news you can use

Implementing a Successful Measurement Program: Tried and True Practices and Tools

by Cheryl Jones

Practical Software Measurement (PSM) is a DOD- and Army-sponsored project to develop measurement guidance and to transition that guidance into widespread use, based on the collective experience of a working group representing government, industry, and universities. PSM defines a practical, information-driven measurement process, along with consistent measurement concepts. In this article, I will discuss these basic concepts as they are described in the book *Practical Software Measurement* [1].

A measure of PSM's success is shown by the adoption of its overall measurement approach by both the Software Engineering Institute's Capability Maturity Model® Integration (CMMI[SM]) and by the international community in the new standard ISO/IEC 15939: *Software Engineering — Software Measurement Process*. Measurement practitioners now have an integrated set of guidance documents, all based on real measurement experience that has proven successful in actual applications.

MEASUREMENT IN THE IT ENVIRONMENT

Information and communication systems are becoming more sophisticated and complex in order to deal with an ever-changing market. Organizations need to make better and more timely decisions to realize success in projects and systems and across the organization. In such an environment, objective information is required to support critical, fact-based decisionmaking.

A good measurement process can supply much of this objective information. Companies such as Honda and Toyota in the auto industry, UPS and FedEx in the shipping industry, Mars in the food industry, and Lockheed Martin in the defense industry have all implemented measurement programs that give them detailed information on their programs and organizations. These data allow them to make rapid, accurate decisions in areas such as best manufacturing and production practices, shipping efficiencies, development approaches, pricing and sales, and other competitive factors.

You can reap the benefits of a successful measurement program by implementing an information-driven approach. The following guidelines can help:

- **Use the results.** The measurement information must help decisionmakers understand project and organizational issues and to evaluate and make key tradeoffs.
- **Start small.** Don't try to do too much too quickly. Start with a core set of measures, evaluate the measures and processes, and phase in a comprehensive program over time. Because IT processes are so interdependent, a small set of measures can often be used to address a wide range of information needs.
- **Provide adequate training.** All users must understand what measurement data represent and how to interpret the results. Offer training in both the methodology and the tools for effective results. Measurement usually requires changes in the business culture, so you will need to actively address change management.
- **Demonstrate commitment.** Acceptance of a new process begins with the demonstration of corporate and management commitment. Renew and sustain commitment as the program evolves over time.
- **Minimize costs.** A measurement process must be cost effective to succeed. Collect only necessary data, target measures and reports to key

information needs, and automate activities whenever possible.

- **Adopt an action orientation.** In the early phases of measurement planning, select measures that address key information needs at both the organization and project levels. Information must be obtained early to reduce risks and to correct problems in a timely manner. The measurement program should be integrated into your organization's business practices, not treated as an add-on process.
- **Communicate.** Good communication improves understanding on all sides and leads to a win-win situation. Communication is essential, and timeliness is critical.

One of the most critical obstacles to measurement success is that the objectives of different groups in an organization are not always aligned and may often be contradictory. For example, every organization monitors project schedule. However, the underlying data and the importance of schedule measures vary within an organization. Most technical managers are concerned with developing a product that meets functional and reliability requirements; schedule and cost objectives are often determined by other parties, such as customers, marketing managers, and senior managers. Senior managers may be more concerned with estimating the length of time to product delivery. The business manager is concerned with the time it takes to market a new capability and the impact of a delay on market share. A process manager may be concerned with a change in software development time and its impact on other processes.

An organizational measurement process must select schedule measures that address all of these information needs. In large organizations, enterprise-mandated schedule measures may be supplemented with project-specific measures, resulting in a flexible program that can be customized by individual projects to meet the information needs of both the organization and the project managers. A successful enterprise-wide measurement program integrates the needs of all decisionmakers.

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GETTING STARTED

If you are just starting to measure your IT software and systems engineering processes and products, producing usable measurement results can be challenging. The good news is that most successful measurement programs are based on a few basic concepts that form the foundation of an effective measurement program and a flexible, cost-effective approach to meeting defined information needs, even in the most complex of environments.

