Software Mini-Assessments: Process and Practice

Gary Natwick, Geoff Draper, and Lennis Bearden
Harris Corp.

This article describes a software mini-assessment rating and evaluation method that provides projects with a quick and easy way to assess its software process maturity, and provides organizational insight into the success of software process institutionalization efforts.

HARRIS INFORMATION SYSTEMS Division (HISD) achieved the Software Engineering Institute's (SEI) Software Capability Maturity Model (SW-CMM[SM]) [1] Level 3 in 1994 and is pursuing Level 4. As part of the effort to maintain and advance this process maturity, the division's Software Engineering Process Group (SEPG) performs periodic software mini-assessments on key projects to determine the strengths and weaknesses of project and organizational processes. The mini-assessment is used as a baseline against which to assess progress toward division goals such as improving process maturity, adherence to division standard software processes, and institutionalization of technology insertion efforts.

Method Overview

The assessment method is based on a CMM-based progress assessment process proposed by Michael Daskalantonakis of Motorola [2] and SEI CMM-based Appraisal for Internal Process Improvement (CBA IPI) vol.1 [3, 4]. In this method, the key activities of each CMM key process area (KPA) are rated according to scoring guidelines in each of the following dimensions:

- Approach — reflects the organizational commitment and managerial support for the practice, as well as organizational capability to implement the practice.
- Deployment — an indicator of institutionalization, reflecting the breadth and consistency of practice implementation.
- Results — assesses the effectiveness of the practice and its positive results over time.

Table 1 provides a matrix of scoring guidelines to be applied to the KPA activities, to ensure the spirit and themes of the CMM are addressed. Each KPA activity is rated 0-10 in each of the dimensions, with each dimension equally weighted. An odd-numbered score is possible if some, but not all, of the criteria for the next higher level have been met. Scores in each dimension are averaged to generate a summary score for the KPA activity component. The KPA goals (described in the CMM) are also scored, based on the individual scores of each activity that maps to the goal. Evidence of project artifacts (e.g. documentation) is noted to substantiate adoption of the key practice.

Overall scores for each KPA are obtained by averaging the scores for each component goal and activity, indicating how well the KPA practices have been implemented within the organization. In general, a score of seven or above indicates a satisfactory score, and likelihood that the KPA will be judged acceptable in a formal capability assessment or evaluation. Low scores identify improvement needs for key activities and KPAs necessary to raise the organizational process maturity. In addition, the KPA scores for a given CMM maturity level can be reviewed to determine an overall summary CMM rating; all KPAs must be rated with scores of seven or above in order to be assessed at a given maturity level. For example, all six Level 2 KPAs and all seven Level 3 KPAs must be rated at least seven or higher in order to obtain an overall rating of Level 3.

To account for satisfaction of overall CMM KPA goals, via a mapping of key activities to goals, the HISD Engineering Process Group (EPG) enhanced the Motorola method. Satisfaction of every KPA goal is a critical CBA-IPI factor in determining satisfaction of the KPA. A history mechanism has also been added to reflect progress since the last assessment. An Excel spreadsheet has been developed to capture assessment data and automatically generate reports for CMM compliance. In addition, a cross-reference to division processes and CMM-specified evidence has been added to every KPA activity to assure completeness in the understanding and response to each evaluation score.

Application

The progress assessment method is used by the HISD EPG primarily to assess the process maturity of individual programs. Currently, only the software process maturity is assessed; however, this method will later extend to support assessments of other functions, such as hardware and system engineering. HISD has adopted the CMM framework for systems engineering process maturity, and has internally developed a hardware CMM process maturity framework for hardware engineering. HISD sponsors separate process teams for each of these disciplines as owners of their respective engineering processes, with the EPG as the integrating process development, management, and improvement mechanism.

To conduct mini-assessments, the EPG holds a kickoff meeting for the mini-assessment participants, who separately complete their ratings of CMM key activities. The EPG collects and consolidates individual ratings, and facilitates a consensus meeting at which final ratings for each key activity are achieved. We have found these consensus meetings to be one of the most valuable parts of the mini-assessment process, as project members across multiple functional disciplines focus on and discuss their project processes in what tends to be almost a team-building exercise. The SEPG analyzes resulting scores and gener-

The Software Capability Maturity Model (SW-CMM) is a service mark of Carnegie Mellon University.

