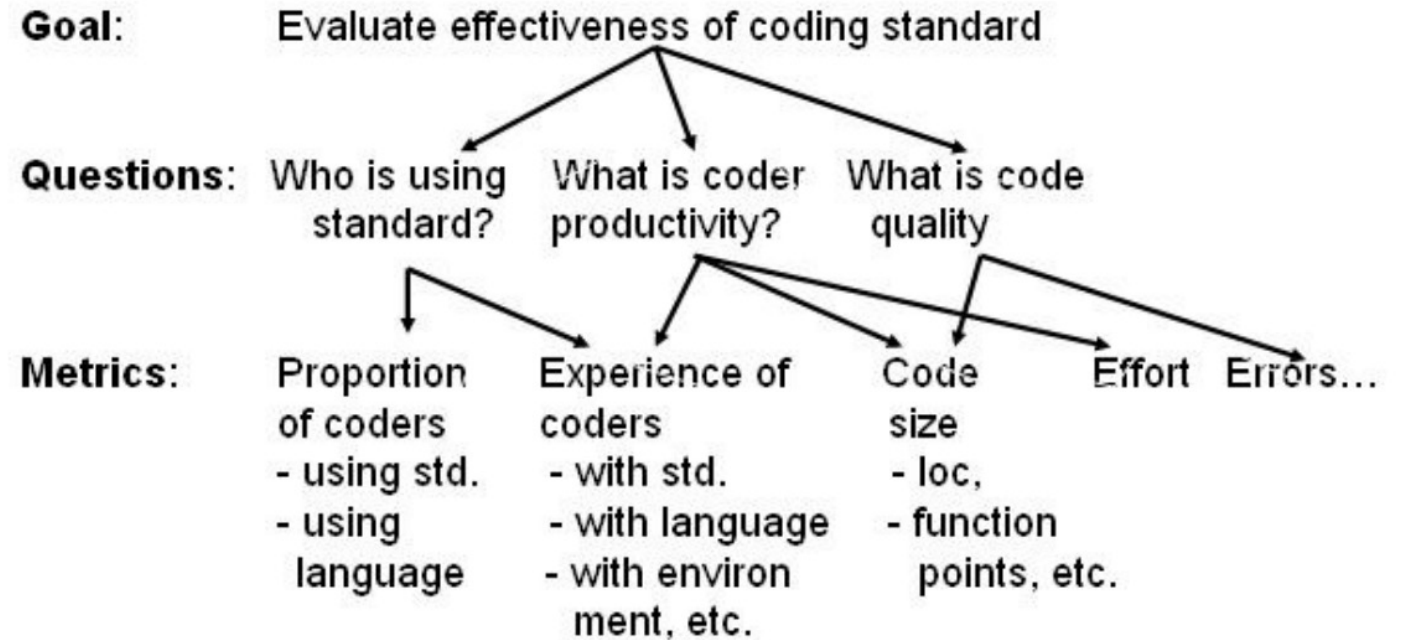
LECTURE SIX: GOAL-QUESTION METRICS PARADIGM

Goal-Questions-Metrics Approach

- A measurement program can be more successful if it is designed with the goals of the project in mind.

- The goal-question-metric approach provides a framework involving three steps:
  - List the major goal of the development or maintenance project
  - Derive from each goal the questions that must be answered to determine whether the goal are being met
  - Decide what must be measured in order to be able to answer the questions adequately

Goal-Questions-Metrics Approach

- By deriving the measurement in this way, it becomes clear how to use the resulting data

Goal: Evaluate effectiveness of coding standard

Questions: Who is using standard?   What is coder productivity?   What is code quality

Metrics: Proportion of coders
- using std.
- using language

Experience of coders
- with std.
- with language
- with environ ment, etc.

Code size
- loc,
- function points, etc.

Effort   Errors…

Goal-Questions-Metrics Approach

- Suppose the overall goal is to evaluate the effectiveness of using a coding standard. That is we want to know whether code produced by following the standard is superior in some way to code produces without it.

- To decide whether the standard is effective we must ask several key questions

  - First it is important to know who is using the standard so that we can compare the productivity of the coders who use the standard with the productivity of those who do not.