There are three recurring lessons learned from successful measurement programs:

1. Measurement is a *consistent* but *flexible* process that must be tailored to the unique information needs and characteristics of a particular project or organization. Measurement must change as the environment and information needs change around it. Measurement is not a list of measures, but a process for refining data to provide information relative to changing information needs.
2. Decisionmakers must *understand* what is being measured. The accurate communication of measurement results to business and technical managers fosters timely decisionmaking.
3. Measurement must be *used* to be effective. The measurement program must play a role in helping decisionmakers optimize overall performance. Successful organizations regularly use their measurement results to make decisions. And since most organizations are composed of a portfolio of distinct projects, project-level information must be aggregated to appropriate levels of the organization to be used effectively.

As an example, defects measures are often an important part of measurement programs. Figure 1 shows a defect indicator for a program that is used to assess product quality and determine whether a product is ready to deliver. With a

flexible process, this same defect information can also be used to address process questions related to how long it takes to fix defects and how many defects require rework (see Figure 2).

PSM

PSM includes two main components: a measurement process model and an information model. The process model includes the activities and tasks of the measurement process. The information model describes the relationship among the measurement concepts and common terminology.

The PSM process, shown in Figure 3, provides a basis for measurement in many IT disciplines, including software engineering, systems engineering, and process improvement measurement. The same basic measurement process can support a wide variety of distinct and changing information needs in each of these areas.

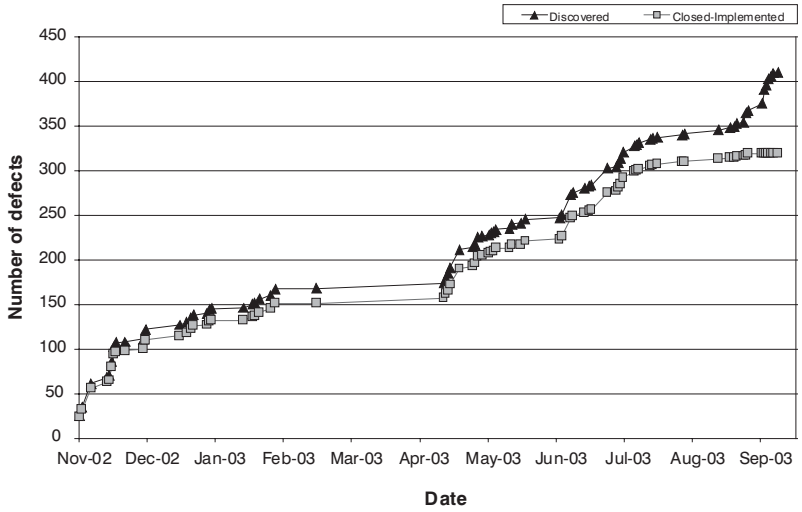

Figure 1 — Discovered vs. closed defects.

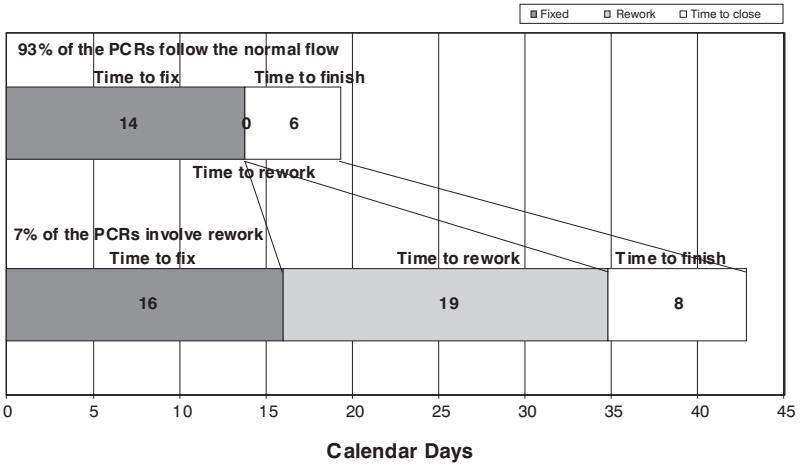

Figure 2 — Time to fix vs. time to close closed defects.