PEER REVIEWS GOALS

1. Peer review activities are planned.
2. Defects in the software work products are identified and removed.

Score	Key Activity Evaluation Dimensions		
	Approach	**Deployment**	**Results**
None (0)	• No management recognition of need • No organization* commitment • Practice not evident	• No part of the organization* uses the practice • No part of the organization* shows interest	• Ineffective
Poor (2)	• Management has begun to recognize the need • Support items for the practice start to be created • A few parts of the organization* are able to implement the practice	• Fragmented use • Inconsistent use • Deployed in some parts of the organization* • Limited monitoring /verification of use	• Spotty results • Inconsistent results • Some evidence of effectiveness for some parts of the organization*
Weak (4)	• Wide but not complete commitment by management • Road map for practice implementation defined • Several supporting items for the practice in place	• Less fragmented use • Some consistency of use • Deployed in some major parts of the organization • Monitoring/verification of use for several parts of the organization*	• Consistent and positive results for several parts of the organization* • Inconsistent results for other parts of the organization*
Marginal (6)	• Some management commitment; some management becomes proactive • Practice implementation well under way across parts of the organization* • Supporting items in place	• Deployed in some parts of the organization* • Mostly consistent use across many parts of the organization* • Monitoring /verification of use for almost all parts of the organization*	• Positive measurable results in most parts of the organization* • Consistently positive results over time across many parts of the organization*
Qualified (8)	• Total management commitment • Majority of management is proactive • Practice established as an integral part of the process • Supporting items encourage and facilitate the use of the practice	• Deployed in almost all parts of the organization* • Consistent use across almost all parts of the organization* • Monitoring /verification for almost all parts of the organization*	• Positive measurable results in almost all parts of the organization* • Consistently positive results over time across almost all parts of the organization*
Outstanding (10)	• Management provides zealous leadership and commitment • Organizational excellence in the practice recognized even outside the organization*	• Pervasive and consistent deployment across all parts of the organization* • Consistent use across all parts of the organization* • Monitoring /verification for all parts of the organization*	• Requirements exceeded • Consistently world-class results • Counsel sought by others

* Evaluations can be performed for single components, programs, or organizations, as applicable.

Notes:

Each KPA key activity is rated separately in each of the above dimensions.
Odd-numbered scores can be assigned if some but not all of the criteria are satisfied for next higher level.
Dimensions are equally weighted to develop overall score for each key activity.
Key activity scores are rolled up into scores for KPAs and overall CMM Level.

Table 1. *Guidelines to rate CMM Key Activities.*

ates a report for briefing of assessment results back to the project.

The process is intended to minimize impact to the program and its staff, yet provide a meaningful assessment of program process strengths and weaknesses for continuous improvement. No inspection of program evidence is performed; however, mini-assessment worksheets provide for recording pointers to such evidence should it be necessary to collect it for a formal process assessment or evaluation. The EPG provides automated tool support (Excel spreadsheet) to support entry, tabulation, and reporting (graphs) of scoring ratings. Organizations may obtain a soft copy of this spreadsheet by contacting the authors via e-mail.

Process Steps

The general steps necessary to deploy the assessment are described below. The estimated project staff time is two hours for debrief/feedback.

1. SELECT PROJECT TO BE ASSESSED, AND DETERMINE PARTICIPANTS. The EPG schedules at least one mini-assessment every other month, with programs selected on a rotating basis to ensure coverage of different product lines and project types (e.g. new development, operations and maintenance, internal research and development). Mandatory program participants for the software assessment include the project manager, chief software engineer, and software quality assurance, at a minimum. Recommended participants include cognizant software engineering managers, program subsystem leads, program management, systems engineering, and other functional representatives on either a full-time or as-needed basis (e.g. configuration management or subcontract managers for applicable CMM

KPAs).

