"An Overview of SPICE’s Model for Process Management"

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Abstract

A suite of standards for software process assessment is being developed by ISO/IEC under the SPICE project. The intent is to harmonize the different efforts around the world to manage the software process. One of the SPICE products is a model for good software engineering and management practices, called the Baseline Practices Guide, which is similar to the SEI’s Capability Maturity ModelSM (CMM) and Northern Telecom/BNR's Trillium. In this paper, we give an overview of the SPICE Project and in particular, the Baseline Practices Guide.

1 Introduction

Based on the work of software process appraisal developers around the world (e.g., CMM [Paulk93a, Paulk93b], Trillium [Trillium], Bootstrap [Kuvaja94], etc.), the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) is currently creating a set of international standards for software process assessment that attempts to harmonize existing approaches [Paulk94a].

One of the objectives of the ISO/IEC effort is to create a way of measuring process capability, while avoiding a specific approach to improvement such as the CMM's maturity levels. The approach selected is to measure the implementation and institutionalization of specific processes. This paper provides an overview of the SPICE Project, the SPICE model, its processes, and its process capability measurement approach.

2 The SPICE Project

Subcommittee 7 of Joint Technical Committee 1 (JTC1/SC7) is the ISO/IEC group responsible for developing standards in software engineering. One of the proposed standards JTC1/SC7 will be progressing is a standard for software process assessment. Initial drafts of that standard are being developed and “trialed” by an independent project under the rubric of SPICE – Software Process Improvement and Capability dEtermination [Paulk94a]. Though SPICE is independent of the ISO/IEC JTC1/SC7 organization, many of the principals in the former belong to the latter, and the original SPICE program of work was approved by JTC1/SC7.

Organizations will be able to use this standard in these ways:
- in capability determination mode, to help a purchasing organization determine the capability of a potential software supplier,
- in process improvement mode, to help a software organization improve its own software development and maintenance processes, and
- in self-assessment mode, to help an organization determine its ability to implement a new software project.

2.1 The SPICE Product Suite

The core set of SPICE products comprising the proposed software process assessment standard are:
- Introductory Guide
- Baseline Practices Guide (BPG)
- Assessment Instrument
- Process Assessment Guide
• Process Improvement Guide
• Process Capability Determination Guide
• Assessor Training and Qualification Guide

The following summarizes the scope of each of these products:

*Introductory Guide*. Entry point into the SPICE product suite. Specifies what is required to claim a SPICE-conformant assessment.

*Baseline Practices Guide*. Identifies practices essential to good software management and engineering and to increasing process capability. (Described in greater detail in section 3.)

*Process Assessment Guide*. Describes steps for performing an assessment and rating the organization against the BPG practices.

*Assessment Instrument*. Describes what type of data to gather in an assessment. Includes exemplar questionnaire consisting of adequacy indicators for BPG practices.

*Assessor Training and Qualification Guide*. Provides criteria for determining whether a candidate is qualified to perform a SPICE assessment.

*Process Improvement Guide*. Guides an organization in applying the other SPICE products for the purpose of improving its software processes.

*Process Capability Determination Guide*. Guides an organization in applying the other SPICE products for the purpose of selecting capable suppliers.

### 2.2 SPICE Project Status

Drafts of all core products of the proposed standard have been developed. A focus for the first half of 1995 is on product consolidation, integration, and completion. The project intends to release the resulting drafts to JTC1/SC7 in mid-1995 for review and further progression.

Concurrent to the above, two years of trials (SPICE product testing) began in early 1995 and will continue through 1996. The objectives of the SPICE trials are as follows:

- Identify shortcomings in the SPICE document set for resolution prior to standardization, particularly regarding coverage, usability, and applicability.
- Seek evidence that results of SPICE-conformant assessments are valid, repeatable, and comparable across organizations.
- Initiate the collection of data regarding the benefits resulting from the use of SPICE.

Through 1995, involvement in the SPICE trials will be limited to existing SPICE project participants. These initial trials will focus on product usability, usefulness, and consistency. Beginning in 1996, trials will be open to the wider software engineering community. These trials will focus more on issues of reliability and validity.

The documents resulting from the JTC1/SC7 reviews and SPICE trials could be ready for balloting as an international standard as early as mid-1997.
3 The Baseline Practices Guide

The Baseline Practices Guide² (BPG) [BPG94] defines, at a high level, the goals and fundamental activities that are essential to good software engineering. The BPG is the SPICE equivalent of the SEI's CMM and Northern Telecom/BNR's Trillium. The BPG describes what activities are required, not how they are to be implemented. The BPG practices may be extended through the generation of application/sector specific Practice Guides to take account of specific industry, sector, or other requirements. The CMM is a possible example of a sector-specific Practice Guide for large, software-intensive projects and organizations. Trillium is a possible example of a sector-specific Practice Guide for software-intensive telecommunications applications.

The BPG categorizes processes into five process categories.