Measurement is an iterative process: the measures are refined as information needs change and as the organization implements improvement actions. The PSM process describes four activities that are part of a successful measurement program:

- **Plan measurement:** Measures are defined to offer insight into project or organization information needs. This includes identifying what the decisionmakers need to know, relating these information needs to those entities that can be measured, and then selecting and specifying prospective measures based on project and organization processes.
- **Perform measurement**: This activity involves collecting measurement data, performing measurement analysis, and presenting the results so that the information can be used to make decisions.
- **Evaluate measurement**: Both the measurement process and the specific measures should be periodically evaluated and improved. Usually, the first implementation of a measurement program does not answer all the information needs of managers. Over time, an organization discovers better measures and refines processes. As an organization matures, information

needs change. Measurement is an iterative process and must be continually refined to sustain success.

- **Establish and sustain commitment**: This activity involves establishing the resources, training, and tools to implement an effective measurement program and ensuring that management is committed to using the information. Much of this activity occurs during the measurement planning phase, while educating managers and creating acceptable common procedures. But corporate commitment must be continually reinforced.

The PSM measurement information model links the decisionmakers' information needs to the process and product attributes that can actually be measured. It relates measurement concepts and enables accurate communication of results within the organization. Figure 4 shows how relevant attributes are quantified and turned into indicators that provide a basis for decisionmaking. PSM defines three levels of measures:

- **Base measures:** Collectible data, such as function points or number of lines of code
- **Derived measures:** Calculated data items, based on the base measures, such as productivity
- **Indicators:** Analytical graphs built from collected and derived data along with decision criteria

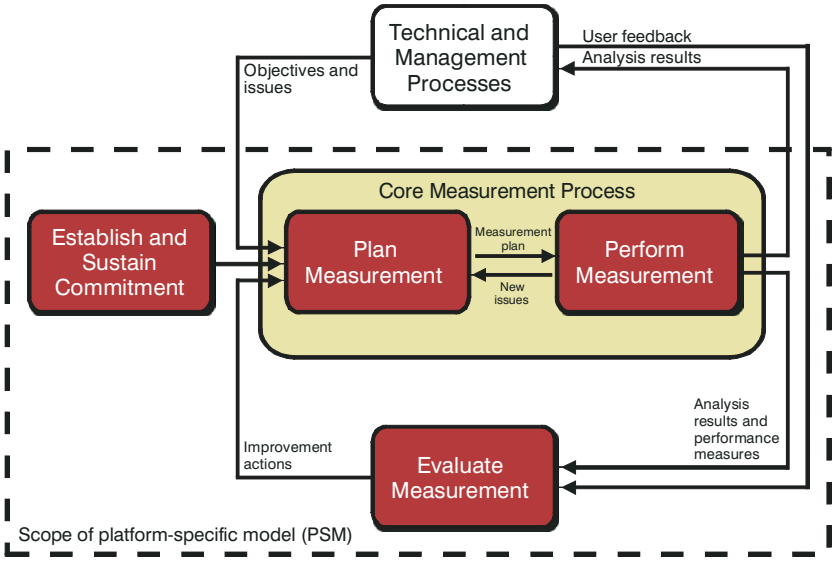

Figure 3 — Four key activities are characteristic of successful measurement programs.