2. BRIEF PARTICIPANTS. The EPG assessment team convenes an overview meeting to describe the assessment goals and methods.
3. PARTICIPANT PREPARATION. The individual participants review the KPA goals and activities, and prepare their own notes and ratings in advance of the assessment utilizing the SEI CMM KPA worksheets provided by the EPG. Examples of the worksheet for a single KPA are shown in Figure 1. Substantiating evidence or examples of applying the practice should be recorded on the forms, but are not physically collected. Entries in the soft copy spreadsheet can be e-mailed to the facilitator to help streamline the assessment meeting.
4. CONDUCT ASSESSMENT. The assessment team and participants convene a meeting at which all individual rating inputs are discussed and consolidated using a Delphi technique to converge on a consensus score on each of the dimensions (approach, deployment, and results) for each KPA activity. Where consensus can not be reached, the lowest score is used. The assessment team facilitates and guides the discussions, questioning the participants on each activity and its process artifacts. The results are recorded in hard copy for subsequent transcription to soft copy media.
5. CONSOLIDATE RESULTS. The assessment team enters the evaluation scores into a spreadsheet, which consolidates and reports the composite results. A summary chart is generated, an example of which is shown in Figure 2, that depicts the assessed summary rating of each KPA, in addition to the range of scores of the strongest and weakest KPA goals. The KPA goal scores are determined by the scores of the individual key activities mapped to each goal, as described in the CBA IPI Lead Assessor's Guide [4]. The assessment team develops a summary briefing of assessed strengths and weaknesses, and recommendations for areas needing improvement.
6. REVIEW RESULTS. The assessment team and participants reconvene to review the assessment findings, including strengths, weaknesses, and recommendations for improvement.
7. DEVELOP ACTION PLAN. The assessed organization develops an action plan to address weaknesses identified during the assessment. Actions may be assigned to the program or to the division EPG. Action plans for program weaknesses are typically internal to the program, unless division interests are directly jeopardized (e.g. severe weakness that would impact division assessment level).
8. FOLLOW-UP. The organization and/or EPG tracks the actions called for by the action plan and monitors the implementation status.
9. PROCESS IMPROVEMENT. On a regular basis (at least annually), the EPG analyzes the process maturity progress of the organization across all projects and reports the results to senior management. The report focuses on the overall organization, not individual projects.

Benefits

The consolidated mini-assessment scores and findings across the division help identify both opportunities for process improvement, and project strengths that may be beneficial for wider adoption across the division. In the past two years, HISD has performed the mini-assessment method on nine projects. The analysis of these findings (in addition to other sources such as risk assessments, process improvement requests, and customer evaluations) have been key to targeting investments in strategic improvements. Because the mini-assessments are performed on projects selected to provide a cross-section of the division, they provide a good way to assess the institutionalization of defined Level 3 processes, which will be a crucial element in the pursuit of Level 4. As such, the mini-assessment findings are closely scrutinized by the EPG and all levels of engineering management, up to and including division senior management. Action plans are generated and tracked to ensure progress on assessed weaknesses, and toward strategic division business goals. Some of

Figure 1. *Sample mini-assessment worksheet for peer reviews KPA.*

Key Activities		Division References	CMM Specified Evidence	Evaluation Dimensions				Project Artifacts/Notes	Goal Mapping	
Number	Description			Approach	Deployment	Results	Score		1	2
1	Peer reviews are planned, and the plans are documented.	Peer Review Handbook	plans						*	
2	Peer reviews are performed according to documented procedure.	Peer Review Handbook	documented procedure							*
3	Data on the conduct and results of the peer reviews are recorded.	Peer Review Handbook 2.5 Report Results	peer review data							*