  - Secondly, we probably want to compare the quality of the code produced with the standard with the quality of non-standard code

Goal-Questions-Metrics Approach

- Once the questions are identified we must analyze each question to determine what must be measured in order to answer the question

  - *For example to understand who is using the standard, it is necessary to know:*

    - *The proportion of coders using the standard.*

    - *It is also important to have an experience profile of the coders, explaining how long they have worked with the standard, the environment, the language, and other factors that will help to evaluate the effectiveness of the standard.*

Goal-Questions-Metrics Approach

- The productivity question requires a definition of productivity, which is usually some measure of effort divided by some measure of product size.

- The metric can be in terms of LOC, function point, or any other metric that will be useful.

- The quality may be measured in terms of the number of errors found in the code, plus any other quality measures of choice

- With this, we generate only those measures that are related to the goal

Goal-Questions-Metrics Approach

- Notice that in many cases, several measurements may be needed to answer a single question. Likewise, a single measurement may apply to more than one question

- The goal provides the purpose for collecting the data, and the questions tell us how to use the data

- In general, typical goals are expressed in terms of productivity, quality, risk, and customer satisfaction. We might need to assess, evaluate, improve or understand the terms.

Goal-Questions-Metrics Approach

- It is important for the goals and questions to be understood in terms of their audience. a productivity goal for a project manager may be different from that for a corporate director.

- To aid in generating the goals, questions and metrics there is a template
  - Purpose: To (characterize, evaluate, predict, motivate, etc.) the (process, product, model, metrics, etc.) in order to (understand, assess, manage, engineer, learn, improve, etc.) it

Example:

Purpose: To evaluate the maintenance process in order to improve it

Goal-Questions-Metrics Approach

- Perspective: Examine the (cost, effectiveness, correctness, defects, changes, product measures, etc.) from the viewpoint of the (developer, manager, customer, etc.)

Example

Perspective: Examine the cost from the viewpoint of the manager

- Environment: The environment consists of the following process factors, people factors, problem factors, methods, tools, constraints, etc

Example

The maintenance staff consists of poorly motivated programmers who have limited access to tools

Assignment

- Suppose your development team has as its goal: Improve the effectiveness of testing. Use the GQM approach to suggest several relevant questions and measures that will enable you to determine if you have met your goal

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Measurement for Process Improvement

- A more mature process is more likely to develop software that is reliable, adaptable, and delivered on time and within budget.

- Measurement quantifies the relationships between the processes, products, resources, methods, and technologies of software development.

- Thus measurement plays a key role in evaluating and improving software processes.

- A popular process evaluation technique is the Software Engineering Institute's (SEI's) Capability Maturity Model Integration (CMMI) for development

Measurement for Process Improvement

- The CMMI for Development provides an ordinal ranking of development organizations from
  - initial (the least predictable and controllable, and least understood)
  - to optimizing (the most predictable and controllable),

Measurement for Process Improvement

- Level of CMMI

  - *Initial: Level 1 processes are ad hoc and "success depends on the competence and heroics of the people in the organization."*

  - *Managed: Level 2 processes are planned; "the projects employ skilled people … have adequate resources … involve relevant stakeholders; are monitored, controlled, and reviewed … ."*

  - *Defined: Level 3 "processes are well characterized and understood, and are described in standards procedures, tools, and methods."* GRP C and D

Measurement for Process Improvement

- *Quantitatively managed: A Level 4 "organization and projects establish quantitative objectives for quality and process performance and use them as criteria in managing projects."*

- Optimizing: A Level 5 "organization continually improves its processes based on a quantitative understanding of its business objectives and performance needs"

- The SEI CMMI distinguishes one level from another in terms of key process activities going on at each level.

Measurement for Process Improvement

- Measure is used in evaluation at each level. Specific goals, questions and metrics are developed to assess whether an organization has reached a particular level.