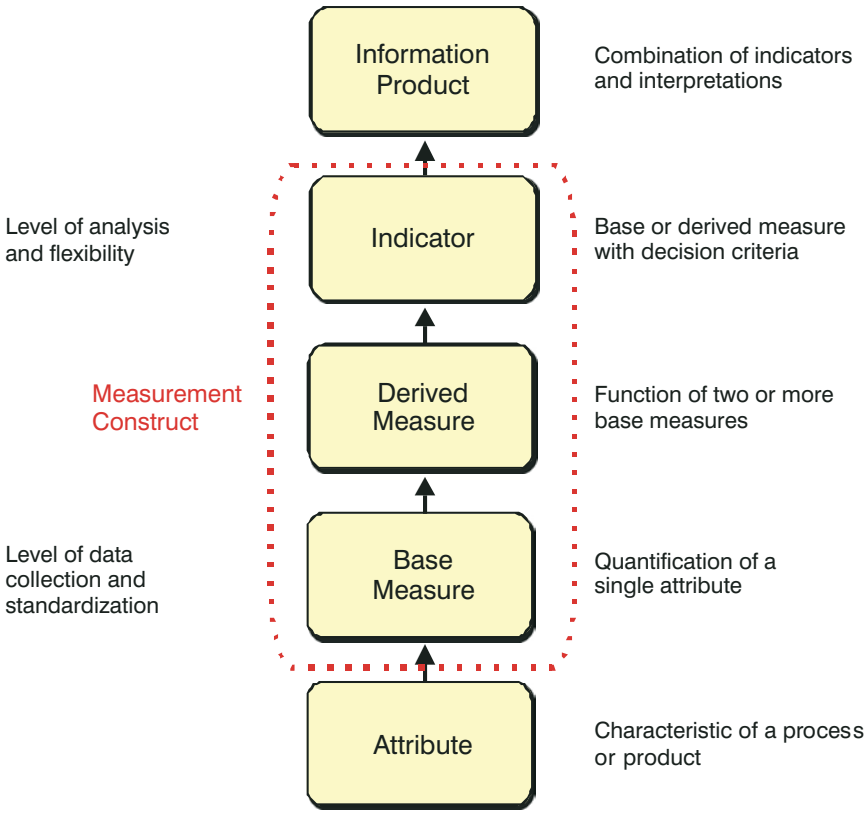

Figure 4 — The PSM Measurement Information Model provides a mechanism for linking information needs to what can be measured.

IMPLEMENTING A MEASUREMENT PROGRAM IN YOUR ORGANIZATION

Implementing measurement programs is a challenging endeavor, especially when organizational and project goals differ or even conflict. But balancing the information needs of both levels is possible if you follow a systematic approach guided by the four PSM activities.

Unless there is a manager or other decisionmaker with an information need, measurement serves no purpose.

The information needs of decisionmakers drive the selection of software measures and associated analysis techniques. These needs are usually derived from a manager's established objectives and issues that hinder the achievement of these objectives. Such issues may include risks, problems, or a lack of information. Unless there is a manager or other decisionmaker with an information need, measurement serves no purpose.

The first task in planning the measurement program is to define the information needs of the organization. Some training is involved in this activity to educate top-level managers and win their support. A one-day workshop with key managers is very useful for identifying and prioritizing their information needs. PSM organizes these information needs into seven classes or categories for planning purposes:

- Schedule and progress
- Resources and cost
- Product size and stability
- Product quality
- Process performance
- Technology effectiveness
- Customer satisfaction

Once you have defined the organizational information needs, you can identify a common set of measures that fulfill many of these needs. These are normally documented in an organizational measurement plan that also describes an organizational measurement repository and the procedures for incorporating project data into that repository. This set of measures will be required from each project in the organization, with appropriate modifications for project specifics. By working toward a common set of organizational measures, you can start your measurement program on a small scale and provide continuity for all project managers in the IT department.

Deciding on which measures to collect involves several practical factors:

- What data already exist and are readily available for analysis?
- What new data would be relatively easy to collect?
- Which measures would contribute immediately to informed decisionmaking?

PSM offers a sample set of measures to guide your choices. PSM measures are based on actual usage and best practices from a wide array of organizations.

The second phase of a measurement program involves the individual projects. Project managers have unique project-level information needs beyond those described by the organization. At the project level, the measurement process should supply the requested organization measures (with appropriate tailoring) along with measures to address project-specific information needs. Having one measurement process simplifies data collection and reduces duplication. Project measures are documented in project measurement plans. Project analysts must collect their own project data while also delivering results for the common organizational measures to the organizational measurement repository for aggregation and analysis.