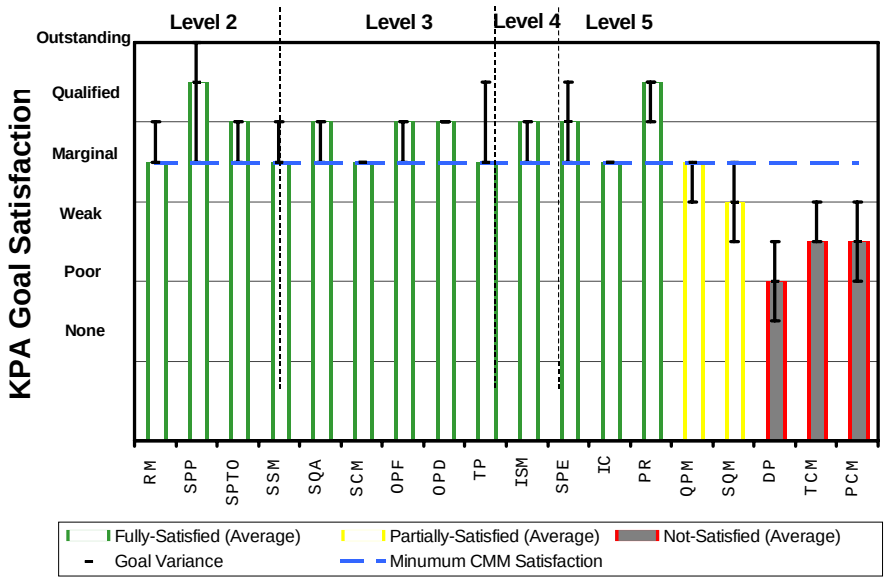

Figure 2. *Example mini-assessment summary analysis.*

the benefits realized include:

1. PROJECT PROCESS REVIEW — The technique forces the project team to spend time reviewing their process from a SEI CMM perspective.
2. PROJECT TEAM BUILDING — By having project leaders across multiple disciplines focused simultaneously on process, many project problems and process integration issues have been surfaced for discussion and resolution.
3. EPG PROJECT AWARENESS — The technique has provided the EPG with in-process feedback on the strengths and weaknesses of division and project processes.
4. PROJECT PROCESS IMPROVEMENTS — The technique has identified project process problems that have been addressed by project process improvement teams.
5. DIVISION PROCESS IMPROVEMENTS — analysis of mini-assessment data from multiple projects has identified organization process weaknesses that the EPG addressed.

In addition, the results from recent formal software capability evaluations (SCEs) show a high correlation with the findings from the mini-assessment method. The mini-assessment method is not a substitute for a formal SCE or CBA-IPI; it complements those methods by providing a quick and easy method for identifying interim process improvements. Due to the success of the tool within HISD, it is being used by several divisions across the Harris Corp. Future enhancements to the process will include:

- expansion of mini-assessments to other functional disciplines and CMM frameworks.
- addition of a method for reassessing projects.
- strengthening the closure plans to ensure all problems raised by the mini-assessment are resolved.

Conclusion

The mini-assessment process practiced by Harris Information Systems Division is a key element of our organizational process improvement strategy. It provides a low-cost but high-yield approach to assessing process maturity and compliance that has proven beneficial to the division and its projects. The authors would be pleased to support requests for additional information on the mini-assessment method, tools, or experience. ◆

About the Authors

Gary Natwick is the metrics leader for the EPG responsible for advancing the Harris Information Systems Division (HISD) to SEI SW-CMM Level 4. Previously, he was the leader of the SEPG advancing the HISD software process maturity to SEI SW-CMM Level 3. He has more than 25 years of software engineering experience (management, development, and process improvement) with Harris Corp. and the Air Force. He earned a bachelor of science degree in electrical engineering from the University of Miami. Natwick is a member of the Institute of Electrical and Electronics Engineers and the Association for Computing Machinery and is an Authorized Lead Assessor in the SEI CBA-IPI method.

Harris Corp.
P.O. Box 37
Melbourne, Fla. 32902
Voice: 407-729-3970
Fax: 407-729-3090
E-mail: gnatwick@harris.com

Geoff Draper is the software focus leader of the EPG responsible for HISD software process definition and improvement. He has more than 15 years experience with Harris Corp. in various software development and leadership positions. Draper earned a bachelor and master of science degrees in computer science from the University of Illinois and Florida Institute of Technology, respectively.

Harris Corp.
P.O. Box 98000
Melbourne, Fla. 32902
Voice: 407-984-5864
Fax: 407-984-6323
E-mail: gdraper@harris.com

Lennis Bearden was the leader of the EPG responsible for all HISD engineering process improvements. He has more than 25 years experience covering all aspects of system development, including hardware, software, system engineering, and program management. His interests are software processes, systems engineering process, and systems architecture. Bearden earned a bachelor and master of science degrees in electrical engineering from the University of Tennessee.