- The **Customer-Supplier** process category consists of processes that directly impact the customer, support development and transition of the software to the customer, and provide for its correct operation and use.

- The **Engineering** process category consists of processes that directly specify, implement, or maintain a system and software product and its user documentation.

- The **Project** process category consists of processes which establish the project, and coordinate and manage its resources to produce a product or provide services which satisfy the customer.

- The **Support** process category consists of processes which enable and support the performance of the other processes on a project.

- The **Organization** process category consists of processes which establish the business goals of the organization and develop process, product, and resource assets which will help the organization achieve its business goals.

3.1 Processes in the BPG

This section lists the 35 processes covered in the BPG, organized into the above 5 process categories:

**Customer-Supplier**
- Acquire Software Product and/or Service
- Establish Contract
- Identify Customer Needs
- Perform Joint Audits and Reviews
- Package, Deliver, and Install the Software
- Support Operation of Software

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² The BPG has recently been renamed “Software Process Assessment Part 2: A model for process management” as part of consolidating the SPICE product suite and aligning their names with ISO conventions. The term BPG is likely to be used informally for some time, however, and is used in this paper.
Each process in the BPG can be described in terms of base practices, which are its unique software engineering or management activities. Process categories, processes, and base practices provide a grouping by type of activity. These processes and activities characterize performance of a process, even if that performance is not systematic. Performance of the base practices may be ad hoc, unpredictable, inconsistent, poorly planned, and/or result in poor quality products, but those work products are at least marginally usable in achieving the purpose of the process. Implementing only the base practices of a process may be of minimal value and represents only the first step in building process capability, but the base practices represent the unique, functional activities of the process when instantiated in a particular environment.

3.1 Capability Levels in the BPG
Evolving process capability is expressed in terms of capability levels, common features, and generic practices in the BPG. A capability level is a set of common features (sets of activities) that work together to provide a major enhancement in the capability to perform a process. Each level provides a major enhancement in capability to that provided by its predecessors in the performance of a process. They constitute a rational way of progressing through the practices, which can be used to harmonize most of the different approaches to rating software processes.

Capability levels provide two benefits: they acknowledge dependencies among the practices of a process, and they help an organization identify which improvements it might perform first, based on a plausible sequence of process implementation. There are six capability levels in the BPG:

**Level 0 Not-Performed**

This level has no common features. There is general failure to perform the base practices in the process. There are no easily identifiable work products or outputs of the process.

**Level 1 Performed-Informally**

Base practices of the process are generally performed. Work products of the process testify to its performance.

**Level 2 Planned-and-Tracks**

Performance of the base practices in the process is planned and tracked. Performance according to specified procedures is verified. Work products conform to specified standards and requirements.

The primary distinction from the previous level is that the performance of the process is planned and managed and progressing towards a well-defined process

**Level 3 Well-Defined**

Base practices are performed according to a well-defined process using approved, tailored versions of standard, documented processes.

The primary distinction from the previous level is that the process is planned and managed using an organization-wide standard process.

**Level 4 Quantitatively-Controlled**

Detailed measures of performance are collected and analyzed. This leads to a quantitative understanding of process capability and an improved ability to predict and manage performance. The quality of work products is quantitatively known.

The primary distinction from the previous level is that the defined process is quantitatively understood and controlled.
Level 5  Continuously-Improving

Quantitative process effectiveness and efficiency goals (targets) for performance are established, based on the business goals of the organization. Continuous process improvement against these goals is enabled by quantitative feedback from performing the defined processes and from piloting innovative ideas and technologies.

The primary distinction from the previous level is that the defined process and the standard process undergo continuous refinement and improvement, based on a quantitative understanding of the impact of changes to these processes.

3.2  Common Features and Generic Practices

A common feature in the BPG is a set of practices (called generic practices) that address the same aspect of process implementation or institutionalization. Common features and generic practices are thus process implementation and institutionalization-focused. The words "common" and "generic" are intended to convey the idea that these features and practices should be applicable to any process, with the goal of enhancing the capability to perform that process. As an example, "planning" is a feature common to improved management of any process.

There is more than one way to group generic practices into common features and group common features into capability levels. The BPG team, which included as members the three authors of this article, was guided by precedents set by approaches such as the SEI’s CMM and Northern Telecom/BNR's Trillium.

The ordering of the common features stems from the observation that some features benefit from (are enabled by) the presence of others. For example, the provision of a well-defined, usable process for an entire organization to tailor and use should follow from some experience in managing the performance of that process at the level of individual projects. An example of this is that prior to institutionalizing a specific estimation process for an entire organization, the organization first attempts to use the estimation process on a project.

Also, some aspects of process implementation and institutionalization should be considered together (not one ordered before the other) since they work together toward enhancing capability. That is why some generic practices are grouped together, and likewise, common features.

The common feature and capability level concepts are useful to consider when performing an assessment or improving an organization's process capability.