The key to balancing the information needs of multiple organizational levels is to define organizational measures that are useful at the project level as well as at the organizational level. Organizational measures are generally based on aggregations of project data. For example, if understanding product quality is an information need for an organization, defect data may be required from each project. At the project level, detailed measures of defects written and closed over time may be generated to address information needs such as "Will this product be ready to begin acceptance testing at the planned time?" At the organizational

level, defect data may be aggregated to address information needs such as "On average, how many defects are written during each phase of a project?" or "For a new project, how much effort and time should be planned for rework related to defect resolution?"

PSM'S RELATIONSHIP TO ISO STANDARDS AND CMMI[SM]

PSM served as the base document for the new international standard on measurement, ISO/IEC 15939: *Software Engineering — Software Measurement Process*. This international standard describes the measurement process in terms of the required tasks and outcomes of a compliant measurement process, along with associated activities and tasks. The standard also defines the measurement information model and associated terminology. PSM provides additional details on the activities and tasks presented in ISO/IEC 15939 and lists detailed steps for successfully implementing these tasks. PSM's detailed "how-to" guidance includes sample measures, lessons learned, case studies, and implementation guidelines. Both ISO/IEC15939 and PSM are coordinated to give users a consistent framework for implementing a measurement program.

The international standard ISO/IEC 15939 was used in turn as an input to the Measurement and Analysis (MA) process area of CMMI. The MA process area provides a methodology for assessing whether a project's measurement program is compliant with the international standard, in addition to supplying relevant information on CMMI-based process improvement activities. The creation of a measurement process area, and its placement at Level 2 (the "Managed" level), helps organizations institutionalize their measurement activities.

Any successful measurement process depends on automating as much of the measurement activity as possible.

The coordination of these documents means that the IT community has a consistent information-driven measurement process and terminology.

PSM INSIGHT

Any successful measurement process depends on automating as much of the measurement activity as possible. The PSM initiative has developed PSM Insight to support measurement analysis. PSM Insight is a desktop tool that helps project managers develop and implement an issue-driven measurement process. It is available as a free download from the PSM Web site (www.psmsc.com).

Based on the PSM process, PSM Insight can help project managers define measures, enter or import measurement data, perform analyses, and create high-quality graphic indicators. While PSM Insight contains templates of commonly used issues and measures, it also offers complete flexibility for customizing the analysis to your project-specific needs.

PSM provides a high level of flexibility in data management, data modification, data browsing, and sophisticated graphing capabilities. Most importantly, you can accurately import and normalize existing data from many other formats. You can:

- Define enterprise-wide measures in an organizational template
- Add on project-specific measures for individual projects
- Define calculated data items from measurement data that have already been collected
- Identify missing or potentially corrupt data with PSM Insight's automatic blank values handling
- Display data as either cumulative or noncumulative, regardless of how the data items were originally defined (PSM Insight does the calculations automatically, so that data can be viewed from different perspectives or in summary totals.)
- Generate indicators in multiple formats to isolate and correct potential problems in a timely manner
- Set a "cap" on the data values that are plotted in snapshot graphs, letting you analyze the project from any point in time

- Generate histograms and calculated series
- Create a reliability indicator for software or systems, using PSM Insight data files as input for the SMERFS3[1] reliability software package
- Generate different types of reports for various organizational levels, providing targeted data to meet managers' specific information needs
- Iteratively modify measures and reports as problems are identified and corrected

SUMMARY

Implementing an objective, fact-based measurement process includes defining organization and project information needs and then selecting measures that supply information relative to those needs. The information must be communicated throughout the organization and used regularly in decisionmaking in order for a measurement process to be successful.

[1]SMERFS3 is an interactive computer program that helps predict hardware, software, and total-system reliability. Reliability model results help answer questions such as "How good is my software?" and "How much testing should be done before our software is released?"

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