GE Harris Railway Electronics
407 North John Rodes Blvd
Melbourne, Fla. 32934
Voice: 407-757-8702

Fax: 407-242-4118
E-mail: lbearden@ge-harris.com

References

1. Paulk, Mark, et al., "Capability Maturity Model for Software, Version 1.1," Technical report CMU/SEI-93-TR-24, Software Engineering Institute, Pittsburgh, Pa., 1993.
2. Daskalantonakis, M.K., "Achieving Higher SEI Levels," IEEE Software, July 1994, Vol. 11, No. 4, pp. 17-24. Reprinted in *CrossTalk*, September 1994, Vol. 7, No. 9, pp. 12-18.
3. Dunaway, Donna K. and Masters, Steve, *CMM Appraisal for Internal Process Improvement (CBA IPI): Method Description* (CMU/SEI-96-TR-007). Pittsburgh, Pa.: Software Engineering Institute, Carnegie Mellon University, 1996.
4. Dunaway, Donna K. *CMM-Based Appraisal for Internal Process Improvement (CBA IPI) Lead Assessor's Guide* (CMU/SEI-96-HB-003). Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pa., 1996.

"High Leverage Best Practices..." continued from page 5.

project consulting experience. They have all been successfully tested in the crucible of successful large-scale software projects.

The Airlie Software Council identified three major areas of software development the 16 Critical Practices address:

- product integrity
- product construction
- project control

These areas and subsumed practices can be found developed further in this journal in Jane T. Lochner's article on page 6. The practices are useful for controlling complexity inherent in all large-scale software projects — and keeping it from spinning into uncontrollable chaos. Each practice makes a high-leverage contribution and are "high-leverage" practices because of the relatively low cost, quick implementation, and dramatic effect on the bottom line.

Where the Rubber Meets the Road

The critical practices and related implementation both defined in the 16-Point Plan were selected to deliver maximum leverage to programs wanting to dramatically improve their bottom-line and to expedite progress in organizations desirous of moving to the SEI CMM Level 3.

The CMM serves as a meaningful strategic framework for process improvement; the 16 Critical Practices constitute a tactical infrastructure that enables software development organizations to effectively address many of the CMM's Key Process Areas (KPAs).

Although these 16 Critical Practices serve this infrastructural role to CMM KPAs, their fundamental role is independent of this relationship to the CMM — they focus, at their essence, specifically on addressing improvements to the bottom-line — enabling significantly reduced time-to-field and related cost reduction and quality improvements. Although many of the CMM KPAs have similar, if not identical titles as critical process, they are largely two sides of the same coin.

This plan was devised to enable and facilitate an effective and straightforward implementation of critical best practices. Discussions with numerous consultants who assist organizations with CMM improvements make it clear that companies typically take between 18 and 24 months to design an improvement plan for getting from CMM Level 2 to Level 3; and during this time much of the process improvement momentum dissipates and management support wanes. The 16-Point Plan can serve well as a template for reaching Level 3. Since CMM Level 2 has a significant focus on improvement in project management and Level 3 has a key focus on team effectiveness, the critical best practices address both of these key improvement areas.

What You Can Do

1. First determine whether or not your project has a detailed plan of all activities needed to achieve the next milestones, together with or including the personnel resources and time allocations necessary for this completion.

   Although obvious, many programs lack this detailed planning. Without it, tracking by earned value will be meaningless, schedule compression cannot be completed, critical path and near-critical path cannot be identified through statistical schedule verification, tools cannot be employed, risk identification capabilities will be diminished, and you will not be able to use schedule automated control and authorization tools. If such a detailed plan does not exist, have one made.

2. Ensure that the effective structured peer reviews trend of a Fagan-like variety are being conducted to all detailed task products; that such reviews constitute task completion criteria for earned value and configuration management purposes; and that architectures are being modeled and simulated.
3. Ensure that a "bottom-up" risk management process is in place — one that has risk identification facilitated among front-line developers with management involvement; risk mitigation planning for high impact, high probability risks that a risk officer can manage and focus the process; and a culture that rewards risk identification — not punishes it. Be sure the likelihood of key development personnel suddenly leaving the project is considered as a major risk. If the project is planning a heavy reliance on reuse, then ensure that this is noted as a major risk as well.
4. Consider the 16 Best Practices and prioritize them in accordance with the needs of your particular program.

More About Best Practices

SPMN has also developed a template plan for large-scale defense projects: the 16-Point Plan for Performance Based

"High Leverage Best Practices..." continued on page 27.