In an assessment, the assessment team should determine which capability level to assign to each process. Where an organization has some, but not all common features implemented at a particular capability level for a particular process, the organization usually is operating at the lowest completed capability level for that process. The common features it is lacking inhibits the organization in effective use of the process.

For example, at capability level 2, if the Tracking Performance common feature is lacking, it will be difficult to track project performance. If a common feature is in place, but not all its
preceding ones (i.e.-those at lower capability levels), the organization may not reap the full benefit of having implemented that common feature.

Processes can and probably will exist at different levels of capability. The organization will use the process-specific information obtained through the assessment as a means to focus the improvements of its processes. The priority and sequence of the improvement of the organization's software processes should take into account their business goals. But within a process, the capability levels provides an organization with an improvement road map.

The common features and generic practices characterize good process management that results in an increasing process capability for any process. A planned, well-defined, measured, and continuously improving process is consistently performed as the common features are implemented for a process. This process capability is built on the foundation of the base practices that describe the unique, functional activities of the process. Capability levels, common features, and generic practices in the BPG are summarized in Table 1.

Table 1. Capability Levels, Common Features, and Generic Practices in the BPG.

<table>
<thead>
<tr>
<th>Capability Level</th>
<th>Common Feature</th>
<th>Generic Practice</th>
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<tbody>
<tr>
<td><strong>Level 1</strong></td>
<td><strong>Performed-Informally</strong></td>
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<tr>
<td>Performing Base Practices</td>
<td>-Perform the process</td>
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<tr>
<td><strong>Level 2</strong></td>
<td><strong>Planned-and-Tracker</strong></td>
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<tr>
<td>Planning Performance</td>
<td>-Allocate resources</td>
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<td></td>
<td>-Assign responsibilities</td>
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<td></td>
<td>-Document the process</td>
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<td>-Provide tools</td>
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<td></td>
<td>-Ensure training</td>
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<td></td>
<td>-Plan the process</td>
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<tr>
<td>Disciplined Performance</td>
<td>-Use plans, standards,</td>
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<td></td>
<td>and procedures</td>
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<td></td>
<td>-Do configuration</td>
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<tr>
<td>Verifying Performance</td>
<td>-Verify process compliance</td>
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<td></td>
<td>-Audit work products</td>
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<tr>
<td>Tracking Performance</td>
<td>-Track with measurement</td>
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<tr>
<td></td>
<td>-Take corrective action</td>
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</tbody>
</table>
Level 3    *Well-Defined*
Defining a Standard Process
- Standardize the process
- Tailor the standard process

Performing the Defined Process
- Use a well-defined process
- Perform peer reviews
- Use well-defined data

Level 4    *Quantitatively-Controlled*
Establishing Measurable Quality
Goals
- Establish quality goals

Objectively Managing Performance
- Determine process capability
- Use process capability

Level 5    *Continuously-Improving*
Improving Organizational Capability
- Establish process effectiveness goals
- Continuously improve the standard process

Improving Process Effectiveness
- Perform causal analysis
- Eliminate defect causes
- Continuously improve the defined process

The BPG capability levels and the CMM maturity levels are similar, yet distinctly different. As in Trillium, the BPG capability levels are applied on a per process basis; CMM organizational maturity levels can be defined as a set of profiles for these processes. It is also practical to distinguish between levels 0 and 1: whether a specific process is performed at all.

The BPG architecture does not prescribe any particular organizational improvement path. Improvement priorities are completely left up to the software organization, as determined in the context of its business objectives. Individual processes, at either the organization or project level, can be measured using this “continuous improvement” architecture for rating processes.

4    **Relationship to CMM Version 2.0**

The SEI plans to begin the CMM Version 2.0 revision effort actively in mid-1995. Together with collaborators and reviewers around the world, the SEI is researching proposed changes to the CMM and prototyping some possible solutions. One of the proposed changes being
investigated is whether to re-architect according to the SPICE BPG continuous improvement architecture.

The SPICE BPG architecture is also being piloted by the Systems Engineering CMM Project, which the SEI is involved in. This will provide early feedback on the value of the SPICE BPG approach.

The SEI has made no commitment or decision yet whether to move to the SPICE BPG architecture. There is a fairly large installed base of CMM users and there is a need to balance between maintaining a stable CMM that can act as a good foundation for process improvement and the need to evolve the CMM.

The SEI is planning to harmonize the CMM with a number of standards such as ISO 9001 and SPICE. But harmonization need not require re-architecting the CMM. There are a few papers exploring this issue [Paulk94b, Paulk95].

5 Conclusion

The BPG is still a work in progress. The road to international standardization is an arduous one. SPICE Project schedule was and still is ambitious. The quality of emerging documents, according to current reviewer feedback, seems generally acceptable. Two years of trials and revision (1995-1996) should help resolve some technical questions. The authors enjoy working with their international colleagues and the SPICE Project, sharing ideas, and learning from each other.

We will look to the trials and ISO/IEC reviews to better understand the directions that SPICE and the BPG, and our own work, should take.

6 References


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