- To reach a particular level, an organization must have measurement values that give the desired answer to each question at the level

- For example, to reach CMMI-Development Level2 Managed, a process must satisfy 15 goals in 7 process areas

   1. *Configuration management goal: Establish baselines, track and control changes, establish integrity*

Measurement for Process Improvement

2. *Measurement and analysis goal: Align measurement and analysis activities, provide measurement result*

3. *Project monitoring and control goals: Monitor project against plan, manage corrective actions to closure*

4. *Project planning goals: Establish estimate, develop a project plan and obtain commitment to the plan*

5. *Process and quality assurance goals: Objectively evaluate processes and work products, provide objective insight*

Measurement for Process Improvement

6. *Requirement management goals: Manage requirements*

7. *Supplier agreement management goals: Establish supplier agreement, satisfy supplier agreements*

- Answers to questions related to the goals in each process area determine whether a goal is achieved.

- These questions tend to be measured by yes or no answer, either a process performs an activity at a required level or it does not.

- For example, answers to the following questions determine whether configuration management process area goals are met

Measurement for Process Improvement

- Does the development process:

1. Identify configuration items?
2. Establish a configuration management system?
3. Create or release baseline?
4. Track change requests?
5. Control changes to configuration items?
6. Establish configuration management record?
7. Perform configuration audit?

Measurement for Process Improvement

- To achieve a level 2 rating, the answer must be YES to questions concerning 65 practices related to 17 goals.

- To achieve level 3 Defines, an organization must satisfy all level 2 goals, plus 27 additional goals in 11 process areas. The answer to questions concerning 88 different practices determine whether the goals are met.

- Level 4 and 5 add additional process areas, goals and question about practices.

Measurement for Process Improvement

- The CMMI and other models, such as ISO-9000, share a common goal and approach, namely that they use process visibility as a key discriminator among a set of maturity levels,

- That is the more visibility into the overall development process, the higher the maturity. Managers and developer can understand and control their development and maintenance activities.

- At the lowest level of maturity , the process is not well understood and better defined.

Measurement for Process Improvement

- At each maturity level, measurement and visibility are closely related; a developer can only measure what is visible in the process and measurement helps to enable and increase visibility.

Combining GQM with Process Maturity

- Suppose we are using the Goal-Question-Metric paradigm to decide what our project should measure. We may identified at least one of the following high-level goals;

  - Improving productivity

  - Improving quality

  - Reducing risk

- Within each category we can represent the goal's satisfaction as a set of subgoals. Each of which can be examined for its implications for Resources, Products and Process.

Combining GQM with Process Maturity

- For example, the goal of improving productivity can be interpreted as several subgoals affecting resources:
  - Assuring adequate staff skills
  - assuring adequate managerial skills
  - Assuring adequate software engineering technology
- Similarly, improving productivity with products can mean
  - Identifying problems early in the life cycle
  - Using appropriate technology
  - Reusing previously built products

Combining GQM with Process Maturity

- Next for each subgoal, we generate questions that reflect the areas of deepest concern.
- For example, if improving productivity is our primary goal, and then assuring adequate staff skills is an important subgoal, we can create a list of questions that we may be interested in having answered such as
  - Does project staffing have the right assortment skills?
  - Do the people on the project have adequate experience?

Combining GQM with Process Maturity

- Similarly, if we have chosen improving quality with a subgoal of improving the quality of the requirement, then the related questions might include:
  - Is the set of requirement clear and understandable?
  - Is the set of requirement testable?
  - Is the set of requirement reusable?
  - Is the set of requirement maintainable?
  - Is the set of requirement correct?

Combining GQM with Process Maturity

- Suppose we want to answer the question: Is the set of requirement maintainable?
  - At Level 1 – the project is likely to have ill-defined requirement. Measuring requirement characteristics is difficult at this level, so we might choose to count the number of requirements and changes to those requirements to establish a baseline.
  - AT Level 2 – the requirement are well defined and we can collect additional information (the type of each requirement) and the number of changes to each type
  - At Level 3 – visibility into the process has improved and intermediate activities are defined, with entry and exit criteria for each activity

Combining GQM with Process Maturity

- Thus the goal and question analysis is the same but the metric recommendation vary with maturity.

- The more mature your process, the richer your measurement. In other words, the more mature your process the more mature your measurement

- GQM help us to understand why we measure an attribute and process maturity suggest whether we are capable of measuring it in a meaningful way